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1903.

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ERRATA.

Page 46, line 4 from bottom, *for* *ÆNEOFASCIATA* *read* *CHALYBEOFASCIATA*.
Plate XXXIV. *for* *HALGERDA WASSINENSIS* *read* *HALGERDA WASINENSIS*.

PROCEEDINGS
OF THE
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.

1903, Vol. II. (May to December).

May 12, 1903.

Dr. HENRY WOODWARD, F.R.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie in April 1903:—

The registered additions to the Society's Menagerie during the month of April were 200 in number. Of these 86 were acquired by presentation and 2 by purchase, 14 were born in the Gardens, 97 were received on deposit and 1 in exchange. The total number of departures during the same period, by death and removals, was 94.

Among the additions special attention may be called to the following:—

A Bactrian Camel (*Camelus bactrianus*), born in the Menagerie April 1st.

A Blesbok (*Damaliscus albifrons*), received in exchange April 8th.

Two Green Geckos (*Phelsuma madagascariense*), deposited by the Hon. Walter Rothschild, M.P., F.Z.S., April 11th.

A large collection of South African animals presented by Col. A. T. Sloggett, C.M.G., April 25th.

Mr. W. B. Tegetmeier, F.Z.S., exhibited a skin and some illustrations of, and made remarks on, a species of Pheasant from Mongolia, which had recently been described under the name of *Phasianus hagenbecki*. He suggested that it would make a handsome addition to our coverts. A full account of Hagenbeck's Pheasant will be found in 'The Field,' vol. ci. p. 775 (1903).

Mr. Frank Finn, F.Z.S., exhibited drawings, half life-size, of the frontlet of a specimen of the Kakur or Barking-Deer (*Cervulus*

Text-fig. 1.



Abnormal antlers of *Cervulus muntjac*.

muntjac) showing a curious abnormality of the antlers (see text-fig. 1). The specimen had been lent to him by an officer in the Indian Medical Service, who had shot the deer in the valley of the

Rydak River, north-east of the Buxa Cantonment, at an elevation of 5000 feet. He made the following remarks upon the exhibit and on other variations in Deer :—

“The specimen is remarkable as exhibiting a pair of antlers, springing from the bony pedicels on their outer sides, somewhat below the ordinary antlers, which are normal in form. Although not alike on the two sides, these little supernumerary antlers have not, except for this, an unnatural appearance; and as the local shikaries had informed my friend that in a part of Bhutan such a variation was not uncommon, it may be that we may ultimately see a four-horned race of the Barking-Deer.

“While on the subject of variation in Deer, I may perhaps be permitted to mention two curious colour-abnormalities in these animals, which have come under my notice in India. In the above-mentioned Kakur I have seen two melanic specimens, both living females, one of which, to my knowledge, came from the Himalayas, and, I believe, the other also. Both were of a peculiar iron-black colour, *i. e.* black of a greyish shade, like that of cast-iron; this grey shade pertaining to the individual hairs, for there was no admixture of white ones. Also, in the Sambhar (*Cervus unicolor*) I have seen two remarkable varieties in quite young specimens. One of these was a very rufous specimen, as red as a Barking-Deer; while the other, which I saw the day after its birth, was spotted with white along the sides of the back, like the adult Barasingha (*Cervus duvauceli*) in its summer coat. Young Sambhar are commonly said to be more rufous than adults, though I have not noticed this in those I have seen; and Mr. W. Rutledge, in whose possession I saw the above rufous specimen, in spite of his long experience as a dealer, was so surprised at this one that he was doubtful of the species. As to the spotted fawn, there is no doubt of its rarity as a variation; I have never seen or heard of a similar specimen, the usual uniformity of the young pelage being a remarkable specific character of the Sambhar.”

Mr. Frank Finn also exhibited a living specimen of the Goldfinch (*Carduelis carduelis*) showing a rare variation, and a skin of the Ruff (*Pavoncella pugnax*) showing albinism, and made the following remarks upon them :—

“The living Goldfinch now exhibited is a male of the large Eastern race sold as ‘Siberian Goldfinches’ by bird-dealers, and is remarkable in that it shows an extremely rare variation in colour. Behind the black band on the head there is on each side a small patch of glossy red feathers, similar to those of the face. I have never before seen such a variation either in this species or in the Himalayan Goldfinch, and the dealer from whom I procured it, Mr. A. Zache, of Great Portland Street, told me he had only seen one other, also a male. Mr. H. Blake-Knox, however, in a valuable paper on ‘Abnormal Plumages in the Goldfinch’ (Zoologist,

2nd series, 1870, pp. 2049-2052), has given several instances of the abnormal extension of red in this species, some forms of which appear to be fairly common.

"Some attention has been directed of late to a variety of the Ruff which has the head and neck white or nearly so, even in winter plumage when the ornamental plumes are absent. The specimen exhibited died recently in the Zoological Society's Gardens, having made, at any rate this year, little progress in putting out a ruff. Specimens of the variety kept in the Calcutta Zoological Garden, however, have produced the nuptial plumage, which was as white as the same parts had been in winter. There were two of these birds, which differed in their back-feathering as much as other Ruffs, one being rufous-mottled, while the other was grizzled. The variation is evidently albinistic, as it may, though very rarely, affect the Reeve as well as the Ruff. There is such a specimen in the Indian Museum, procured half-a-century ago by Blyth. I myself have obtained several specimens of the form in the Calcutta Bazaar, which, without exception, were adults, as shown by the colour of their feet; so that the variation in question would seem to supervene late in the life of the individual possessing it. The white-headed birds kept alive did not seem at all deficient in vigour, and no doubt under especially favourable circumstances this very beautiful variety might become quite common. It has, however, the obvious disadvantage of being very conspicuous, which may, perhaps, account for its restriction to adult individuals."

Mr. F. E. Beddard, F.R.S., exhibited and made remarks upon some preserved and injected brains of Mammalia which had been prepared from specimens formerly living in the Society's Gardens.

The following papers were read:—

1. A Contribution to the Study of Double Monstrosities in Fishes. By JAMES F. GEMMILL, M.A., M.D., Lecturer in Embryology, Glasgow University*.

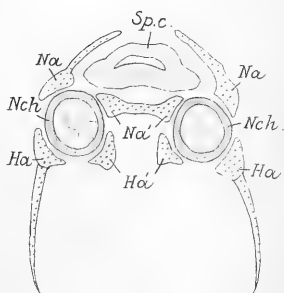
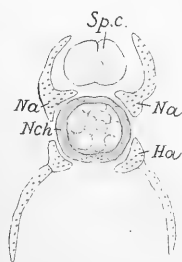
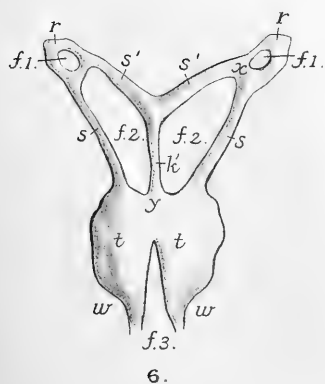
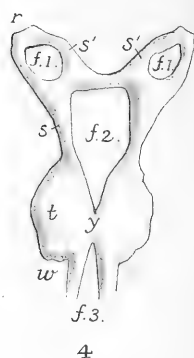
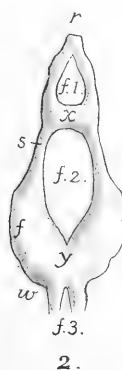
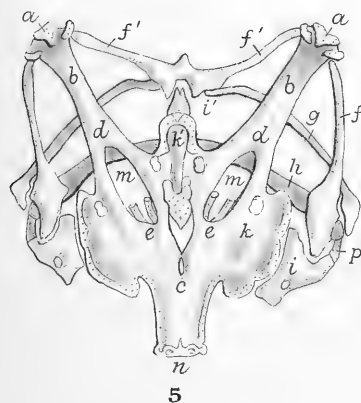
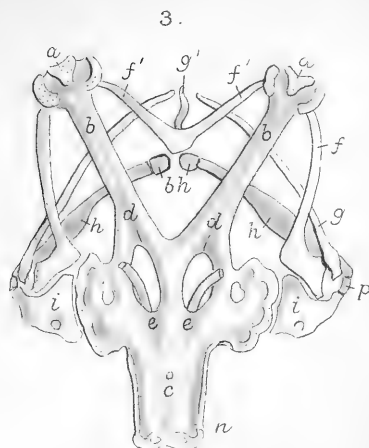
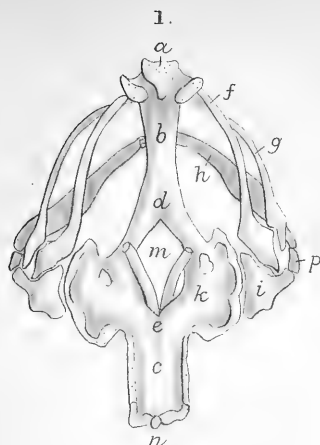
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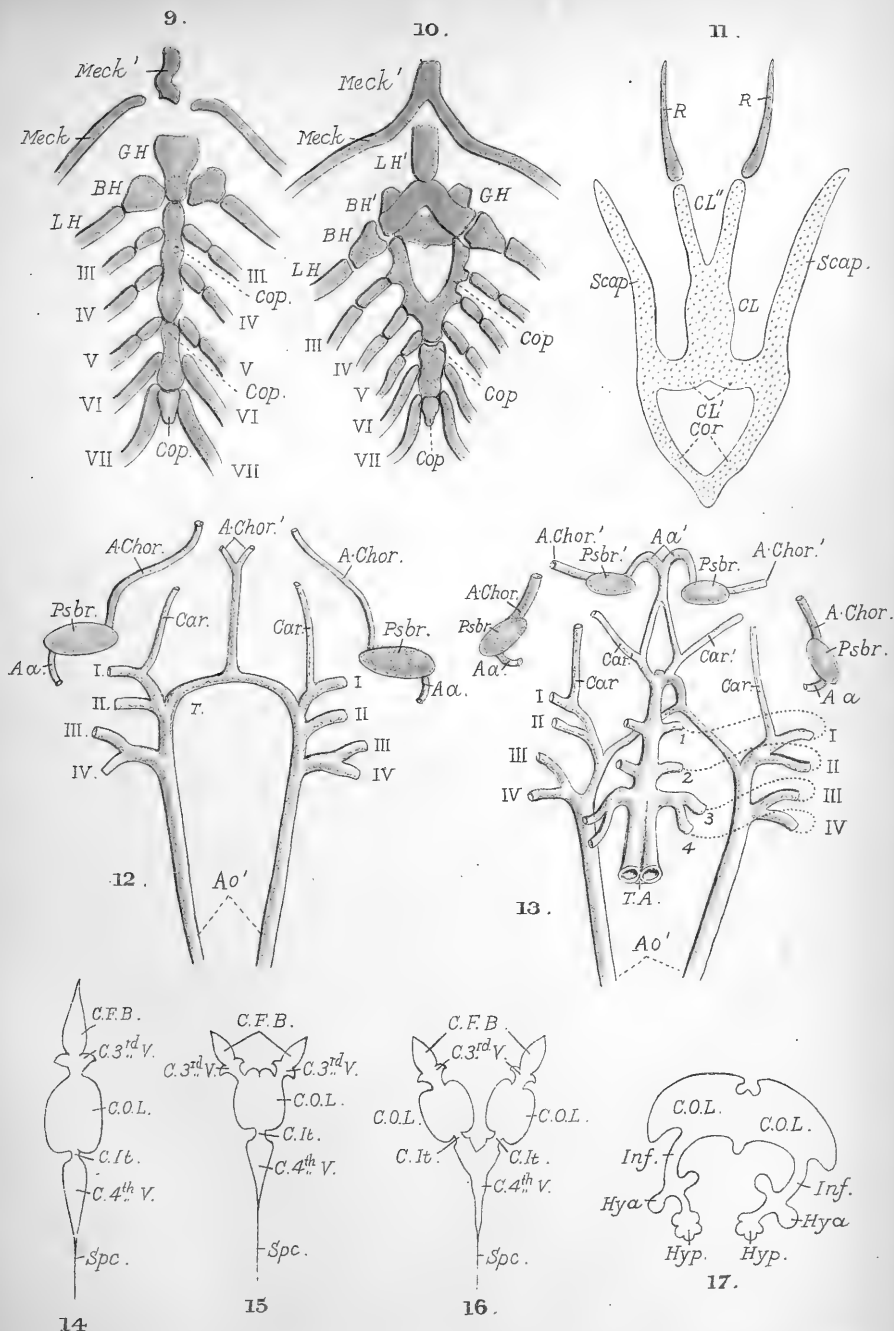
(Plates I.-IV. †)

This paper contains an account of the anatomy of a set of double monster Trout embryos, studied from serial sections and illustrated by reconstruction drawings. For purposes of comparison, a similar but shorter account of the anatomy of normal

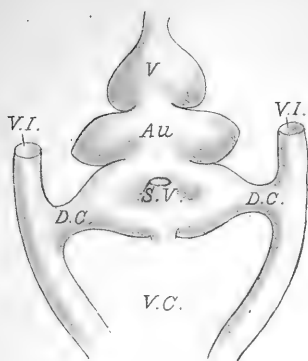
* Communicated by F. G. PARSONS, F.Z.S.

† For explanation of the Plates, see p. 21.

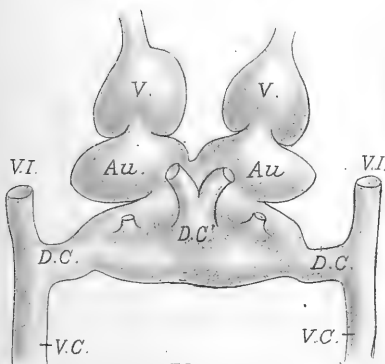
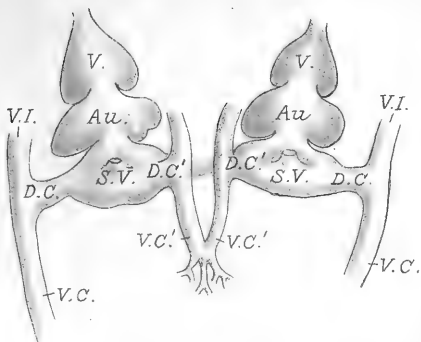




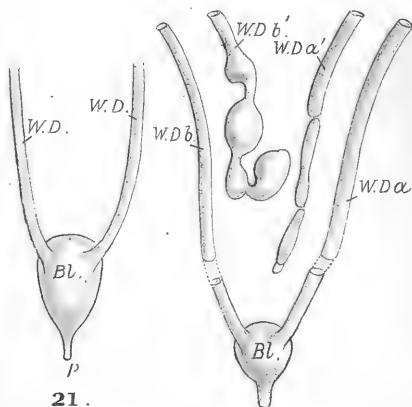
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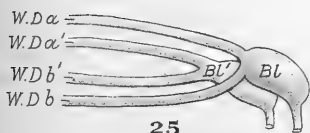


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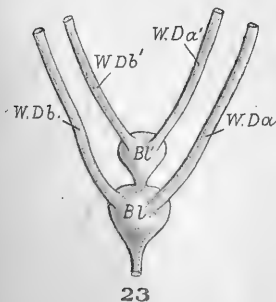


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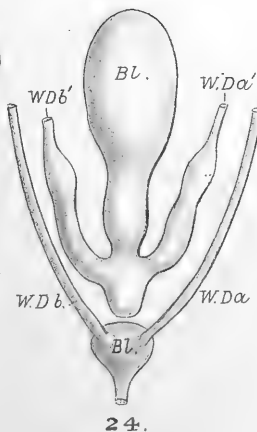
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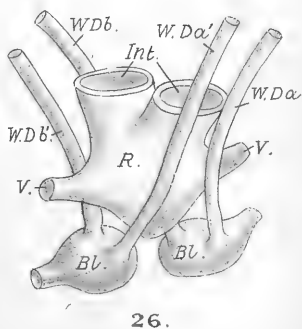
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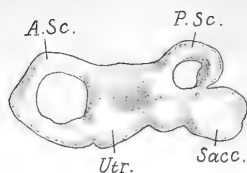


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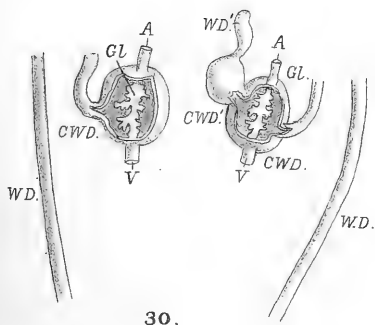
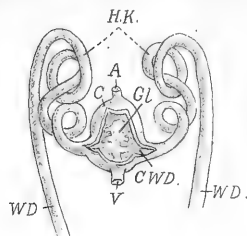


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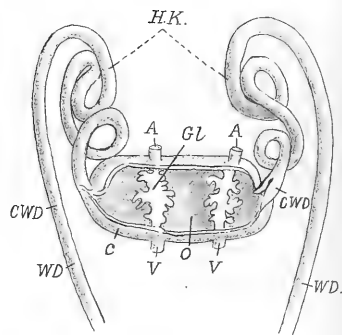
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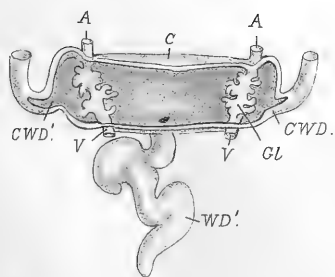
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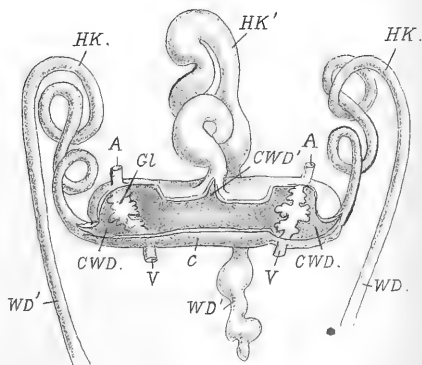
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29.



32.



31.

Trout embryos at a corresponding age—three weeks after hatching—is also given.

The frequency of occurrence, the causation, the general appearances, and the classification of double monstrosities in fishes have been the subject of many papers and notices, lists of which are given by Prof. B. C. A. Windle in the 'Proceedings' of the Zoological Society of London, 1895, p. 423, and by Dr. Franz Schmitt in the 'Archiv für Entwicklungsmechanik der Organismen,' Bd. xiii. p. 34. The classification adopted here is on the same lines as that of Windle (*l. c.*), and has special reference to the material at my disposal. All my specimens were examples either (*a*) of union by the yolk-sac, or (*b*) of anterior duplicity. The former require only to be mentioned here, as each of the twin bodies contains a complete and separate complement of organs, while the latter may be conveniently divided into—

Class I. Union in head-region :

- (*a*) the twin brains united at the optic lobes ;
- (*b*) the twin brains united at the medulla oblongata.

Class II. Union in pectoral region :

- (*a*) the adjacent pectoral fins not represented ;
- (*b*) the adjacent pectoral fins present, but united and reduced in size.

Class III. Union at posterior part of body :

- (*a*) the two alimentary canals united a considerable distance in front of the vent ;
- (*b*) the two alimentary canals united close to the vent.

ANATOMY OF NORMAL TROUT EMBRYOS.

In normal Trout embryos of the same age as the monstrosities, ossification has not yet begun. The parachordal cartilages are uniting round the anterior end of the notochord and have already joined with the trabeculae cranii, which, coalescing in front of the pituitary space, run forwards as a median flattened bar to meet the nasal cartilages. The pituitary space gives passage to the choroidal and internal carotid arteries and to the back part of the musculus rectus oculi externus (Pl. I. fig. 1). On either side, the parachordals have grown upwards in the form of laminar plates, which meet in the mid-dorsal line over the upper part of the medulla, but leave a narrow V-shaped fontanelle over the lower part (Pl. I. fig. 2, *f* 3). The auditory capsules are firm bosses of cartilage, moulded on the labyrinth, closed externally, but widely open towards the brain. Dorsally, they are connected with each other by a thin vault of cartilage roofing the cerebellum ; anteriorly, they are continuous with the supraorbital bars to be afterwards described ; ventrally, they join the trabecular and parachordal cartilages ; and externally they articulate with the hyomandi-

bulars (Pl. I. fig. 1). The fifth nerves emerge through deep grooves between the trabeculae and the auditory capsules, while the vagus and glosso-pharyngeal nerves pass out together through a foramen in the cartilage connecting the auditory capsules with the parachordals. A single opening in the floor of the capsules on either side gives passage to the internal jugular vein and the facial nerve. The nasal cartilage is connected with three pairs of bars: (1) the trabeculae cranii, (2) the palatoquadrates, and (3) the supraorbitals. These last pass backwards along the dorso-lateral angles of the brain to join the anterior part of the auditory capsules on either side. Over the pineal body and the third ventricle the supraorbitals are connected together by a bridge of cartilage, but no such *tegmen* exists over the cerebral or optic lobes, the spaces left uncovered being the anterior and the middle fontanelles (Pl. I. fig. 2, *f* 1, *f* 2). The hyomandibulars are connected with (1) the outer aspect of the auditory capsules, (2) the posterior ends of the palatoquadrates, and (3) the interhyals. The Meckelian bars are slender, and meet below the mouth in a symphysis. Posteriorly they articulate with the palatoquadrates, but not with the hyomandibular or interhyal cartilages. In the hyoid arches, glossohyals, hypohyals, ceratohyals, and interhyals can be distinguished. The branchial cartilages are five in number, and have the usual forms and relations. The pectoral girdle is represented by a comparatively short bar of cartilage on either side—the coraco-scapular—and is far from being a complete arch ventrally. The limb-cartilage is an unsegmented plate continuous with the coraco-scapular bar. The notochord consists of pith-like tissue surrounded by a very firm capsule, and its anterior end is embedded in the fused parachordal cartilages. In the position of each future vertebra there are four cartilaginous nodules, placed respectively at the dorso-lateral and ventro-lateral corners of the notochord, and prolonged into processes for the neural and hæmal arches (Pl. I. fig. 7).

The anatomy of the central nervous system and of the organs of special sense, and of the heart and blood-vessels, is, with certain differences in the relative size of parts, practically the same as in the adult condition. As regards the aortic roots, it may be stated that the first root, *i. e.* the first branchial vein, gives off the hyoid and carotid arteries and then passes backwards to join the second root. The resulting trunk bends inwards to the middle line, and, meeting with its fellow from the opposite side, forms the upper part of the aorta. This part is next joined on either side by a trunk formed by union of the third and fourth roots. The carotids pass forward beneath the parachordals and, traversing the pituitary space from below, reach the base of the brain. The hyoid artery arises from the first aortic root at its ventral end, perforates the hypohyal, runs up along the hyoid bar, and, after passing through a foramen in the hyomandibular, is continued mainly into the pseudobranch. The efferent vessel of the pseudobranch passes forwards and inwards, traverses the pituitary space

from below, and, after running alongside the optic nerve, ends in the choroidal gland of the eye. Of the two cardinal veins, the left is usually the larger.

The head-kidney, or pronephros, contains a single median glomerulus of considerable size, inside the cavity of which is a large vascular tuft supplied by a branch directly from the aorta. The Wolffian ducts, on either side, begin by a funnel-shaped opening in the glomerulus cavity. Then, bending forwards, they become convoluted, and are embedded in highly vascular lymphoid tissue. They then arch backwards, remaining convoluted for a short distance, and end in the urinary bladder (Pl. III. fig. 21 & Pl. IV. fig. 28). The mesonephros is just beginning to develop in connection with their middle and posterior parts. The urinary bladder opens by a mesial pore situated just behind the vent.

The intestinal canal is completely shut off from the yolk-mass, and there is an open diverticulum for the air-bladder.

ANATOMY OF DOUBLE MONSTROSITIES.

I. *Union in Head-region.*

The anatomy of specimens belonging to this group is very complex, as the region of transition from the double to the single condition involves the brain, the cranial nerves, and the organs of special sense, as well as the cranial, mandibular, and branchial cartilages. The twin heads are placed symmetrically, side by side, and lie in the same horizontal plane. As regards the brain, union had occurred, in my specimens, either (*a*) in the optic-lobe region, or (*b*) at the medulla oblongata. These two groups require to be described separately, as the details of their anatomy differ in many important respects. I shall begin with a typical example of (*a*).

There are two notochords in front, and therefore, potentially at least, two pairs of parachordal cartilages, but the four cartilages have united to form a single basilar plate (Pl. I. fig. 3, *c*). In front, the two nasal cartilages are placed widely apart; each contains a right and left olfactory pit, and is continuous behind with a pair of (now united) trabeculae cranii. The two pairs of trabeculae converge as they pass backwards; their inner or adjacent elements unite to form a median flattened bar, which joins the basilar plate formed by the parachordals. At the same time, the outer elements of each pair of trabeculae have diverged from the inner elements to enclose a pair of pituitary spaces, the latter lying one on each side of the median bar formed by union of the inner trabecular elements. There are only two auditory organs, and their cartilages are continuous with the outer trabecular and parachordal elements in the floor of the skull. Dorsally, the auditory capsules are connected over the cerebellum by a vault of cartilage, which is narrower antero-posteriorly than in the normal condition. Over the medulla the laminae of the parachordals nowhere form a complete vault. Accordingly the

posterior fontanelle is much larger than in a normal case (Pl. I. fig. 4, *f* 3). Each nasal cartilage is connected with a pair of palato-quadrate bars, the inner or adjacent elements of which converge, fuse, and end abruptly without being attached to a suspensorium; the outer bars are continued backwards on either side, and articulate with the hyomandibulars attached to the auditory capsules. Articulating with the united part of the inner palato-quadrate bars is a small twisted piece of cartilage, which passes downwards in the septum between the two mouth-openings, and represents an inner or adjacent pair of Meckelian cartilages. Dorsally, each nasal capsule is continuous with a pair of supraorbital bars, of which the outer elements pass backwards on either side to join the auditory capsules, while the inner or adjacent elements are connected with each other and with the outer bars over the pineal body. Behind this the adjacent bars disappear, the result being that over the region of the cerebral lobes there are two small anterior fontanelles, while over the optic lobes there is a single large middle fontanelle (Pl. I. fig. 4). The hyoid bars and the branchial cartilages are normal, except that they diverge rather more widely than is usual. Each arch, however, may be looked upon as being composite, *i. e.* as consisting of the outer elements of a double set of arches. The suspensoria on either side of the two periotic capsules are normal.

As mentioned above, the notochord is double in front, two notochords being present as far back as the fourteenth body-segment. These converge together at an acute angle and finally unite. The condition of the neural and hæmal arch cartilages is illustrated in Pl. I. fig. 8. Where the two notochords are some little distance apart, the inner or adjacent neural arches are displaced so as to form a floor for the transversely-expanded spinal cord, while the inner hæmal arches remain as small nodules of cartilage. As the notochords come closer together the inner neural and hæmal arches alike disappear, while the outer arches assume a normal form and position.

The brain and its cavities show a degree of duplicity which is indicated diagrammatically in Pl. II. fig. 15. There are two pairs of cerebral lobes and two thalamencephala, diverging forwards from a single composite optic lobe region. The cerebral lobes and thalamencephala, besides diverging, are rotated slightly in such a way that they lie closer together dorsally than ventrally. There are two pairs of olfactory nerves, two pairs of optic nerves, and two sets of pineal diverticula. There are also two infundibula, which converge as they pass downwards and backwards. Each ends in a hypophysis sac after giving off the usual diverticula for the hypoaria (Pl. II. fig. 17). The inner hypoarium on either side, owing to want of space, is smaller than normal, and lies above and in front of the outer hypoarium. The optic lobes show a remarkable transition between the double and the single condition. Their cavity and roof-parts are single, while the basal structures are doubled. There are thus two pairs of 3rd nerves.

There is one pair of trigeminal nerves representing the right and left 5th nerves of the right and left twin heads. The succeeding cranial nerves are also normal, *i. e.* there is only a single pair of each. A rudiment of inner or adjacent pairs of trigeminal ganglia may be recognised in the form of a thin elongated band of tissue containing small nerve-cells and lying in the middle line underneath the region of the pons. This band of tissue has no central or peripheral nerve-fibres. The pons and cerebellum are single, but their internal structure shows traces of duplicity, especially in the case of the pons. The medulla oblongata is slightly expanded transversely, but otherwise is normal.

In the anterior part of the spinal cord there is a curious and interesting reappearance of duplicity, coextensive with the duplicity of the notochords, and with the presence, ventral to them, of a median composite muscular mass representing united adjacent lateral muscles. In this region, the spinal cord is greatly expanded in a transverse direction, its cavity is spindle-shaped, and, in addition to the usual nerve-roots, it gives off, on the ventral aspect in each segment, a pair of small additional motor roots which are distributed to the median muscular mass just mentioned.

There are two pairs of olfactory organs and nerves. The outer eyes (right eye of right twin head and left of left head) are normal, but lie further back than usual, so that their optic nerves pass backwards as well as outwards from optic commissure to eyeball. The inner or adjacent eyes may or may not be fused with one another. In the former case, there is usually a single lens, which is sometimes larger and sometimes smaller than in the normal case; the sclerotic and choroid coats are single; the retinae never unite, each showing its own choroidal fissure, optic nerve, and choroidal gland. In all cases the external rectus muscles are absent; the superior obliques are absent or rudimentary, but the remaining ocular muscles are present in two sets.

The heart and the ventral aorta are normal, but the dorsal aorta and its roots, and the choroidal and carotid arteries, require description. The union of the main collecting-trunks on either side to form the dorsal aorta is carried backwards for a very considerable distance, and takes place only at the level of union of the notochords. The pseudobranch on either side receives a branch from the hyoid artery, and its efferent vessel passes to the choroidal gland of the corresponding (*i. e.* outer) eye. The choroidal glands of the inner or adjacent eyes are supplied by blood which has not passed through the pseudobranch. In the specimen from which Pl. I. figs. 3, 4, & 8 were taken, the arrangement of vessels is quite symmetrical and is indicated in Pl. II. fig. 12. A transverse arch vessel connects the upper aortic roots, and gives off a common choroidal artery which soon bifurcates. The two resulting vessels pass through the separate pituitary spaces, and are distributed to the choroidal glands of the adjacent eyes.

As is well known through the work mainly of Johannes Müller ('Vergleichende Anatomie der Myxinoiden'), the pseudobranch and the choroidal gland are so related to one another in osseous fishes that a pseudobranch is never present in species which have no choroidal gland, while in rare instances only is a choroidal gland present where there is no pseudobranch. It is therefore of considerable interest to note that the choroidal glands of the inner or adjacent eyes, in the type of monstrosity under consideration, derive their blood-supply directly from the first aortic root. There is a certain amount of variation in the exact mode of origin of the choroidal and carotid arteries. For instance, cases occurred in which these vessels all arose from the first aortic root on one side only, instead of both roots participating equally as in the specimen figured (Pl. II. fig. 12).

As regards the alimentary canal, there are two mouths, but the pharynx and the rest of the canal are single, the only evidence of duplicity being the presence of two air-bladder diverticula.

The mesonephros, ureters, bladder, and urinary pore are normal, but the pronephric glomerulus is composite, or may be double. An example of the composite condition is figured in Pl. IV. fig. 29. The glomerulus is larger than in the normal case, and contains two vascular tufts between which is a median compartment that obviously corresponds to the fused adjacent halves of a pair of glomeruli, but has no Wolffian ducts in connection with it. In the specimen from which figure 30 (Pl. IV.) was taken the two glomeruli are separate, but one of them has only a rudimentary Wolffian duct arising from its inner side, while the other has none at all. Fig. 29 (Pl. IV.) should be compared with figs. 31 and 32 on the same Plate, which show a still greater degree of duplicity in the pronephros.

Of composite muscles, the most important are contained in the median mass mentioned on page 9 as underlying the twin notochords, and innervated by the small extra motor roots of the composite spinal cord. This muscular mass is segmented serially by septa which correspond exactly with the septa of the outer (normal) lateral muscles. In the head-region some small and intricately arranged muscles are found connected with the cartilages which represent the reduced adjacent Meckelian and palato-quadrate bars. These muscles are obviously rudiments of adjacent mandibular and temporal muscles. It has been noted previously that there are no external rectus muscles in connection with the adjacent eyes, and that the superior obliques are either rudimentary or entirely absent.

A typical specimen of the second subgroup of Class I. will next be described, *i. e.* a specimen which shows *the twin brains uniting at the medulla oblongata*.

The structure of the cranial skeleton in this type agrees with that of the monstrosity last described, except that the place of union of the skeletal elements is carried further back. This gives

room for greater development on the part of the inner or adjacent elements in the twin heads (Pl. I. fig. 5). The two converging pairs of trabeculae are separate along their whole length, and each unites posteriorly with corresponding parachordals. The two pairs of parachordals are separate in front, but posteriorly the adjacent elements in each pair unite, so that a single composite basilar plate of cartilage containing two notochords underlies the lower half of the medulla oblongata. The inner or adjacent palato-quadrates converge posteriorly and coalesce. The united part articulates (1) below, with a small bifid cartilage representing fused adjacent Meckelian bars; and (2) higher up, with a small cartilage representing fused adjacent hyomandibulars. The inner or adjacent supraorbital bars converge posteriorly, unite with one another, and end by becoming continuous with the roof of a small box of cartilage which is wedged into the apex of the angle between the twin heads and represents fused adjacent periotic capsules. This structure will be described later on, but it may be mentioned here that its roof is continuous posteriorly with a vault of cartilage which connects the two outer (normal) periotic capsules over the cerebella. In this way double sets of anterior and middle fontanelles are left over the cerebral lobes and mid-brains respectively of the twin heads (Pl. I. fig. 6).

The inner or adjacent hyomandibulars are extremely rudimentary, and are fused together to form a small bifid piece which articulates (1) anteriorly, with the fused adjacent palato-quadrates, (2) posteriorly, with the fused adjacent periotic capsules, and (3) inferiorly, with a rudiment of the fused adjacent hyoid bars. The small artery for the supply of the inner or adjacent pseudobranchs passes up through the notch at the anterior end of this cartilage. The inner or adjacent auditory capsules are extremely rudimentary, being completely united, compressed from side to side, and wedged into the position above indicated. They contain a single distorted labyrinth, and are entered by small auditory nerves on either side, which are distributed symmetrically over the labyrinth. This composite auditory capsule is connected anteriorly with the fused adjacent supraorbital bars, and ventrally with the adjacent trabecular and parachordal cartilages on the inner sides of the two pituitary spaces. Behind it a small triangular opening is left, bounded on either side by the converging parachordals. These unite posteriorly, but leave a narrow foramen between them for the exit of a small nerve, which represents a reduced adjacent pair of vagus and glosso-pharyngeal nerves (Pl. I. fig. 5). It will be seen from what precedes that there are five fontanelles, one over each pair of cerebral lobes, one over each mid-brain, and one over the composite medulla oblongata (Pl. I. fig. 6).

There are two mouth-openings placed side by side, one under each head, and separated from one another by a thick dorso-ventral septum. This septum contains (1) remains of the adjacent mandibular and hyoid cartilages, (2) much confused muscular

tissue, and (3) two arteries which will be afterwards described, one being a continuation of the ventral aorta, and the other a small artery for the supply of the inner or adjacent pseudobranchs. The two mouth-openings lead into separate buccal cavities, but the œsophagus is single, the septum above mentioned ending opposite the second branchial cartilage.

The mandibular apparatus may be described as consisting of a composite arcade underlying the two mouth-openings. The outer portions of this arcade are formed by normal (outer) Meckelian bars (*i. e.* right bar of right twin head and left bar of left head), while a small mesial portion of the arch is formed by rudimentary adjacent Meckelian bars (Pl. II. fig. 10, *Meck'*). These latter bars are united at their proximal ends, and there articulate with the fused adjacent palato-quadrates. Distally, each of the inner bars unites in a symphysis with its corresponding outer Meckelian bar. As the inner bars are exceedingly reduced in size, the two symphyses lie close together in the tissue of the septum separating the two mouth-openings. The hyoid apparatus may also be described as forming a composite arcade, the main part of which consists of the outer arches of the twin heads, while in the middle are interposed the fused remains of the inner arches (fig. 10). These remains consist of (1) a single twisted piece of cartilage articulating, without the intervention of an interhyal, with the fused adjacent hyomandibulars, and representing ceratohyals; and (2) two incompletely separated hypohyals, articulating below with two glossohyals which are also incompletely separated. Connected with the outer sides of these glossohyals are the hypohyal pieces of the outer arches (Pl. II. fig. 10, *BH*). No adjacent elements are interposed in the series of branchial cartilages. The only evidence indicating duplicity is to be found in the second copular piece, *i. e.* that succeeding the glossohyals. This piece is double anteriorly, but it becomes single opposite the articulation with it of the second branchial cartilage. The succeeding copular pieces are single, but they are a little broader than normal, especially in front.

The notochords remain separate as far back as the twentieth somite. For the arrangement of the neural and hæmal arch cartilages in the transition region, see above, page 8.

There are two sets of brain cavities and masses as far back as the level of the fourth ventricle. The fourth ventricle is single posteriorly, but it bifurcates in front into two canals leading into the separate mid-brains. The posterior part of the medulla and the anterior part of the spinal cord are composite, and show the following characters:—(1) they are much drawn out transversely, and (2) they give origin to small adjacent nerve-roots. These roots in the medulla are extremely rudimentary, and their ultimate distribution could not be traced, but in the spinal cord the nerve-roots in question are better developed and form a regular series of pairs of nerves coming off from the ventral aspect of the cord and distributed to the somites of the median

muscular mass which lies ventral to the notochords (compare page 9). In this monstrosity, as in the one previously described, the anterior part of the spinal cord, though it lies nearer to the place of union of twin bodies, shows greater structural duplicity than does the medulla oblongata.

All the outer cranial nerves belonging to the twin heads are normal and need no further mention. Of the inner or adjacent nerves, the 1st, 2nd, 3rd, and 4th are normal; the 5th and its ganglia are reduced in size; the 7th and 8th with their ganglia are very rudimentary; while only a remnant of the adjacent glosso-pharyngeal and vagus remains. I was unable to follow out the 6th pair, but the presence of well-developed external rectus muscles makes it probable that these nerves were present. As has already been mentioned, the inner or adjacent auditory capsules are much reduced in size, their auditory sacs being completely united and forming a single labyrinth, symmetrical in shape, compressed from side to side, and receiving the two adjacent auditory nerves. The arrangement of the sensory epithelium inside the various parts of this labyrinth is also bilaterally symmetrical. A reconstruction drawing of this labyrinth is given in Pl. IV. fig. 27. Sacculæ, utricle, and anterior and posterior semicircular canals are all represented, but there is no trace of a horizontal semicircular canal.

The heart is normal and gives origin to a single ventral aorta, which for a short distance upwards has a double cavity, owing to the presence of a median antero-posterior septum, which, however, disappears further forwards. The gill-arteries on either side are normal, but in addition to them the ventral aorta gives rise to several small irregular branches which ramify in spongy tissue surrounding the ventral ends of the branchial cartilages, and which may be taken to represent a very rudimentary set of adjacent gill-arteries. But the most striking feature of the ventral aorta is that, instead of ending in the first gill-arteries, it is continued forwards and arches dorsally in the tissue of the septum between the two mouth-openings. Passing through the space between the adjacent glossohyals and the succeeding copular piece, it comes to lie behind the small cartilage which represents adjacent ceratohyals. Then, reaching the base of the skull, it bends backwards, and divides into two equal branches which join the upper aortic roots on either side (Pl. II. fig. 13). In the first part of its course, this continuation of the ventral aorta gives off (1) two inner or adjacent carotid arteries, which, after running forwards and outwards, pass through their corresponding pituitary spaces; and (2) two arteries for the supply of the inner or adjacent pseudobranchs. These arteries run at first forwards and dorsally behind the adjacent glossohyals; then curving forwards they unite in front of the adjacent ceratohyals; then, separating again, they pass between the adjacent palato-quadrate and the hyomandibulars, and are distributed to their corresponding (*i. e.* inner) pseudobranchs. On either side the first aortic root gives

off (1) a hyoid artery which sends a branch to the corresponding outer pseudobranch, and (2) a carotid artery. It then joins the second aortic root, and shortly afterwards meets the continuation of the ventral aorta previously mentioned. The resulting vessel is then joined by the third and fourth aortic roots, but it remains separate from its fellow so long as the notochords are separate, *i. e.* back to the twentieth somite.

The arrangement of vessels which has just been described and which is illustrated in Pl. II. fig. 13 is somewhat remarkable. Mixing of arterial with venous blood must have taken place in no slight degree, and certain parts in each twin head must have been supplied by blood coming directly from the ventral aorta. There is no trace of a pair of adjacent jugular veins, and it is difficult to make out from sections the course of the venous blood coming from the adjacent sides of the twin heads. But as there is a considerable amount of spongy tissue below the base of the skull and in the septum between the mouth-openings, it is probable that the blood in question found its way into the median and the main jugulars. The presence of this spongy tissue no doubt indicates congestion.

The pronephric glomerulus (Pl. IV. fig. 32) is composite. It is remarkably large, and is divided into three compartments by two vascular tufts each of which has an afferent and an efferent vessel. Normal Wolffian ducts arise from the outer compartments, while the middle compartment gives origin to a sacculated tubule which passes backwards a short distance to end blindly, and which represents fused adjacent Wolffian ducts.

There are two buccal cavities, but the oesophagus and the rest of the alimentary tract are single except for the presence of two air-bladder diverticula.

The composite muscles described on page 9 are well developed in this monstrosity.

II. *Union in Pectoral Region.*

Class II. of the monstrosities has next to be described. In it the twin bodies are united in the region of the pectoral fins. All specimens of this Class have separate gullets, air-bladders, and stomachs, but a single liver, intestinal canal, and vent. The hearts are more or less closely united. Two subgroups of this Class are naturally distinguished from one another—(a) a group in which union of the twin bodies takes place so far forward that adjacent pectoral fins are not present; and (b) a group in which adjacent pectoral fins are present, but are united and reduced in size.

(a) *Adjacent Pectoral Fins not represented.*—The brain, the cranial and branchial skeletons are double. So also are the alimentary canals down to the level of the stomach. The chief interest in this type centres round the heart and blood-vessels. A reconstruction drawing of the heart and origins of the vessels of

a typical specimen of this group is given in Pl. III. fig. 19. (The hepatic veins are not shown because, in the removal of the yolk-sac, the liver had been damaged, obscuring the relations of its vessels.) The whole of this double heart lies inside a large composite pericardial cavity, which is prolonged a little forwards on either side round the origins of the ventral aorta. The ventricles are separate, the auricles communicate with one another, and there is a single large sinus venosus opening by a wide ostium into the auricles at their junction (Pl. III. fig. 19, *V.Au*). The sinus venosus receives blood (*a*) on either side from the duct of Cuvier formed by union of the outer cardinal and internal jugular veins of the twin embryos (*i. e.* from the right duct of Cuvier of the right embryo and from the left duct of Cuvier of the left embryo); (*b*) from two separate middle jugular veins; and (*c*) from a large trunk formed by union of the inner or adjacent internal jugular veins of the twin heads (Pl. III. fig. 19, *Dc*). This last trunk obviously corresponds to fused adjacent ducts of Cuvier which receive internal jugular veins only and have no corresponding cardinals.

The head-kidney in this specimen is illustrated by Pl. IV. fig. 31, and corresponds to the description given on page 14.

The notochords and spinal cords are still widely separate opposite the pectoral region, and they remain separate for a considerable number of somites behind it, but ultimately they fuse, so that the posterior part of the body contains a single notochord and a single spinal cord.

The behaviour of the neural and hæmal arches and of the median muscular mass corresponds to the description on page 8. These structures, however, may be studied to greater advantage in the type at present under consideration, as the whole transitional region is open for observation. The dorsal ends of the adjacent fifth branchial cartilages are fused, but otherwise the twin branchial skeletons are quite separate. The ventral ends of the two coraco-scapular bars fail by a wide interval to meet each other below the pericardium.

In a typical specimen belonging to group (*b*) of Class II., in which *adjacent pectoral fins were present but united* and reduced in size, fusion was more complete towards the posterior (radial) border of the cartilage than towards the anterior border. Thus, near the anterior border, there was only a small bridge of cartilage between them; further back they approached one another, and the bridge was wider; while at the posterior border they were united along their whole length. As regards the adjacent coraco-scapular bars, they were quite separate, except at their ventral ends, which were fused together and projected downwards into a septum between the two pericardial sacs. The ventral ends of the two outer coraco-scapular bars were very widely distant from one another.

The same specimen may be used as a type for illustrating the

heart and vessels in this group (Pl. IV. fig. 20). There are two pericardial cavities separated by a septum of connective tissue, which is thin posteriorly, but in front is thick and contains the fused ventral ends of the adjacent coraco-scapular bars just mentioned. Auricles and ventricles are completely separate, and the sinus venosi communicate only by a narrow neck. Each sinus venosus has a pair of ducts of Cuvier, the inner or adjacent ducts being smaller than the outer. This difference depends mainly on the fact that the inner or adjacent ducts are small and short. They can be traced backwards inside the substance of the head-kidney, but are soon found to unite and to break up into venules in the lymphoid tissue (Pl. III. fig. 20, *Vc'*).

The glomerulus of the head-kidney is shown in Pl. IV. fig. 31. It is greatly elongated in a transverse direction, and the tubule from its middle compartment, representing fused adjacent Wolffian ducts, passes forwards so as to lie between the two adjacent cardinal veins which have just been referred to. It ends blindly and is so much sacculated as to suggest a certain degree of pressure in the fluid secreted by the glomerulus. A similar point will be noted later (page 17), where one of the urinary bladders in a double monstrosity had no urinary pore.

III. *Union at Posterior Part of Body.*

In Class I., the twin heads lie symmetrically, side by side, exhibiting lateral union, but in Class II. there is a slight convergence ventrad of the sagittal planes of the twin bodies; while in Class III. this convergence exists in a very marked degree, giving rise to ventro-lateral union of the twin bodies, or, even, in extreme cases, to what may be described as ventral union. Roughly speaking, the further back union of the twin bodies takes place, the greater is their ventral convergence. This is in harmony with the fact that the twin bodies are lying tangentially on the surface of a single small yolk-sphere.

It will be convenient to subdivide Class III. into (a) *cases in which union takes place well in front of the vent*, and (b) *cases in which union takes place quite close to the vent*.

In group (a) the alimentary canal is single for a considerable distance posteriorly, the united portion being provided with two dorsal mesenteries, one from each twin body; the head-kidneys are quite separate and are normal, but their inner or adjacent Wolffian ducts end blindly in the mesonephric region, while the outer Wolffian ducts pass backwards as the ureters of the single normal bladder (Pl. III. fig. 22). In this group, moreover, the ventral convergence of the twin bodies is not too great but that it can readjust itself at the region of transition, and allow the spinal cords, as in Classes I. and II., to unite anterior to the place of fusion of the notochords.

Group (b) of Class III. includes cases in which union takes

place close to the anus. Ventral convergence of the sagittal planes of the twin bodies is always marked, and is often extreme enough to allow the notochords to unite anteriorly to the place of union of the spinal cords and of the dorsal edge membranes. The notochords are always double opposite the vent and for a considerable distance behind it, but I have not met with any cases in which they remained separate to their extreme tips. The dorsal aortæ unite at the same level as the notochords, and the caudal veins a little in advance of the aortæ. On the other hand, the spinal cords, while they usually unite far back in the caudal region, in extreme cases may remain separate altogether.

The ventral edge membranes tend to unite earlier than those of the dorsal edge, but in cases of pure ventral union there may be two composite ventral edge membranes at opposite corners of the quadrangular composite body, the other corners of which carry normal dorsal edge membranes. Apparently, during the concrescence of the twin bodies, the blastema for the ventral edge of each was kept apart in two halves, each of which, continuing to occupy a lateral position, met and fused with a corresponding part derived from the other twin.

In all of my specimens except one (Pl. III. fig. 26) the vent is single, and in all of them the intestines are united close to the vent. Franz Schmitt, however (*l. c.* p. 53) refers to a case in which, apparently, no such union had taken place.

Very great variation is found in the arrangement of the ureters, bladders, and urinary pores in this group. All my specimens have two bladders, which sometimes communicate with one another and sometimes are quite separate. In all cases, the right ureter of one twin and the left ureter of the other open into one of the bladders, while the two remaining ureters go to the second bladder. Thus, each bladder receives a right and a left ureter derived from different embryos, and, except in cases of symmetrical ventral union, the ureters which go to the one bladder may be recognised as the inner or adjacent pair, while those which go to the other may be recognised as the outer pair. In such cases, the first bladder lies anterior and ventral to the second, with which also it frequently communicates, especially when destitute of an external opening.

Attention may be drawn to figs. 23, 24, 25, 26, on Plate III., which are reconstruction diagrams illustrating the principal variations referred to above. Figure 23 was drawn from a specimen in which the bladder (*BL'*) in connection with the inner or adjacent pair of Wolffian ducts has no urinary pore, but opens into the bladder (*BL*) in connection with the outer pair of Wolffian ducts (*WDa*, *WDb*). Figure 24 illustrates a case in which the first bladder (*BL'*) had no opening and was enormously expanded, as were also the lower ends of its ureters. Figure 25 is from a specimen in which the bladders (*BL'* and *BL*) were separate and had urinary pores which opened in the mid-ventral line, one behind the other. It will be seen that

in this case the two bladders lie in the same plane and have corresponding right and left sides. But the right side of *BL'* is in connection with a left Wolffian duct (*Wda'*), while the left side is in connection with a right Wolffian duct. Such a transposition is exceedingly rare in double monstrosities. Figure 26 was taken from a case of symmetrical ventral union. Two vents and two urinary pores were present, and as they opened laterally in pairs towards opposite sides, they lay in a plane at right angles to the sagittal plane of the twin bodies. This arrangement has many parallels in teratology, *e.g.* in cases of ischiopagous double monstrosity*. It preserves the natural correspondence between rights and lefts in the ducts and bladders, which, as has just been seen, is inverted in the case from which figure 25 of Plate III. was taken.

GENERAL.

With the rarest exceptions, all double monstrosities in fishes are examples either of anterior duplicity or of union by the yolk-sac. The explanation of this remarkable fact seems to me to be as follows:—In all these cases, two centres of gastrulation form on the edge of the blastoderm at a greater or less distance from one another. The spreading of the blastoderm over the yolk-mass goes on freely all round except at and near the primitive streak. There, changes take place which lead to increase in length of the embryonic axis, and which are interpreted by many as concrescence. If the two centres of gastrulation happen to be near one another, the whole of the blastoderm edge separating them eventually will be used up in the process of concrescence; the later formed parts of the embryonic axes will be drawn closer and closer to one another, until in their turn the axes themselves coalesce. The degree of union will be in inverse proportion to the original distance from one another of the two centres of gastrulation. Should the two centres of gastrulation be so far apart that the middle portion of the intervening blastoderm edge is not involved in concrescence but is left free to extend over the yolk-mass, the two embryonic axes will be independent along their whole length, and the only structures which connect them will be the blastoderm and the yolk-sac. According to this view, double monsters showing anterior duplicity are the result of what may be called *primary fusion*, that is, concrescence of their growing embryonic axes.

In birds, typical concrescence can occur only during the earliest stage of formation of the primitive streak, *i.e.* so long as the groove of the sickle and knob is open. Any subsequent concrescence can take place only by the incidental drawing in and utilisation of lateral blastema at the growing zone. This process

* J. F. Gemmill in 'Journal of Anatomy and Physiology,' vol. xxxvi. p. 263.

cannot exercise the same compelling influence in approximating the growing embryonic axes as it may do in fishes. The question of the origin of the different kinds of double monstrosities in birds and mammals is complicated by other factors and cannot be discussed fully here; but the considerations suggested above may throw some light on the fact that practically all double monstrosities among fish with united bodies show anterior duplicity, whilst in mammals and birds there are as many or more cases of posterior duplicity.

As was indicated previously (p. 16), both subgroups of Class I. exhibit simple lateral union. It may be interesting, in these cases, to compare the behaviour, as regards union, of various mesial and lateral organs. Of the three primitive axial structures, the notochords are the last to unite, and the alimentary canals the first, while the neural axes are intermediate (pp. 7, 8, 10). It may be taken as a general rule, in monstrosities of this type, that structures and parts of structures which lie nearest the notochords retain evidence of duplicity longest. Thus, the optic lobes mentioned on p. 8 have single roof parts, while their basal structures are double; the composite spinal cord (pp. 9, 12) has additional nerve-roots coming off from its ventral aspect; there are two air-bladder diverticula in a case where the alimentary canal was single up to the mouth (p. 10), while there is only a single liver in a case where the alimentary canal was double down to the pylorus (p. 14); duplicity of the dorsal aorta is coextensive with duplicity of the notochord, while the heart and pericardium are single (p. 9); the cartilages of the neural and hæmal arches are in double sets for many somites in a case where all the branchial cartilages are single (p. 8).

The slowness with which the notochords unite may be due in part to their small size and to the nature of their tissue, but is probably to be referred mainly to their central position and to the fact that they are flanked by the bulky mesoblastic somites, so that *primary fusion* is deferred as long as possible and secondary fusion is prevented. The early union of the neural axes and of the alimentary canals, and the earlier union of their dorsal and ventral walls respectively, may be explained in part by *primary fusion*, if one remembers that the dorsal wall of the neural axis is formed from the outer edges of the neural groove, and that the ventral wall of the alimentary canal is for a long time incomplete. But such facts as the very marked increase of duplicity in the spinal cord as compared with the medulla oblongata in Class I. (a) and (b) (pp. 9, 13), indicate that, in addition to the *primary fusion* of concrescence, *secondary fusion* has played some part in moulding organs at the transitional region. The greater simplicity of the medulla is explained, in part by its greater size as compared with the spinal cord, but chiefly by the fact that the notochords are closer together at their anterior ends (where they are surrounded by the parachordal cartilages) than they are in the cervical region where the median muscular mass serves to

press them widely apart. The growth in bulk of this mass which causes this pressure can only have occurred at a relatively late stage. Almost perfect coalescence of the medullæ has thus been allowed through secondary fusion, while the upper parts of the spinal cords have been kept markedly composite. Further, there is reason to believe that nearly all the composite mesenchymal structures occurring at the transitional region have been produced through secondary fusion.

The monstrosities grouped under Class III. (p. 16) do not exhibit symmetrical lateral union, owing to their marked ventral convergence, and, accordingly, what has been said above regarding the behaviour of different organs at the transitional region does not apply to this Class.

In all cases except those of pure ventral union (for an example of which see p. 18), the change from the double to the single condition is effected at the expense of the inner or adjacent elements, while the outer elements become the right and left sides of the single region of the body. This rule has long been recognised as holding good in similar double monstrosities among the higher vertebrates. For the sake of easy reference, it may be useful to tabulate here the principal composite structure, produced by fusion of adjacent elements, and mentioned in the descriptive part of this paper:—

Trabeculæ cranii,	page 7,	Plate I., fig. 3, <i>d</i> .
Parachordal cartilages,	" 7, 11,	" figs. 3, 5, <i>c</i> .
Vertebral do.,	" 8,	" fig. 8, <i>Na'</i> , <i>Ha'</i> .
Palato-quadrata do.,	" 8, 11,	" figs. 3, 5, <i>f'</i> .
Supraorbital do.,	" 8, 11,	" figs. 4, 6, <i>s'</i> .
Periotic do.,	" 11,	" fig. 5, <i>k'</i> .
Hyomandibular do.,	" 11,	" fig. 5, <i>i'</i> .
Meckelian do.,	" 8, 12,	" fig. 3, <i>g'</i> , 9, 10, <i>Meck'</i> .
Hyoid do.,	" 12,	Plate II., fig. 10, <i>LH'</i> , <i>BH'</i> .
Pectoral fin do.,	" 15,	" fig. 11, <i>CL</i> .
Jugular veins,	" 15,	Plate III., fig. 19, <i>DC'</i> .
Cardinal veins,	" 15,	" fig. 20, <i>VC'</i> .
Pseudobranch arteries,	" 9,	Plate II., fig. 12, <i>A.Chor'</i> , fig. 13, <i>Aa'</i> .
Pronephric glomerulus,	" 10, 16,	Plate IV., figs. 29, 31, 32.
Wolffian ducts,	" 16,	" figs. 31, 32.
Muscles,	" 9,	
Eyes,	" 9,	
Internal ear,	" 11,	Plate IV., fig. 27.
Optic lobes,	" 8,	Plate II., figs. 15, 17.
Medulla oblongata,	" 12,	" fig. 16.
Spinal cord,	" 9, 12.	
Cranial nerves,	" 13.	

As a rule, where adjacent muscles persist, there are also corresponding motor nerves. But the small muscles described as

surrounding the fused adjacent Meckelian and hyoid bars in Class I. (p. 10) are destitute of nerves.

Development of parts may take place without the presence of nerves of general sensation. Thus in Class I. (*a*) no trace exists of adjacent trigeminal nerve-fibres, yet the inner sides of the snout and head are well developed wherever they have sufficient space.

On the whole, the anatomy of the series of monstrosities which has been described in this paper is remarkably symmetrical, both twins contributing equally to the sum of structures in the transitional region, in which, moreover, the law that union takes place between homologous structures alway holds good.

EXPLANATION OF THE PLATES.

(Reconstruction Diagrams.)

PLATE I.

Fig. 1. *Cranial and hyomandibular skeleton* of a normal Trout embryo, seen from above, after removal of the roof-cartilages by a section supposed to pass horizontally through the nasal and periotic cartilages (pp. 5, 6).

- a*, olfactory pit and cartilage.
- b*, trabeculae cranii.
- c*, parachordal cartilages.
- d*, placed just in front of pituitary space.
- e*, " " behind pituitary space.
- f*, palato-quadrate bars.
- g*, Meckel's cartilage.
- h*, hyoid bar.
- i*, hyomandibular.
- k*, placed in floor of periotic capsule.
- m*, pituitary space with external recti muscles passing through it.
- n*, notochord embedded in the parachordals.

Fig. 2. *Roof-cartilages of skull* of a normal Trout embryo, seen from above (p. 6). (For lettering see under fig. 6.)

Fig. 3. *Cranial and hyomandibular skeleton* of a double-monster embryo, seen from above as in fig. 1. The duplicity affects the anterior cranial structures only (pp. 7, 8). Lettering as above; see also under fig. 5.

Fig. 4. *Roof-cartilages of skull* of the double monster illustrated in fig. 3. For lettering see under fig. 6.

Fig. 5. *Cranial and hyomandibular skeleton* of a double monster exhibiting a slightly greater degree of duplicity than that of fig. 3 (pp. 11, 12).

In figs. 3 & 5, *a, b, c*, &c. represent the same structures as in fig. 1; *f', g', i', k'* are the inner or adjacent (reduced) structures corresponding to the fully-developed outer *f, g, i, k* (*i. e.* palato-quadrate, Meckelian, hyomandibular, and periotic cartilages).

Fig. 6. *Roof-cartilages of skull* of the double monster illustrated in fig. 5.

- f1, f2, f3*. Anterior, middle and posterior fontanelles.
- r*, cartilage of roof of nasal pits.
- s*, supraorbital bars (*s'*, adjacent reduced pair).
- t*, cartilage of roof of periotic capsule.
- w*, parachordal cartilage.
- x, y*, tegmental cartilages above third ventricle and cerebellum respectively.

Fig. 7. *Vertebral cartilages* in normal Trout embryo (p. 6).

Fig. 8. " " " any double monstrosity near the transitional region.

- Sp.* Spinal cord.
- Nch.* Notochord.
- Na.* Neural arch cartilage (*Na'*, adjacent reduced neural arch cartilage).
- Ha.* Hæmal arch cartilage (*Ha'*, adjacent reduced hæmal arch cartilage).

PLATE II.

Fig. 9. *Ventral ends of the Meckelian, hyoid, and branchial cartilages* of the monstrosity illustrated in figs. 3 and 4 (see pp. 7, 8).

Fig. 10. *Ventral ends of the Meckelian, hyoid, and branchial cartilages* of the monstrosity illustrated in figs. 5 and 6 (pp. 11, 12).

- Meck.* Outer Meckelian bars.
Meck'. Inner or adjacent Meckelian bars united and greatly reduced.
GH. Glossohyal.
BH. Hypohyal.
LH. Ceratohyal.
BH'. Inner or adjacent hypohyals partly united.
LH'. ceratohyals united.
 III, IV, V, VI, VII. "The branchial cartilages.

Cop. Copular pieces, the anterior one being bifid.

Fig. 11. *Transverse section of a composite pectoral fin*, from a monstrosity in which union took place just behind the pectoral fins (see p. 19).

Scap., Cor. Scapular and coracoid parts respectively of the coraco-scapular bars. The ventral ends of the coracoid parts are united.

CL. The limb-cartilages united for the greater part of their length.

R. The rays (not cartilaginous).

Fig. 12. *Diagram of the aorta and its roots* in the monstrosity referred to on p. 9.

Ao'. Aorta, the two limbs uniting further back.

I, II, III, IV. Aortic roots, *i. e.* branchial veins.

Car. Carotids.

Aa. Artery to pseudobranch, a branch of the 1st branchial.

Psbr. Pseudobranch.

A.Chor. Choroidal artery.

A.Chor'. The arteries for the choroidal glands of the inner or adjacent pair of eyes. They arise by a single stem from the middle of a vessel connecting the aortic roots on either side, and go to the choroidal glands without passing through a pseudobranch.

Fig. 13. *Diagram of ventral aorta, aorta and aortic roots* in the monstrosity illustrated in figs. 5, 6, 16 (see p. 13).

Lettering as above, with in addition :

TA. Ventral aorta and its branches 1, 2, 3, 4.

Car'. Inner or adjacent carotids, giving off *Aa'* arteries to the inner or adjacent pseudobranchs *Psbr'.*

It will be seen there are two sets of carotid and afferent pseudobranch arteries, the inner sets being derived directly from the ventral aorta. The ventral aorta arches dorsally in the septum between the two mouths of the monstrosity, reaches the base of the skull, and then divides into two limbs which are continued backwards to join the aortic-collecting roots on either side.

Fig. 14. *Outline of central cavity of brain* of normal Trout embryo. Lettering as in fig. 16.

Fig. 15. *Outline of central cavity of brain* of the monstrosity illustrated in figs. 3, 4, & 9 (p. 8). Lettering as in fig. 16.

Fig. 16. *Outline of central cavity of brain* of the monstrosity illustrated in figs. 5, 6, 10 (p. 12).

C.F.B. Cavity of the hemispheres.

C3rd V. " 3rd ventricle.

COL. " optic lobes.

CIt. " iter a tertio ad quartum ventriculum.

C4th V. " 4th ventricle.

Sp. " spinal cord.

Fig. 17. *Outline of transverse section of central cavity* in anterior part of optic lobe region of the brain illustrated in fig. 15. There are two infundibula and two sets of hypoarial cavities, while the main optic lobe cavity is single (p. 8).

COL. Cavity of optic lobes.

Inf. Infundibulum.

Hyp. Hypophysis sac.

Hya. One of the hypoarial cavities.

PLATE III.

- Fig. 18. *Diagram of heart &c. of normal Trout embryo.* Lettering as in fig. 20.
 Fig. 19. *Diagram of heart &c. of the monstrosity illustrated in figs. 5, 6, 10, and 16 (p. 15).* Lettering as in fig. 20.
 Fig. 20. *Diagram of heart of the monstrosity referred to on p. 16.*
 V. Ventricle.
 Au. Auricle.
 SV. Sinus venosus.
 DC. Duct of Cuvier.
 DC'. Inner or adjacent ducts of Cuvier.
 VJ. Jugular vein.
 VC. Cardinal vein.
 VC'. Inner or adjacent cardinal veins.
 Fig. 21. *Diagram of Wolffian duct & urinary bladder of a normal Trout embryo (p. 7).* Lettering as in fig. 26.
 Fig. 22. " " " in the monstrosity referred to on p. 16. Lettering as in fig. 26.
 Fig. 23. " " " in the case referred to on p. 17. Lettering as in fig. 26.
 Fig. 24. " " " in the case referred to on p. 17. Lettering as in fig. 26.
 Fig. 25. " " " in the case referred to on p. 17. Lettering as in fig. 26.
 Fig. 26. " " " in the case referred to on p. 18.
 BL. Bladder.
 BL'. Bladder formed by the inner or adjacent pair of Wolffian ducts.
 WD. Wolffian duct.
 WDb, WDb'. Right and left Wolffian ducts belonging to one of the twins in each of the figures.
 WDa, WDa'. Left and right Wolffian ducts belonging to the other twin in each of the figures.
 Int. Intestine.
 R. Rectum.
 V. Vent.
 P. Urinary pore.

PLATE IV.

- Fig. 27. *Lateral view of the composite auditory sac present in the monstrosity illustrated in figs. 5, 6, 10. (See pp. 11, 13.)*
 Sacc. Sacculæ.
 Utr. Utricle.
 a.sc. An anteriorly placed semicircular canal.
 p.sc. A posteriorly " "
 Fig. 28. *Diagram of head-kidney of a normal Trout embryo (p. 7).*
 GL. Glomerular tuft of vessels.
 A. Afferent vessel.
 V. Efferent vessel.
 C. Capsule of glomerulus.
 CWD. Commencement of Wolffian duct *WD*.
 HK. Coils of Wolffian duct in head-kidney.
 Fig. 29. *Composite head-kidney in a double monstrosity (p. 10).* Lettering as in fig. 28.
 Two glomerular tufts are present in a cavity divided into three chambers.
 O. Mesial chamber.
 Fig. 30. *Head-kidney in a double monstrosity of same general type as last, but here the glomeruli have not united together, though the adjacent halves of each give origin to no Wolffian duct or only to a short blind one (p. 10).* Lettering as in fig. 28.
 Figs. 31 & 32. *Head-kidney glomeruli of other two double monstrosities showing a degree of duplicity greater than that illustrated in fig. 29 (pp. 14, 16).*
 A blind sacculated tube comes off from the middle compartment of the composite glomerulus and represents united adjacent Wolffian ducts.

2. The Metamorphoses of the Decapod Crustaceans *Ægeon* (*Crangon*) *fasciatus* Risso and *Ægeon* (*Crangon*) *trispinosus* (Hailstone). By ROBERT GURNEY, B.A., F.Z.S.

[Received March 2, 1903.]

(Plates V. & VI.*)

During a residence of nearly a year at Plymouth, I was able to obtain and study a very great variety of Decapod larvæ, and among them those of five species of Crangonidæ. Of these five species, which it will be convenient here to consider as all belonging to the genus *Crangon*, three, namely *Crangon vulgaris*, *C. spinosus*, and *C. nanus*, have already been fully described by Sars, and *C. vulgaris* has also attracted the attention of a number of other workers in this field of research. The remaining two species, *Crangon trispinosus* and *C. fasciatus*, have remained hitherto unrecognised. The identity of these larvæ was placed beyond all doubt both by hatching them from the egg and by observing the last moult to the adult form. Attempts at rearing the larvæ hatched in the Laboratory were quite unsuccessful, though with the same methods (plunger jars) and under apparently similar conditions I was able to rear the larvæ of *Pandalina brevirostris* right through to the postlarval form.

Description of the Larvæ.

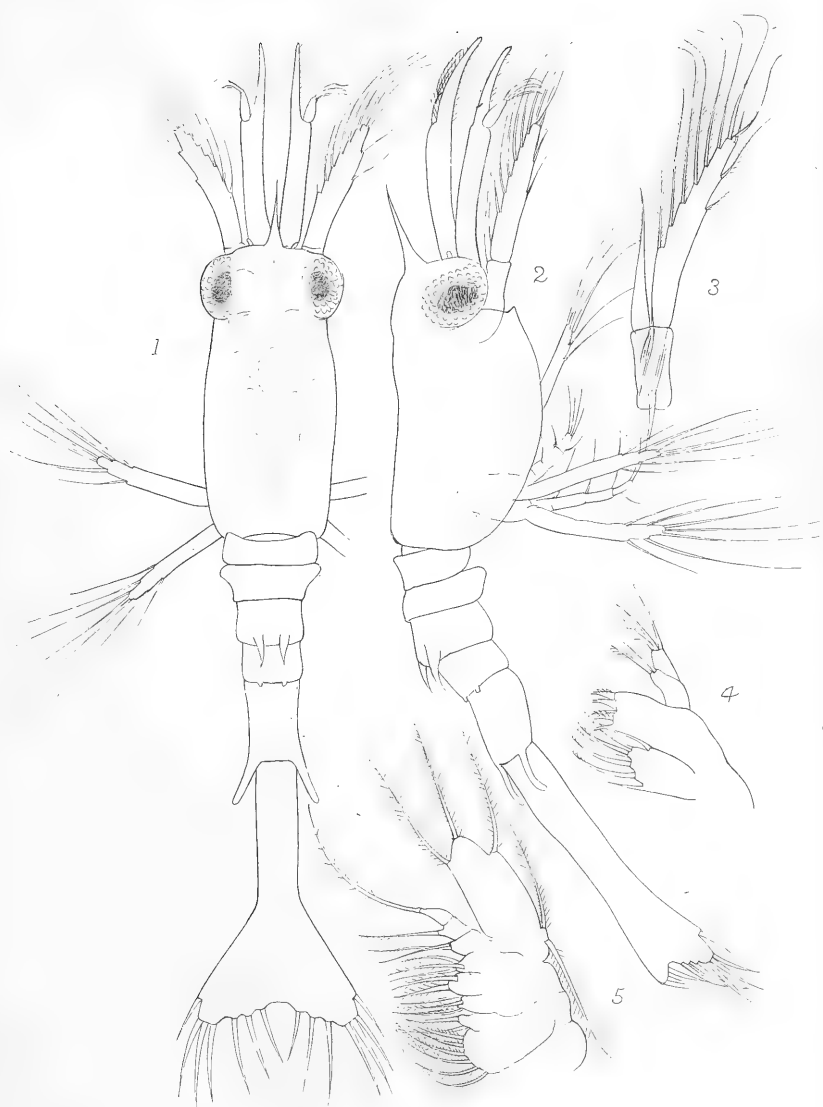
I. CRANGON FASCIATUS (Risso).

Length of larva on hatching, exclusive of the rostrum †, 1·8 to 2·05 mm. Average of 24 specimens 2·0 mm. The rostrum measures about ·17 mm. at this stage.

The general form of the body is slender, the abdominal segments being not distinctly narrower than the thorax. The carapace is prolonged anteriorly into a slender, pointed rostrum, reaching about half the length of the peduncle of the first antenna. Below, its margin is evenly arched and without teeth, ending in front, at the base of the second antenna, in a blunt process. There is no fold of the carapace over the eyes, so that the latter appear as prominent faceted areas of the carapace itself (see Williamson, 1901, p. 113). In front of the eyes, and on either side of the rostrum, is a small knob-like process (see Pl. V. fig. 1). I can find

* For explanation of the Plates, see p. 30.

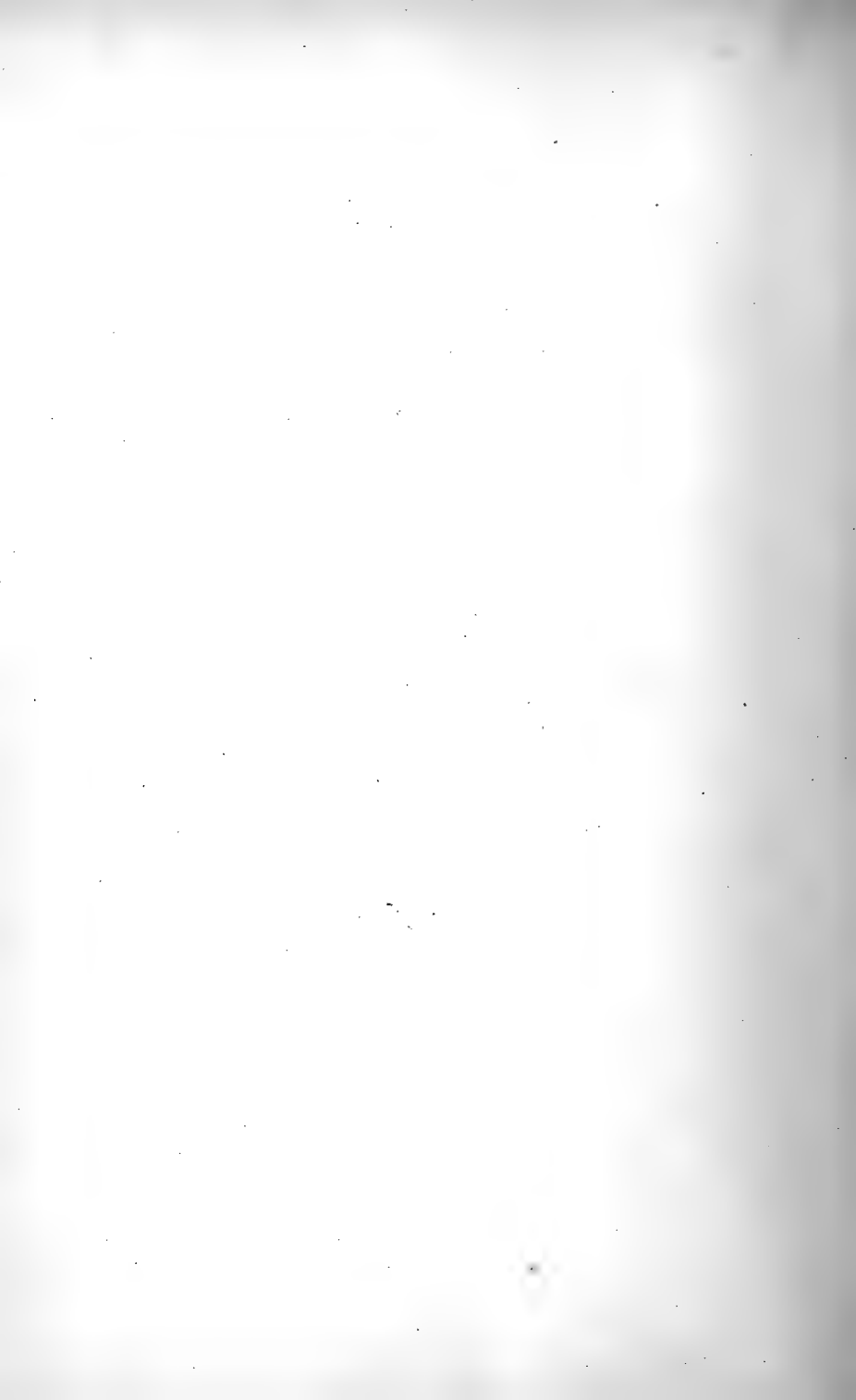
† As here, so in the case of *C. trispinosus* the rostrum is left out of account, as measurements from the anterior edge of the eye to the edge of the lateral lobe of the tail-plate give a truer basis of comparison for body-length of different species.

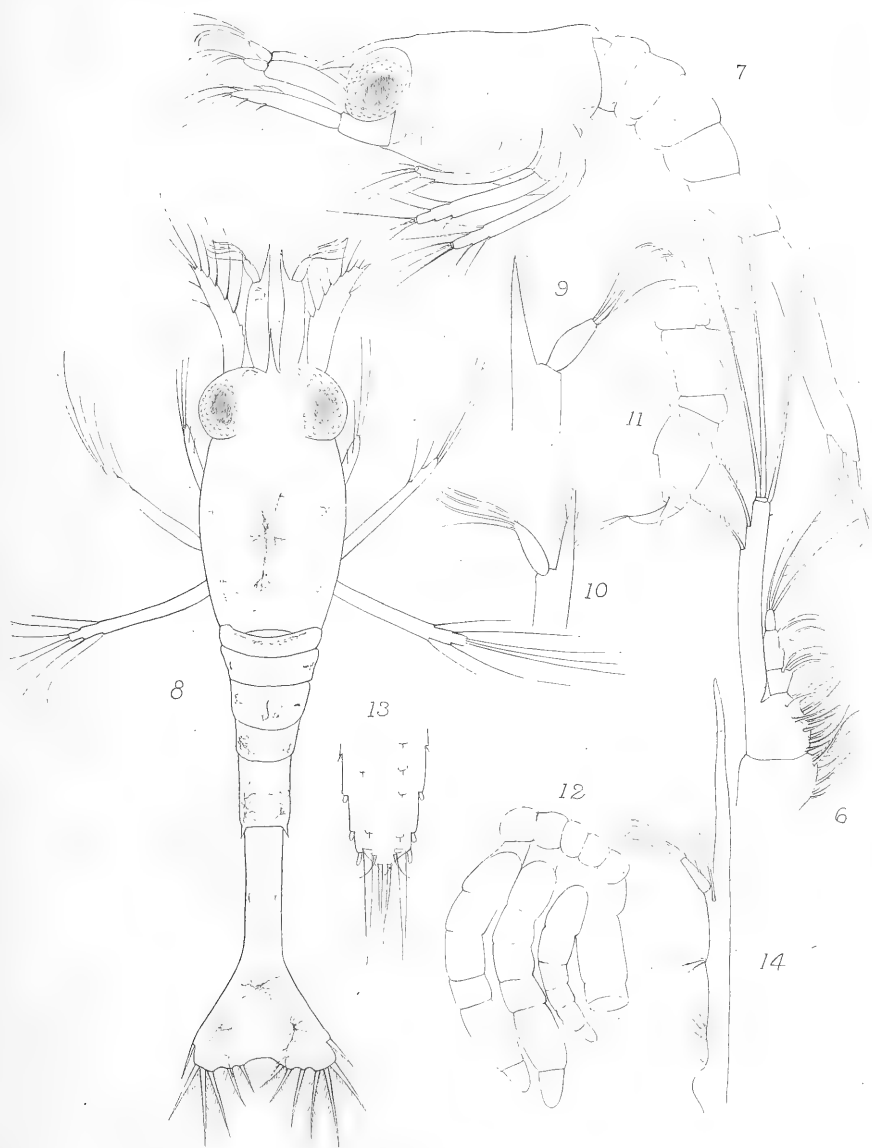


R.G.del.

Bale & Danielsson Lith, sculp.

CRANGON LARVÆ.





R.G.del.

Bale & Danielsson Ltd, sculp.

CRANGON LARVÆ.

no mention of these structures in the descriptions of any *Crangon* larvæ, though they are certainly present both in *C. trispinosus* and in *C. nanus*. It seems to me quite possible that they represent the frontal sensory processes which have been found on certain Cirripede nauplii for example, and which have been supposed to be the vestiges of a pair of preoral appendages.

In the abdomen, the first and second segments are characterised by the lateral expansion of their epimera (Pl. V. fig. 1), which makes them appear considerably broader than the succeeding segments. The third segment bears dorsally two strong backwardly directed spines. In the fourth segment these spines are represented by a pair of very small knobs, while in the succeeding segment they are shifted somewhat laterally and have the form of a pair of long, downwardly curved, blunt processes. The tail-plate is of the usual Crangonid type, with seven strong ciliated spines on either side. These spines, however, are somewhat peculiar in having quite blunt terminations, a feature which persists in the later stages also.

The first antennæ are unusually long—about two-thirds the length of the carapace. The inner flagellum, which is a direct prolongation of the stem, is ciliated and very bluntly pointed. This blunt termination looks at first sight like the result of an injury; but as all the larvæ were the same in this respect, this condition is clearly normal. The scale of the second antenna (Pl. V. fig. 3) is long and very narrow, with seven internal setæ, two setæ and a short spine terminally, and two short external setæ. The first maxilla (Pl. V. fig. 4) has a two-jointed palp, and in other respects this appendage and the first maxilla also conform exactly to the characteristic crangonid type.

The exopodite of the first maxillipede (Pl. VI. fig. 6) has three apical setæ, and two setæ on its external edge, differing in this respect from *Crangon vulgaris*, which has but one external seta. In the endopodite I can detect only three joints, and in the same way in the other maxillipedes I can only make out four. Williamson shows the palp of the first maxillipede in *Crangon vulgaris* as distinctly divided into four joints, but though there are certainly four small lobes, I cannot trace the separation of the second segment into two, nor of the third segment in the case of the other two pairs.

The more advanced larvæ of *Crangon fasciatus* are comparatively rare in the tow-net collection, but four stages are to be distinguished in my material. That corresponding to stage iv. of *C. vulgaris*, i.e. with the pleopods represented by short buds, I have not found, though there can be but little doubt that it occurs.

In the last stage (stage v.) the length of the body is about 3.5–3.8 mm., the rostrum extending about .2 mm. beyond the eyes. The form of the rostrum, which acquires its definitive shape in the second stage, differs from that of the first stage.

The basal part between the eyes is broad, and distally it contracts suddenly and tapers to a sharp point. In one example this narrow part was found to be bifid down to its base, though the postlarval form moulted from it was in no way abnormal. The general form of the carapace is unaltered.

In the abdomen the laterodorsal spines of the fifth segment are longer, and end in a sharply down-curved hook. I have drawings of a larva taken in July 1901 at Plymouth, in which this spine is of an unusual length, being about two-thirds the length of the long sixth segment.

The tail-plate, now distinctly separated from the sixth segment, is much narrower at the end compared with its total length, and its sides are not straight, but conspicuously curved. There are still seven setæ on each side of the posterior margin, but a short way up the side on either hand is a minute knob, representing the eighth seta found in other species.

The antennæ (Pl. VI. fig. 14) are now still more elongated, the flagellum of the second antenna now considerably exceeding the scale in length. The latter has now a large number of marginal setæ.

Such changes as have occurred in the maxillæ are unimportant. In the maxillipedes five joints can now be detected in the endopodite of the second and third, but that of the first remains to all appearance three-jointed. All the thoracic appendages, as well as the pleopods, are now present, and have the usual Crangonid form. The first five pairs of thoracic appendages have exopodites. As regards the gills, not having any example of stage iv., I cannot offer any observations as to their origin, but in the last stage they are well developed, and the five posterior pairs are distinctly pleurobranchs. In this respect *C. fasciatus* and also *C. trispinosus* differ from *C. vulgaris*, in which Williamson describes the gills as having the position of arthrobranchs at this stage.

The foregoing account shows that the larva of *C. fasciatus* is readily distinguishable from all other *Crangon* larvæ yet described. The larva most closely approaching it seems to be one described by Claus (1861, taf. ii. fig. 1). This larva possibly may be that of *C. sculptus*, and differs from that now under consideration in its much more compact body and the relative length of its dorsal abdominal spines. The length of the antennæ, slender body, and shape and size of the abdominal spines are distinctive of the larva of *C. fasciatus*.

The next moult leads at once to the postlarval stage, in which the adult form is assumed. The young shrimp has the broad, depressed form of the adult, with its characteristic square rostrum and bright, somewhat banded, colouring. The only important point of difference lies in the sculpturing of the carapace. In this first postlarval stage the carapace is smooth except for a short anterior median ridge, with two or three blunt prominences.

II. CRANGON TRISPINOSUS Hailstone.*

Length of the first larva 1·8 to 2·0 mm.; average for twenty-five specimens being 1·9 mm. The body is light greenish yellow in colour, with a conspicuous branching chromatophore placed dorsally in the middle of the thorax. In general form the zœa resembles that of *C. nanus*, the body being comparatively thick-set and tapering gradually backwards.

The lateral edges of the carapace are deeply arched below and perfectly smooth except for a blunt spine-like prominence below the base of the second antenna (Pl. VI. fig. 7). Anteriorly it is prolonged into a short pointed rostrum barely half the length of the peduncle of the first antenna. The carapace is not folded off over the eyes, so that the latter appear to be a part of it. The same pair of small outgrowths in front of the eyes as were described in *C. fasciatus* also occur in *C. trispinosus* (Pl. VI. fig. 8). No trace of them can be detected in later stages.

The abdominal segments have their posterior dorsal edges usually evenly rounded, without spines, but the fifth segment sometimes has a pair of short dorso-lateral spines, and traces of them can often be detected. The tail-plate is of the usual form, the spines being sharply pointed, and not blunt as in *C. fasciatus* (Pl. VI. fig. 8).

In the form of the appendages *C. trispinosus* differs so little from *C. nanus*, which has been fully described by Sars, that it is not necessary to describe them in full. The first antennæ of *C. nanus*, however, differ from those of *C. trispinosus* in that the inner flagellum is armed with a few minute spines in addition to the long cilia which are common to both (Pl. VI. figs. 9 & 10). The second antennæ in the two species agree in all respects, but both species differ from *C. echinulatus*, which is in other respects closely similar, in the much narrower form of the scale.

In the later stages of the larva the body becomes more compact and thick-set, having an appearance very characteristic of this species and of *C. nanus*, from which, however, it is easily distinguishable by the absence of spines from the abdominal segments and from the lower edges of the carapace.

The rostrum is now very broad at the base, contracting suddenly near its end and continuing as a short, sharp spine. As far as the scanty material at my disposal for the study of the later stages goes, the spines occasionally developed on the fifth abdominal segment of the first larva are lost with the first moult.

The gills appear in the fourth stage of development. At this stage five gills can be seen placed, as it appears to me, in the position of pleurobranchs—that is to say, they are well above the apparent attachment of the legs (Pl. VI. fig. 12). As the legs

* Claus has figured (1884, taf. vii.) a *Crangon* larva which almost certainly belongs to this species. The absence of abdominal spines, the form of the rostrum, and the presence of an exopodite on the second pereopod identify the larva with *C. trispinosus*.

are six-jointed, one might assume that a seventh is fused with the body-wall, in which case the gills might be interpreted as arthrobranchs or podobranchs at will. Still, in the common acceptance of the term, they certainly seem to me to be properly designated as pleurobranchs.

I have been unable to detect at this stage the small arthrobranch found in the last larva and in the adult on the third maxillipedes.

The first postlarval stage differs from the adult in that there is but a single median tooth on the dorsal surface of the carapace, instead of three teeth transversely arranged. For this reason the young shrimp at this period is hardly distinguishable from *C. nanus*; but the latter is somewhat smaller, and the single median tooth of the carapace seems to rise from a short median ridge.

Sars figures a small posterior tooth in this ridge, corresponding to the second tooth of the adult, but I have been unable to detect it in my specimens. The possession of peculiarly distinct larval forms with sudden transition to a uniform postlarval type is one of the most remarkable features in crangonid metamorphosis, and the two forms described are no exception to the rule.

Conclusions.

Our knowledge of Decapod metamorphosis is for the most part very fragmentary, and for this reason it has been impossible to use the larval stages as evidence of relationship. We have, however, an exceptionally full knowledge of the metamorphosis of the Crangonidæ; and it will be interesting to see if a comparison of the larvæ will throw light on the classification of the group. The eleven species of Crangonidæ which have been recorded as British have been divided up among five genera:—*Crangon* Fabr., *Cheraphilus* Kinahan, *Egeon* Risso, *Pontophilus* Leach, and *Sabinea* Owen; though Ortmann in his revision of the family joins *Cheraphilus*, *Egeon*, and *Pontophilus* into one genus *Pontophilus*. The genus *Sabinea* may here be left out of account.

Looking, then, at the larvæ of the species that have been described, we find them falling, as it seems to me, naturally into three groups:—

1. *C. vulgaris* and *C. allmanni*: characterised by a one-jointed maxilla-palp and the absence of an exopodite on the second leg in the Mysis-stage.

2. *C. trispinosus*, *C. nanus*, *C. echinulatus*, and *C. fasciatus*: characterised by their two-jointed maxilla-palp, possession of five pairs of exopodites in the Mysis-stage, form of the rostrum, and arrangement of the abdominal spines.

3. *C. spinosus* and *C. norvegicus*: distinguished from the second group by their extremely elongated body form, shape of the rostrum, possession of a single long median spine on the third abdominal segment, and by the form of the tail-plate.

C. fasciatus cannot be separated generically as a larva from the other species named. A characteristic of the group to which it belongs is the paired arrangement of the abdominal spines. It is true that they are practically absent in *C. trispinosus*, but their occasional appearance on one segment shows that their loss is a recent one. Classifying therefore on the basis of the larval form, we must merge the genus *Cheraphilus* into *Ægeon*, leaving the genus *Pontophilus* to include *P. spinosus* and *P. norvegicus*.

This arrangement seems to fit the adults as well as it does the larvæ. In the first place, Ortmann seems to have made an error in including all the above-mentioned forms in a single genus *Pontophilus*. He gives as characters of this genus "Gills seven; six pleurobranchs (*i, k, l, m, n, o*), and one rudimentary podobranch *h*"; but I have found the following gill-formula to hold for *Cheraphilus trispinosus*, *C. nanus*, and *Ægeon fasciatus* :—

	<i>a.</i>	<i>b.</i>	<i>c.</i>	
VI.....	Ep			
VII. ...	Ep			
VIII...	Ep±	1		
IX.....	...	...	1	
X. ....	...	...	1	
XI. ....	...	...	1	
XII. ...	...	...	1	
XIII. ...	...	...	1	= 6 + 2 or 3 Ep

In *Pontophilus spinosus* there are seven gills, there being a podobranch upon the second maxillipede.

If this statement holds good for the remaining species, then the two genera *Cheraphilus* and *Ægeon* should be separated from *Pontophilus*. As regards their relation to one another, the only important differences between them seem to lie in the shape of the rostrum and the direction of the bend of the apices of the gills (Spence Bate). Such differences do not seem to me of sufficient importance to allow of generic distinction, and I have therefore in the heading of this paper treated the two species dealt with as both belonging to the genus *Ægeon* Risso.

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EXPLANATION OF THE PLATES.

PLATE V.

- Fig. 1. *Crangon fasciatus* (p. 24). First larva, dorsal view. $\times 65$.
 2. " The same, lateral view. $\times 65$.
 3. " Second antenna. $\times 100$.
 4. " First maxilla. $\times 185$.
 5. " Second maxilla. $\times 185$.

PLATE VI.

- Fig. 6. *Crangon fasciatus* (p. 24). First maxillipede. $\times 124$.
 7. *Crangon trispinosus* (p. 27). First larva, lateral view. $\times 65$.
 8. " " dorsal view. $\times 65$.
 9. " " end of first antenna. $\times 140$.
 10. *Crangon nanus* (p. 27). End of first antenna. $\times 150$.
 11. *Crangon trispinosus* (p. 27). 1st pereopod of the last larva. $\times 50$.
 12. " Pereiopods 2 to 5 showing gills. Stage iv. $\times 100$.
 13. " Telson of first postlarval stage. $\times 100$.
 14. *Crangon fasciatus* (p. 24). Last larva, first antenna. $\times 72$.

3. Descriptions of New Species of South-American Coleoptera of the Family *Chrysomelidae*. By MARTIN JACOBY, F.E.S.*

[Received April 9, 1903.]

The following paper is based on the material which has gradually accumulated in my collection during several years, and which contains examples of species of which I have been unable to find any descriptions. The fine insects of the genus *Doryphora*, of which hitherto about 400 species were known, are here further augmented by more than 30 new species. A few others are described from Central America which were not known to me at the time of the publication of the 'Biologia' of that country, and these belong to the genera *Desmogramma*, *Stilodes*, *Deuterocampta*, *Cosmogramma*, *Zygogramma*, *Prosicela*, *Leptinotarsa*, *Calligrapha*, and *Elythrosphaera*.

* Communicated by the SECRETARY.

DORYPHORA BREVIFASCIATA, sp. nov.

Flavous, the antennæ black, the head with two greenish-black spots; thorax with a few fine spots, the base with a narrow transverse greenish band; elytra widened posteriorly, geminate punctate-striate, a sutural band, narrowed posteriorly, the lateral margins, and a short transverse band below the middle greenish æneous.

Length 9 millim.

Head with a few minute punctures, flavous, the vertex with two large subquadrate metallic green spots; antennæ extending beyond the base of the thorax, black, the terminal joints strongly widened, the basal joints flavous below; thorax of usual shape, the surface with a few fine punctures, flavous, the base with a narrow transverse, deeply concave band, not extending to the lateral margins, dark metallic green; scutellum metallic green; elytra wider at the base than the thorax, gradually widened posteriorly, strongly geminate punctate-striate at the inner disc, the sides irregularly punctured below the middle, flavous, the suture with a metallic green band which is suddenly narrowed below the middle, each elytron with a short transverse band at the latter place not extending to either margin and the lateral margins metallic green; below and the legs flavous, the mesosternal process short.

Hab. Brazil. (A single specimen.)

In coloration this species comes near *D. jucunda* Stål, but in the latter the head and underside are metallic æneous, and the elytral transverse band extends across the entire disc and is placed higher up.

DORYPHORA SPHÆRICA, sp. nov.

Subglobular, testaceous, the antennæ and tarsi black; thorax strongly punctured at the sides; elytra strongly geminate punctate-striate near the suture, irregularly punctured at the sides.

Length 9 millim.

Head very closely and finely punctured, labrum testaceous, apex of mandibles black; antennæ with the terminal joints strongly widened, black, the three basal joints flavous below; thorax somewhat narrowed anteriorly, the sides feebly rounded, the anterior angles distinct, but not pointed or produced, the disc convex, finely and sparingly punctured at the middle, strongly and closely semirugose punctate at the sides; scutellum smooth, shining; elytra very convex, deeply punctured in double and treble rows at the inner disc, irregularly so at the sides; underside and legs pale fulvous, the tarsi black, the mesosternal process very short.

This is a species of almost subglobular shape, of which I unfortunately do not know the "habitat," and of which a single specimen is contained in my collection; there will be no difficulty in recognising the species on account of the uniform coloration, the black antennæ and tarsi, in connection with the shape.

DORYPHORA NIGROVARIANS, sp. nov.

Black; thorax sparingly and minutely punctured; elytra finely geminate punctate-striate, flavous, a transverse curved band below the base, another deeply dentate one below the middle not extending to the suture, a small spot at the sides near the apex, and the suture black, the latter widened into a sharp triangular mark near the apex.

Length 10 millim.

Of somewhat flattened appearance, the head sparingly and finely punctured, with a small fulvous spot at the vertex; antennæ with the terminal joints broadly flattened, black, the lower three joints flavous below; thorax rather short, the sides strongly rounded anteriorly, the extreme anterior angles fulvous, the surface obscure greenish black, very sparingly and minutely punctured, the lateral margins accompanied by a row of deep punctures; scutellum black; elytra bright yellow, finely punctured in double or treble rows, except near the apex where the punctuation is more irregular, the suture widened near the apex into an anchor-shaped pointed mark, black; below the base is a transverse black band which curves upwards at the shoulders, this band is widened near the suture, below the middle is another deeply dentate transverse band which touches the lateral but not the sutural margin, lastly a small black spot is attached to the lateral margin near the apex; underside and legs black, the mesosternal process short and broad.

Hab. Brazil.

I do not know the exact locality of this well-marked species, of which I possess a single specimen.

DORYPHORA SEMIVIRIDIS, sp. nov.

Bright metallic green, the elytra fulvous; thorax strongly punctured at the sides; elytra semi-regularly and very deeply punctured.

Length 8 millim.

Head metallic green, the vertex with a small fulvous spot; antennæ with strongly widened terminal joints, black, the lower three joints flavous below; thorax short, more than twice as broad as long, the sides straight at the base, strongly rounded anteriorly, the angles not produced, the surface bright metallic green, impunctate at the middle, strongly punctured at the sides; scutellum metallic green; elytra with the greatest elevation at the middle, pale fulvous, almost foveolate-punctate, the punctures arranged in two or three rows near the suture, more irregularly so at the sides, their epipleuræ fulvous; below and the legs metallic green, the mesosternal process very short.

Hab. Costa Rica.

This must be a rare species, as I have not come across it during the progress of the Central-American monograph in the 'Biologia'; it will find its place near *D. signiceps* Stål, from which it differs

in the non-convex elytral interstices and the more irregular punctation.

DORYPHORA PARAGUAYENSIS, sp. nov.

Metallic green, the labrum and a spot at the vertex testaceous; thorax short and strongly transverse, the sides rugosely punctured, the extreme lateral margins testaceous; elytra flavous, strongly geminate punctate-striate, the suture, the lateral margins, and a discoidal stripe, from the base to below the middle, metallic green.

Length 10 millim.

Head sparingly and finely punctured, metallic green, a central spot at the middle of the vertex and the labrum testaceous; antennæ extending to the base of the thorax, black, the basal joints fulvous below, terminal joints widened; thorax at least three times broader than long, the sides rounded, the anterior angles not produced but acute, the disc sparingly punctured, the sides strongly rugose-punctate, the extreme lateral margins and the anterior angles testaceous, the surface bright metallic green; scutellum of silky green appearance; elytra not wider at the base than the thorax, having their greatest elevations placed at the middle, flavous, each elytron with about ten rows of deep punctures, placed mostly in double rows, those near the suture and the last submarginal row consisting of single punctures only, a sutural band gradually narrowed towards the apex, the lateral margins and a discoidal broad stripe also greatly narrowed posteriorly and abbreviated at the apex, metallic bright green; underside metallic green, coxæ and mesosternal process flavous, the latter very short.

Hab. Paraguay. (A single specimen.)

Of nearly similar coloration as *D. vinula* Stål, but with geminate punctate elytra, differently coloured thorax and underside.

DORYPHORA FLAVIMANA, sp. nov.

Head and thorax flavous, each with four greenish spots, minutely punctured; elytra finely geminate punctate-striate, flavous, the sutural and lateral margins, a spot on the shoulders, a transverse dentate band below the base, and a transverse large spot below the middle dark æneous; underside and legs flavous, antennæ black.

Length 10 millim.

Head with a few very minute punctures, flavous, with four greenish spots placed subquadrately, another very small spot is situated at the edge of the clypeus; antennæ extending beyond the base of the thorax, slender, black, lower two joints flavous below, terminal joints but slightly widened; thorax short, of usual strongly transverse shape, the sides straight at the base, the surface with a few minute punctures, flavous, narrowly margined with greenish æneous; the disc with four greenish spots placed transversely, the two middle ones larger and of elongate shape;

scutellum fulvous; elytra evenly convex, light flavous, punctured in double rows, the punctures fine, rather irregularly placed here and there, all the margins narrowly, and a humeral spot dark æneous, below the middle is a broad transverse band with strongly dentate edges and not extending to the sides, another transverse, slightly curved band is placed below the middle touching the lateral margins but not the suture, the latter is likewise of æneous colour and widened angulately opposite the posterior band, with which it is nearly connected at that place; elytral epipleuræ, underside and legs flavous, the tibiæ streaked with black at the outer margin, mesosternal process short and straight.

Hab. Vilcanota, Peru. (A single specimen.)

In the Museum of the Stettin collection another specimen from Bolivia is contained, sent to me for examination, which I cannot separate from this species, but the elytral band at the base is not dentate but concave at the anterior margin and is connected with the humeral spot, and the posterior band is reduced to a transverse spot not extending to either margin; in other respects there are no differences of importance.

DORYPHORA DIVERSIPES, sp. nov.

Head and thorax flavous, the former with a triangular black mark, the latter with two narrow black bands, impunctate; elytra obscure æneous, closely punctured, the lateral margins flavous; legs and underside testaceous, marked with black.

Length 9 millim.

Of very moderately convex shape; the head impunctate, flavous, with a greenish-black V-shaped mark at the vertex; antennæ short and feeble, blackish, the basal joint and the base of the following two or three joints flavous, terminal joints not longer than broad; thorax with feebly rounded lateral margins, not narrowed anteriorly, the anterior angles not mucronate, the disc impunctate, flavous, with two narrow blackish bands from the base to the apex, one at each side, and slightly curved, shape of the thorax twice and a half broader than long; scutellum flavous; elytra not wider at the base than the thorax, obscure brownish æneous, finely and closely punctured, the punctures near the suture arranged in indistinct double rows, the lateral margins narrowly flavous, with a single row of deeper punctures; underside testaceous, the sides of the breast and the abdomen partly black, legs flavous, femora and tibiæ with a black streak below, tarsi entirely black; mesosternal process flavous, very short.

Hab. Peru. (A single specimen.)

DORYPHORA AMICTA, sp. nov.

Underside bluish black, upperside metallic violaceous; head and thorax obscure bluish, finely punctured; elytra closely semi-punctate-striate, the interstices minutely granulate and aciculate here and there.

Length 12 millim.

Of subquadrate, parallel shape; the head sparingly and finely punctured, dark blue, subopaque, labrum testaceous, stained with black; antennæ extending below the base of the thorax, black, apex of terminal joints fulvous, the latter joints widened but longer than broad; thorax of usual shape, the sides strongly rounded anteriorly, the anterior angles mucronate, the disc very minutely and rather closely punctured, of the same colour as the head; scutellum black, shining; elytra finely punctured in closely approached rows, which are fairly regular even at the sides, the interstices minutely granulate and partly aciculate, their epipleuræ blue without, testaceous within, the mesosternal process long and straight.

Hab. Peru. (A single specimen.)

This species cannot be referred to *D. prasina* Erichs.: the elytra are violaceous and the rest of the insect is dark blue, not green; the sculpturing of the thorax and elytra is different, and the latter are neither widened posteriorly nor produced at the apex as Stål states in his description of the species. The punctuation of the elytra also differs from that of the other blue species from the same locality.

DORYPHORA SEMINIGRA, sp. nov.

Black, the elytra dark metallic green, subopaque; thorax very closely punctured at the sides; elytra with closely approached, double, irregular rows of punctures.

Length 15 millim.

Head closely punctured round the eyes, black; antennæ with the terminal five joints widened, slightly longer than broad, entirely black; thorax twice as broad as long, the lateral margins straight at the base, rounded near the apex, the anterior margins acutely pointed, the surface flattened at the sides, the latter finely rugosely punctured, the middle sparingly and very finely punctate, black, opaque; scutellum black; elytra dark green, moderately shining, strongly punctured in irregular double rows, closely placed; underside and legs black, mesosternal process short and stout.

Hab. Peru. (A single specimen.)

Larger than *D. prasina* Erichs., of different coloration, and with the sculpturing of the elytra stronger and geminate, the latter have their greatest elevation at the middle.

DORYPHORA BISTRIGUTTATA, sp. nov.

Greenish black, the thorax closely and strongly punctured, with a fulvous spot at the anterior margin; elytra very closely and strongly punctured at the sides, semipunctate-striate near the suture, greenish, each elytron with a round spot near the scutellum, another near the apex, and a transverse band at the middle fulvous.

Length 14 millim.

Head finely punctured between the eyes, opaque, greenish;

antennæ short and filiform, black, the lower two joints fulvous below, the apex of the last joint likewise of this colour, terminal joints slender, not widened; thorax rather more than twice as broad as long, the sides straight at the base, rounded anteriorly, the anterior angles acute but not produced, the disc closely rugose-punctate at the sides, less closely punctured at the middle, dark greenish, with a small fulvous spot placed at the middle of the anterior margin; scutellum black; elytra with the greatest elevation near the base, strongly deflexed posteriorly, more strongly punctured than the thorax, the punctures larger at the sides near the base and crowded, the inner disc more regularly punctured in rows, dark greenish, with a rounded spot near the scutellum, a more elongate and larger spot near the apex, a transverse band at the middle (not extending to either margin), and the lateral margins from the base to the middle fulvous; the latter colour also extends to the epipleuræ in the same degree; mesosternal process long and slightly curved.

Hab. Colombia. (A single specimen.)

Much smaller than *D. fulgora* St., and with entirely differently shaped fulvous markings.

DORYPHORA SEXSPILOTA, sp. nov.

Testaceous, the underside and legs metallic greenish black; thorax impunctate, the disc greenish, the lateral margins flavous; elytra geminate punctate-striate near the suture, irregularly punctured laterally, the sutural margin, a small spot on the shoulder and two others near the suture, before and below the middle, metallic greenish.

Length 10 millim.

Head with a few fine punctures, green, opaque; antennæ short, black, the lower joints fulvous below, terminal joints slightly widened; thorax with feebly rounded sides, the anterior angles pointed but not produced, the middle of the disc impunctate, the sides finely punctured, flavous, the middle portion greenish, opaque, in shape of a broad transverse band, the sides of which are concave and acutely separated from the flavous portion; scutellum metallic green; elytra strongly and very closely punctured, the punctures from the suture to the middle of the disc arranged in double rows, the sides irregularly punctate, the interstices raised into smooth longitudinal narrow lines, the suture narrowly metallic green, the shoulders with a Λ -shaped green spot, two other spots are placed between the third and fourth interstices before and below the middle; underside and legs greenish black, shining, the mesosternal process very short and blunt.

Hab. São Paulo, Brazil. (Three specimens.)

DORYPHORA SUBMETALLICA, sp. nov.

Æneous, the head and thorax opaque, nearly impunctate; elytra

regularly punctate-striate, testaceous, the basal margin, a broad sutural band, connected with a transverse band before the middle and extending downwards, and the lateral margins narrowly æneous.

Length 12 millim.

Head with a few very minute punctures, dull æneous; antennæ black, the lower two joints fulvous below, the terminal joints widened (the last two joints wanting); thorax twice as broad as long, the lateral margins straight, the anterior angles acute, pointed, the surface of the same colour as the head and similarly sculptured, opaque; elytra with their greatest elevation near the base, punctured in very regular rows, the punctures rather elongate in shape, piceous, the ground-colour flavous, the lateral margins very narrowly and the suture broadly dark æneous, the base with a narrow æneous stripe extending to the middle of the width of the elytra, followed by a broad transverse æneous band which at each end curves downwards at right angles to below the middle, this downward branch is rather suddenly constricted at its middle; underside and legs metallic æneous, shining; meso-sternal process moderately long and straight.

Hab. Peru. (A single specimen.)

DORYPHORA ECUADORIENSIS, sp. nov.

Black, thorax closely and finely punctured; elytra flavous, strongly, closely, and irregularly punctured, the suture greenish black, a transverse spot at the shoulders of triangular shape, a small sutural spot, another below the middle, and a curved elongate stripe at the sides bluish black.

Length 10 millim.

Head closely and finely punctured; antennæ short, black, the basal two joints flavous below, terminal joints gradually and but little widened, the last joint long; thorax black, with a slight greenish tint, the anterior angles acute but not tuberculate, the disc very closely punctured at the sides and the base, the punctures of different size, middle of the disc sparingly punctate, the sides with an obsolete depression; scutellum triangular, greenish black; elytra rather pointed at the apex, flavous, very closely and strongly punctured, especially so at the sides, the punctures of piceous colour, irregularly placed with some indications of rows near the suture, the latter greenish black, the shoulders with a transverse triangular spot, nearly connected with another small sutural spot below the base, a curved elongate, posteriorly narrowed stripe at the sides, and another small subsutural spot, both below the middle, blackish; underside and legs greenish black, the meso-sternal process rather short.

Hab. Ecuador. (A single specimen.)

This is not a variety of *D. instabilis* Stål, which the species resembles somewhat, as the elytral sculpturing as well as that of the thorax are quite different.

DORYPHORA HISTRIONICA, sp. nov.

Greenish black, the head and thorax sparingly punctured; elytra regularly punctate-striate, the sutural and lateral margins greenish black and accompanied by a flavous, narrow stripe.

Length 9 millim.

Head with a few fine punctures; labrum testaceous; antennæ black, the basal two joints fulvous below, terminal joints widened; thorax of usual shape, the sides straight, the anterior angles scarcely pointed, the surface finely and sparingly punctured at the middle, more strongly so at the sides; scutellum blackish; elytra evenly convex, finely and regularly punctate-striate, each elytron with ten rows of punctures, a sutural and a more narrow lateral stripe greenish black, the third and the ninth interstice flavous, joined at the apex, the rest of the surface fulvous; the mesosternal process stout and curved.

Hab. Bolivia. (A single specimen.)

A small species, well distinguished by its system of coloration.

DORYPHORA FRUHSTORFERI, sp. nov.

Head black; thorax impunctate, black, the sides and a spot at the anterior margin flavous; elytra finely geminate punctate-striate, flavous, the sutural and lateral margins and two rounded spots placed transversely below the middle black; underside black, legs and antennæ fulvous.

Length 10-11 millim.

Head entirely impunctate, black, opaque; labrum flavous; antennæ extending to the base of the thorax, fulvous, the terminal joints transversely widened, the last one more elongate; thorax more than twice as broad as long, the sides slightly rounded, the surface entirely impunctate, black, a spot at the middle of the anterior margin and the sides (in shape of a subtriangular large spot) flavous; elytra very finely and regularly geminate punctate-striate, flavous, the sutural and lateral margins narrowly black, below the middle a black spot is attached to the lateral margins and a larger spot is placed between it and the suture; the underside black, the legs fulvous, with the posterior femora more or less stained with piceous, mesosternal process short.

Hab. Espirito Santo, Brazil.

Of this very distinct species I received two specimens from Mr. Fruhstorfer.

DORYPHORA VIRIDIORNATA, sp. nov.

Dark fulvous; thorax minutely punctured, with two broad metallic green spots or bands; elytra strongly punctured in double rows, pale fulvous, each with a transverse broad metallic green band at the base and a triangular spot below the middle.

Length 9 millim.

Head extremely finely punctured, fulvous; the vertex with two small greenish spots; antennæ entirely fulvous, the terminal

joints distinctly widened; thorax strongly transverse, the sides rather strongly rounded before the middle, the anterior angles pointed, the surface very finely and subremotely punctured, fulvous, the entire sides occupied by a large subquadrate metallic green patch; scutellum fulvous; elytra with deep but remotely placed punctures arranged in double rows, the punctation much finer towards the apex, flavous or pale fulvous, with a broad transverse metallic green band at the base, not extending to either margin, and another triangular broad spot below the middle; underside fulvous, stained with greenish æneous, legs entirely fulvous, the mesosternal process rather short.

Hab. Peru.

The metallic green elytral patches are separated by the narrow fulvous margins and at the middle by a slightly broader division or fulvous band; those of the thorax are divided at the middle by a narrow, anteriorly widened fulvous band, the sides are likewise more broadly fulvous.

DORYPHORA HONDURAENSIS, sp. nov.

Fulvous, the thorax with four green spots placed transversely, sparingly punctured; elytra strongly punctate-striate, a strongly curved transverse band at the base, another straight band below the middle, and a spot near the apex metallic green.

Length 12 millim.

Head with a few minute punctures, fulvous; antennæ extending to the base of the elytra, fulvous, the terminal joints thickened; thorax with the lateral margins strongly rounded anteriorly, the angles acute, the surface sparingly but strongly punctured, fulvous, with four black spots, placed transversely, two smaller ones at the sides round and two larger elongate ones at the middle; scutellum fulvous; elytra with rows of deep punctures which run in pairs at the sides but single at the inner disc, the ground-colour fulvous, at the base a strongly angulate band of green colour is placed in a slightly oblique direction and not extending to either margin, another band parallel to the first is situated below the middle and a transverse spot near the apex; underside and legs fulvous, the mesosternal process very short.

Hab. Honduras. (A single specimen.)

This species resembles in its system of coloration and pattern *D. viridifasciata* Jac. (Biol. Centr.-Amer., Coleopt. vol. vi. pt. 1), but differs in the entirely fulvous head and in the shape of the first elytral band, which is almost semicrescentic, the other band is also much narrower, slightly angulate near the lateral margins, and both are of slightly oblique direction.

DORYPHORA ÆNEOFASCIATA, sp. nov.

Fulvous; head and thorax finely punctured, each with four green spots; elytra geminate punctate-striate, flavous, a broad transverse band near the base, curved upwards and including a flavous spot and a transverse spot below the middle, greenish æneous.

Length 10 millim.

Head finely and sparingly punctured, fulvous, with four small green spots placed quadrately; antennæ black, lower two joints flavous below, the terminal joints gradually widened; thorax of usual shape, the anterior angles not produced, the surface finely and remotely punctured, fulvous, the anterior and posterior margins and four spots placed transversely on the disc, metallic green; scutellum dark fulvous; elytra geminate punctate-striate, flavous, the lateral margins, the suture, a curved transverse band at the base, greatly dilated at the suture and curved upwards at the shoulders, and an oblique spot below the middle greenish æneous; underside and legs fulvous, mesosternal process short and straight.

Hab. Colombia.

Somewhat similarly coloured as *D. gerstaeckeri* Stål, but with the head and the thorax fulvous and spotted with green.

DORYPHORA TERMINATA, sp. nov.

Black, thorax with a few fine punctures; elytra finely punctate-striate, the interstices slightly convex, black, the apex flavous with a small black spot.

Length 12 millim.

Head impunctate; antennæ black, the terminal joints rather strongly widened; sides of the thorax slightly constricted at the base, feebly rounded, the anterior angles produced outwards into a small point; elytra with distantly placed irregular rows of fine punctures, black, the apex in shape of a broad triangular patch, flavous, including a small black spot on each elytron; legs and underside black, mesosternal process long and curved.

Hab. Costa Rica. (A single specimen.)

Of entirely black coloration with the exception of the flavous apex of the elytra.

DORYPHORA BAHIAENSIS, sp. nov.

Pale fulvous, the antennæ (the basal four joints excepted) black; thorax finely and sparingly punctured; elytral punctuation arranged in irregular double rows, fine, the punctures piceous, surrounding small palish smooth spots.

Length 12 millim.

Head impunctate, fulvous; antennæ rather short, black, the basal four joints fulvous, the terminal joints very broadly flattened; thorax more than twice as broad as long, the sides straight, the anterior angles acute but not pointed or produced, anterior margin deeply concave behind the eyes, the disc finely and sparingly punctured, not more closely but a little more strongly so at the sides; scutellum fulvous; elytra with their greatest elevation at the middle, rather finely punctured, the punctures near the suture here and there arranged in irregular double rows which are more plainly marked near the apex, the interstices with numerous

slightly raised smooth pale spots or patches of irregular shape; below coloured like the upper surface; the mesosternal process long and stout.

Hab. Bahia, Brazil. (A single specimen.)

Distinguished by the unicolorous upper and under sides and by the broadly flattened terminal joints of the antennæ and their colour.

DORYPHORA IMITANS, sp. nov.

Below black, above fulvous; thorax flavous, minutely punctured; elytra finely and irregularly punctured; antennæ black, the anterior femora flavous.

Length 12 millim.

Head nearly impunctate, palpi black; antennæ with the terminal joints distinctly widened, black, the basal joint flavous; thorax scarcely more than twice as broad as long, the sides straight at the base, rather strongly obliquely narrowed anteriorly, the anterior angles pointed, the disc finely and rather closely punctured, the punctures of unequal size; scutellum fulvous; elytra regularly convex, finely punctured in irregular double rows near the suture, the sides irregularly punctate, fulvous, the extreme basal margin piceous, the interstices smooth; below black, the anterior femora entirely, the others more or less fulvous below; the mesosternal process short and broad.

Hab. Colombia. (A single specimen.)

The thorax in this species is less transverse in shape and more suddenly pointed anteriorly than in *D. bahiaensis*; the elytra are differently sculptured and the mesosternal process is much shorter.

DORYPHORA FLAVOANNULATA, sp. nov.

Oblong, below black, above and the legs dark fulvous; thorax remotely and strongly punctured at the sides; elytra regularly punctate-striate, an interrupted ring-shaped band from the base to the middle and an entire similar ring near the apex, flavous; antennæ and the last abdominal segments pale flavous.

Length 9 millim.

Head minutely punctured, pale fulvous, labrum testaceous; antennæ extending beyond the base of the thorax, pale fulvous, terminal joints subquadrately widened; thorax nearly three times broader than long, the sides straight, rounded near the anterior angles only, the disc finely and remotely punctured, the sides more strongly so, but little flattened; scutellum pale; elytra oblong and parallel, moderately convex, regularly and moderately strongly punctate-striate, fulvous, sometimes with a slight greenish tint, a ring-shaped band, interrupted at its inner and posterior margin, extending from the base to the middle and another nearly round and uninterrupted ring near the apex, obscure flavous; below black, with the exception of the fulvous legs and similarly coloured mesosternal process, the latter long and stout, slightly curved, last abdominal segment flavous.

Hab. Peru. (Three specimens.)

Somewhat resembling *D. æstuans* L., but the underside black and the elytral markings in shape of two rings; in all my specimens the anterior band is interrupted near the suture and at the posterior edge, but this may not be always the case.

DORYPHORA SANGUINIPENNIS, sp. nov.

Black, the tibiæ metallic greenish; head with one, thorax with two obscure fulvous spots at the sides, the latter closely punctured; elytra reddish fulvous, finely and irregularly punctured, the interstices minutely aciculate.

Length 14 millim.

Oblong, parallel, the greatest convexity at the base of the elytra; the head very finely and closely punctured, greenish black, with a triangular fulvous spot at the vertex; antennæ extending to the base of the elytra, bluish black, the terminal joints gradually and strongly widened, but slightly longer than broad; thorax twice as broad as long, the sides flattened, the anterior angles not produced, the disc closely, finely, and somewhat rugosely punctured at the sides, much more sparingly so at the disc, the latter blackish, with a small fulvous spot at each side; elytra scarcely wider at the base than the thorax, closely, irregularly, and rather finely punctured, the interstices finely aciculate; mesosternal process rather short and stout.

Hab. Provinz Goyaz, Brazil. (A single specimen.)

DORYPHORA STAUDINGERI, sp. nov.

Greenish black, the last four joints of the antennæ pale flavous; thorax minutely and closely punctured; elytra closely punctured in double or treble rows, flavous, a broad transverse band at the base, a narrower one below the middle, the suture, and numerous small spots below the second band greenish-black.

Length 11 millim.

Elytra with the greatest height at the base, from there to the apex deflexed; head finely punctured, opaque, greenish black, labrum testaceous; antennæ extending nearly to the middle of the elytra, the basal two or three joints below and the terminal four pale yellow, the latter widened, longer than broad, the other joints black; thorax nearly three times broader than long, the sides rounded anteriorly, the anterior angles produced into a point, the surface closely and finely punctured, less closely so at the disc, the sides with a small fovea, the colour similar to that of the head; scutellum shining, blackish; elytra strongly punctured in closely approached treble rows, the margins of the bands irregularly notched, both bands of oblique direction, the first one placed immediately below the base, double the width of the second one, which is situated immediately below the middle, both bands not quite extending to the lateral margins, the second one gradually dissolved into numerous small spots which fill out the posterior

portion of the elytra; the suture likewise greenish black; the epipleuræ blackish; the mesosternal process long and stout.

Hab. Colombia. (A single specimen.)

At once to be separated from other nearly similarly marked species by the colour of the antennæ and other details.

DORYPHORA STERNALIS, sp. nov.

Greenish black; thorax narrow, subquadrate, extremely closely and distinctly punctured; elytra geminate punctate-striate, flavous, with the suture and three narrow elongate stripes on each greenish; mesosternal process extremely long.

Length 11 millim.

Head rather closely punctured, labrum fulvous, stained with black; antennæ with the terminal joints twice as long as broad, black; thorax twice as broad as long, the lateral margins perfectly straight from the middle downwards, almost slightly concave, the anterior angles pointed; the disc broadly flattened at the sides, extremely closely punctured, less crowded at the middle, the interstices slightly wrinkled; elytra distinctly wider at the base than the thorax, strongly geminate punctate-striate near the suture, closely and irregularly punctured at the sides, flavous, the suture and three posteriorly connected stripes, which are wider than the spaces separating them, metallic greenish, the outer interstice near the lateral margins of double the width of the others; the mesosternal process extremely long, extending to the head.

Hab. Ecuador. (A single specimen.)

This species has the longest mesosternum of any *Doryphora* I am acquainted with; it is very pointed and slightly curved.

DORYPHORA NIGROVIOLACEA, sp. nov.

Metallic greenish black below, above blackish purplish, subopaque; thorax obscure greenish, nearly impunctate; elytra extremely finely punctured, with some obsolete more regular rows of punctures here and there.

Length 11 millim.

Head impunctate; antennæ extending beyond the base of the elytra, black, the basal two joints fulvous below, terminal joints widened, longer than broad; thorax rather more than twice as broad as long, the anterior angles pointed, the surface entirely impunctate, of silky appearance; elytra very finely and sparingly punctured, with some punctures placed in distant rows; mesosternal process moderately long.

Hab. Venezuela? (A single specimen.)

This is a very sombre-coloured species, of purplish black, with very finely punctured elytra, of which the rows can only be seen if examined carefully; I know of no other similarly sculptured species. The greatest height of the elytra is at the base if the insect is examined sideways.

DORYPHORA VIGINTIPLAGIATA, sp. nov.

Black, above flavous, head and the disc of the thorax greenish black, the latter extremely minutely punctured; elytra strongly and semiregularly punctured, each elytron with ten obscure æneous elongate spots (4, 3, 3) placed transversely below the base and below the middle.

Length 12 millim.

Oblong, the greatest convexity placed at the middle of the elytra; the head sparingly and finely punctured, with a small flavous spot at the vertex; antennæ nearly extending to the base of the thorax, black, the lower four joints flavous below; terminal joints distinctly widened; thorax more than twice as broad as long, the sides rounded anteriorly, the angles acutely pointed, the surface flattened at the sides, exceedingly finely and closely punctured; the disc, in shape of a large transverse patch, greenish black, the anterior and lateral edges of the patch sinuate, the rest of the surface flavous; scutellum black; elytra closely and strongly punctured in irregular rows, which are slightly arranged in pairs near the suture, flavous, with ten elongate blackish-æneous spots arranged in three transverse rows, one below the base consisting of four spots, of which one occupies the shoulders, the second row below the middle composed of three spots, the outer one of which is strongly transverse in shape, and the third row of three small spots near the apex.

Hab. Espirito Santo, Brazil. (A single specimen.)

This species might easily be mistaken for *D. fasciato-maculata* St., which it resembles almost entirely in coloration and pattern, but is much larger, the thorax is much more transverse and is devoid of the small spot placed at each side of the larger patch as in the above-named species, the elytra have the punctation less regularly and less distinctly geminate. In all specimens of *D. fasciato-maculata* I have seen the thoracic central patch extends quite to the anterior margin; in the present insect the latter is flavous like the sides, in both species the suture is narrowly æneous as well.

DORYPHORA LATERALIS, sp. nov.

Olivaceous green, more or less stained with testaceous below, antennæ entirely testaceous; thorax very minutely and sparingly punctured; elytra strongly punctate-striate, the extreme basal margin and a sutural stripe dark fulvous, the ninth interstice obscure flavous.

Length 15 millim.

Subglobular, deflexed posteriorly, the head impunctate, the labrum testaceous; antennæ slender, the terminal joints scarcely thickened, entirely testaceous; thorax twice and a half broader than long, the sides straight at the base, rounded anteriorly, the anterior angles broad and produced but not mucronate, the disc convex, dull green, subopaque, with some minute punctures, the

extreme margins pale; scutellum greenish brown; elytra very regularly punctate-striate, the punctures deep and closely placed, the interstices slightly convex, impunctate, olive-green, the suture piceous or dark fulvous, the ninth interstice obscure flavous, costate posteriorly; below greenish, the tarsi testaceous more or less mesosternal process stout and straight.

Hab. Espirito Santo, Brazil (*Fruhstorfer*).

Much larger than *D. dejeani* Germ. or the allied species, and at once distinguished by the piceous sutural stripe. I know only a single specimen of this species, which is not an immaculate variety of *D. piceo-maculata* Jac., on account of the totally different elytral sculpture.

DORYPHORA SEXPLAGIATA, sp. nov.

Dark violaceous; antennæ black; thorax extremely finely and closely punctured, the angles fulvous; elytra scarcely more strongly punctured, the punctures partly arranged in rows, the interstices finely aciculate, each elytron with three flavous spots, one at the base, one at the margin at the middle, and the third near the apex.

Length 12 millim.

Below black with a bluish gloss, above violaceous; head with a few fine punctures; antennæ black, the terminal joints subquadrately widened, one-half longer than broad; thorax rather flat, the sides straight, the anterior angles slightly tuberculiform, fulvous, the surface extremely finely and rather closely punctured; scutellum black, impunctate; elytra with the greatest convexity at the base, deflexed at the posterior portion, very finely punctured in closely approached, irregular rows, violaceous, with a transverse spot near the scutellum, another of oblique shape at the middle of the lateral margins, and a third, subtriangular spot near the apex, bright flavous; mesosternal process long and straight.

Hab. Peru. (Two specimens.)

This species must not be confounded with *D. sexmaculata* Jac., also from Peru, in which the elytra are either greenish or brown and are strongly punctate; the spots, although similarly placed, are also of different shape.

DORYPHORA CYANEOFASCIATA, sp. nov.

Dark fulvous below; head and thorax fulvo-æneous, minutely and closely punctured, opaque; elytra regularly and closely punctate-striate, testaceous, with a broad transverse oblique band below the base and a narrower band below the middle, as well as the suture, metallic blue, apical portion with minute bluish spots.

Length 12 millim.

Head minutely punctured, obscure æneous; labrum and palpi fulvous; antennæ blackish, the lower three or four joints fulvous, terminal joints distinctly widened; thorax coloured like the head, twice as broad as long, the sides broadly flattened, rounded from the middle to the anterior angles, the latter mucronate, produced

in front of the eyes, the surface very minutely and evenly punctured; scutellum obscure fulvous; elytra strongly and closely punctate-striate at the anterior portion, much more finely so towards the apex, where the punctation is less regular, of pale flavous ground-colour with two metallic blue bands, the first below the base and of double the width of the second one, extending obliquely to the lateral margins where it is much narrowed, the second band immediately below the middle and running parallel with the first, the suture likewise narrowly margined with blue, and the space between the second band and the apex filled with numerous small bluish spots; elytral epipleuræ, the underside, and legs dark fulvous with æneous gloss; mesosternal process very long and stout.

Hab. Peru. (A single specimen.)

In general markings this species resembles *D. æneofasciata*, but the elytral bands extend quite to the margins and are of different shape and size, and the anterior portion of the elytra is devoid of spots; the sculpture also is quite different. The same remarks apply also to the species when comparing it with *D. bifasciata* Fab.

DORYPHORA FLAVOFASCIATA, sp. nov.

Fulvous, the intermediate joints of the antennæ black; thorax remotely and strongly punctured; elytra strongly punctate-striate, a spot near the scutellum, another near the shoulders, an oblique subsutural and another submarginal longitudinal band, flavous.

Length 12 millim.

Head impunctate; antennæ extending beyond the base of the thorax, the lower five joints fulvous, the terminal two joints flavous, the others black, terminal joints slightly thickened, scarcely longer than broad; thorax three times broader than long, the sides strongly flattened, the lateral margins straight at the base, rounded in front, anterior angles acute, the disc rather strongly and remotely punctured; elytra regularly convex (highest before the middle), finely but rather regularly punctured in closely approached rows, more strongly punctured at the base, with an elongate spot near the scutellum, a submarginal band to which another spot is joined above the shoulders, and another subsutural band abbreviated anteriorly and posteriorly, flavous; below entirely fulvous, mesosternal process very long and nearly straight.

Hab. Colombia. (A single specimen.)

Of nearly similar coloration as *D. chevrolati* St., but much larger, the thorax broader and flattened, and the elytral punctation quite different.

DORYPHORA ÆNEOFASCIATA, sp. nov.

Greenish black below; thorax obscure æneous, very finely punctured, the lateral margins flavous; elytra irregularly punctured, pale flavous, with numerous small æneous spots and two

transverse metallic green bands, one below the base, the other, of oblique shape, at the middle.

Length 10-11 millim.

Head minutely and closely punctured, obscure æneous, opaque; antennæ short, black, the basal two joints below and the apex of the last flavous; thorax about twice as broad as long, the sides straight at the base, rounded anteriorly, the anterior angles mucronate, extending to the end of the eyes, the extreme lateral margins flavous, the disc coloured like the head, very closely and finely punctured, the punctation even throughout; scutellum black; elytra pale testaceous, closely, strongly, and irregularly punctured, covered with numerous, closely placed, green, small spots of irregular shape and size, below the base a narrow transverse metallic green band extends across the suture but not to the lateral margins, another similar band of strongly oblique direction is placed at the middle and is slightly abbreviated at each end; mesosternal process long and robust.

Hab. Peru. (Two specimens.)

Several similarly marked species are known, but they are either of much larger size or devoid of the thoracic flavous margins; in *D. bifasciata* Fab. and *D. maculata* Oliv. the anterior elytral bands are curved upwards and the suture is likewise provided with an æneous stripe; the elytral epipleuræ in the present species are entirely flavous.

DORYPHORA FASCIATIPENNIS, sp. nov.

Greenish æneous, the thorax remotely punctured; elytra closely geminate punctate-striate, a subsutural and marginal longitudinal narrow stripe, connected by a transverse one below the middle, flavous.

Length 8 millim.

Head finely and sparingly punctured; antennæ greenish æneous, the terminal joints moderately widened, twice as long as broad; thorax sparingly punctured at the middle, the sides impunctate; elytra evenly convex, strongly and closely geminate punctate-striate, the first two rows near the suture, single, the flavous bands narrow, the sutural one placed on the third interspace, the lateral one close to the margin which remains of the ground-colour, both bands are joined at the apex and connected below the middle by another short transverse band; the mesosternal process very short, claw-joints unarmed.

Hab. Balzapamba, Ecuador.

A small beetle, resembling in its markings several species of the genera *Zygogramma* and *Cosmogramma*, but a true *Doryphora*.

STILODES FLAVOFASCIATA, sp. nov.

Black, the labrum, palpi, and basal joints of the antennæ flavous; thorax opaque, nearly impunctate; elytra similarly sculptured, black, a narrow transverse and finely divided band at the base,

another below the middle, and a third near the apex, bright flavous.

Length 10 millim.

Head impunctate, black, opaque and of silky appearance; labrum flavous; antennæ extending to the base of the elytra, the lower joints flavous, the terminal three or four joints piceous, one-half longer than broad; thorax strongly transverse, the sides straight, the anterior angles not produced, the surface sculptured like the head, with a few minute punctures; scutellum black, shining; elytra with extremely feeble rows of punctures, which are entirely obsolete below the middle, black, with three narrow transverse bright yellow bands, the first at the base and divided by a very narrow perpendicular black stripe at the shoulders, the second narrow band below the middle, slightly constricted near the sides, the third short and broader band of oblique direction near the apex, elytral epipleuræ flavous; underside and legs black, shining, the trochanters dark fulvous; metasternal epipleuræ nearly impunctate.

Hab. Espirito Santo, Brazil.

Closely allied to *S. transversofasciata* Jac., but of entirely different sculpturing and with the elytral bands of different shape.

STILODES FLAVILABRUM, sp. nov.

Blackish blue, the labrum flavous; head impunctate; thorax finely punctured, opaque; elytra strongly punctate-striate, flavous, a broad band at the base, another below the middle, not extending to the lateral margins, and the apex, more or less, bluish black.

Length 10 millim.

Of rather elongate shape, pointed at the apex, the head opaque, impunctate, greenish; the labrum flavous; antennæ rather slender, blackish, the lower three joints flavous below; thorax about one-half broader than long, the sides straight, the surface opaque, of silky appearance, finely and subremotely punctured, greenish black; scutellum black, shining; elytra with regular and deep rows of punctures, the punctures much finer on the flavous portion and not always evenly placed, the sutural and lateral margins, two broad transverse bands before and below the middle, and the apex to a small extent, bluish-black; underside and legs shining blue-black, the last abdominal segment with a small fulvous spot at each side; the metasternum impunctate at the sides.

Hab. São Paulo, Brazil.

Like the preceding species closely allied to *S. transversofasciata* Jac., but with both elytral bands laterally interrupted, the thorax very finely and the elytra much more strongly punctured, and the general size much larger.

STILODES FRUHSTORFERI, sp. nov.

Black, the antennæ fulvous; thorax sparingly punctured, with two flavous spots anteriorly; elytra punctate-striate, a spot near

the scutellum, another at the lateral margins before the middle, and a transverse spot near the apex, flavous.

Length 9–10 millim.

Head sparingly punctured, black, opaque; labrum and antennæ fulvous, the terminal joints transversely widened; thorax strongly transversely convex, the sides rounded, the anterior angles not produced, the surface sparingly punctured, black, opaque; scutellum impunctate, black; elytra finely punctate-striate, pointed posteriorly, black, opaque, with an oblong spot near the scutellum, a subquadrate spot at the lateral margin before the middle, and another transverse one near the apex, flavous; underside and legs black, shining, apex of the tibiæ clothed with fulvous pubescence.

Hab. Espirito Santo, Brazil (*Fruhstorfer*).

Of this distinctly marked species I have six specimens which I received from Mr. Fruhstorfer.

STILODES ECUADORIENSIS, sp. nov.

Testaceous, the head greenish black; thorax sparingly punctured; elytra regularly punctate-striate, the punctures placed on narrow black stripes, the fourth stripe abbreviated; underside greenish piceous.

Length 10 millim.

Head metallic greenish, finely and sparingly punctured; labrum flavous; antennæ slender, greenish black, the basal joint, the outer ones below and the two or three terminal joints entirely flavous; thorax twice as broad as long, the sides perfectly straight, the posterior angles acute, the surface remotely and strongly punctured, testaceous; scutellum metallic green; elytra with rows of deep punctures, the latter not always regularly placed, the second, third, and fourth, and the sixth, seventh, and eighth rows metallic greenish black in shape of narrow stripes, the fifth row of this colour near the apex only, the others all more or less interrupted posteriorly; underside stained with blackish; legs entirely testaceous.

Hab. Santa Inéz, Ecuador (*Haensch*).

Of this neatly marked species two specimens are contained in my collection.

STILODES (?) *GEOMETRÆ*, sp. nov.

Flavous, two spots at the head, the disc of the thorax, and the breast black; thorax finely punctured; elytra closely and irregularly punctured, flavous, with a narrow oblique olivaceous black band from the shoulders to the middle and another at the sides to the apex, both bands joined at the suture and at the shoulders.

Length 10 millim.

Head closely punctured, black, this colour divided into two large spots by a narrow central flavous stripe, the space in front of the eyes and the labrum likewise flavous; antennæ entirely

flavous, the terminal joints strongly transverse; thorax more than twice as broad as long, the sides straight, the anterior angles produced forwards, the disc finely and closely punctured near the base, less closely so at the sides and anteriorly, the first-named portion flavous, the disc black, this colour in shape of a sub-quadrated patch the sides of which are concave, the anterior edge slightly divided at the middle; scutellum black; elytra somewhat widened posteriorly, closely, irregularly, and rather finely punctured throughout, flavous, with two oblique narrow blackish stripes joined at the shoulders, the first extending below the middle and connected down the suture with the lateral stripe, the flavous ground-colour therefore forms a large triangular patch at the anterior portion and another one at each side, the suture is likewise black for a short distance at the base; the breast black, the abdomen and legs flavous; metasternum scarcely raised, claw-joint bidentate.

Hab. Marcapata, Peru.

This interesting species scarcely fits into any of the groups as arranged by Stål, on account of the entirely irregularly-punctured elytra, at the same time the other characters agree with *Stilodes*; from any of the species the present one is distinguished by the system of coloration and the rather curious pattern of the elytra. I received a single specimen from Herr Bang-Haas, of Dresden.

DEUTEROCAMPTA PUNCTICOLLIS, sp. nov.

Fulvous, the apical joints of the antennæ, the knees, and tarsi black; thorax strongly and closely punctured; elytra regularly punctate-striate, fulvous, the sutural margins narrowly black.

Length 8 millim.

Head finely punctate, fulvous; antennæ black, the basal two joints fulvous, terminal ones transversely widened; thorax of the same shape as that of *D. scutellata*, but more closely punctured, the punctures at the sides scarcely stronger than those at the disc; scutellum fulvous; elytra regularly punctate-striate, each elytron with 10 rows of punctures, the subsutural row abbreviated before the middle, the extreme sutural margins black; the knees and the tarsi black, the rest of the under surface fulvous.

Hab. Brazil?

Closely allied to *D. scutellata*, of which it may possibly be a variety, but the thorax more closely and evenly punctured, the scutellum and underside fulvous, the legs also differently coloured.

DEUTEROCAMPTA SCUTELLATA, sp. nov.

Underside and legs, the terminal joints of the antennæ, and the scutellum black, above fulvous; thorax strongly punctured at the sides, elytra regularly and strongly punctate-striate.

Length 8 millim.

Head impunctate, fulvous; antennæ short, black, terminal joints transverse, broader than long, the lower two joints fulvous;

thorax slightly narrowed anteriorly, the sides obliquely rounded, the surface strongly and closely punctured at the sides, sparingly so at the middle; scutellum black; elytra with very regular and deep rows of punctures, the latter evenly placed, the subsutural row not extending to the middle, the colour like that of the head and thorax; underside and legs black, the metasternal parapleuræ strongly punctured, third tarsal joint simple.

Hab. Brazil.

Differs from *D. luteola* St. in the black scutellum and regular elytral punctuation, from *D. nigrimana* St. in the unspotted thorax, colour of the underside, &c.; also in the same way from *D. obscurimana* St. *D. flavida* St. has the elytra geminate-punctate. I know only of a single specimen of this species, contained in my collection without detailed locality.

DESMOGRAMMA STÄLI, sp. nov.

Dark fulvous, the thorax with a transverse obscure greenish-æneous band, remotely punctured; elytra strongly punctate-striate, the third and the ninth interstice, as well as the basal margin, flavous, the other interstices alternately fulvous and greenish-æneous; underside greenish, legs fulvous.

Length 8 millim.

Head sparingly punctured, fulvous, the space between the eyes greenish-æneous; antennæ with the terminal five joints strongly widened, black, the lower seven joints and the apex of the last one fulvous, third joint very elongate; thorax more than twice as broad as long, the sides straight, the surface remotely and rather strongly punctured, dark fulvous, with an obscure transverse greenish-æneous band placed at the anterior margin and not extending to the sides, to this band another spot is joined at the middle and extending to the base; scutellum flavous; elytra with regular rows of deep punctures, dark fulvous, the second, fourth, sixth, eighth, and tenth interstice greenish-æneous, the third and ninth as well as the basal margin bright flavous, joined at the apex; below greenish, the margins of the abdominal segments and the legs fulvous, the femora stained with æneous: claw-joint simple, prosternum raised anteriorly, metasternum truncate.

Hab. Brazil.

Of this species, quite distinct in its system of coloration from any of its allies, I have a single specimen without detailed locality; the submarginal flavous stripe is slightly curved at the middle and has a single row of punctures posteriorly; the elytral epipleuræ are fulvous.

DESMOGRAMMA PERUANA, sp. nov.

Black, head and thorax finely punctured; elytra regularly punctate-striate, flavous, a sutural band and the lateral margins more narrowly black.

Var. Head and thorax fulvous.

Length 7 millim.

Head scarcely perceptibly punctured, with a slight greenish tint; antennæ black, the basal joint flavous below, terminal joints gradually widened, the last joint more elongate; thorax with straight sides, the anterior angles pointed, the surface very finely and sparingly punctured; scutellum blackish, elongate; elytra wider at the base than the thorax, finely and very regularly punctate-striate, flavous, the suture (to the extent of the third row) and the last marginal interstice black; underside and legs black, claw-joint simple, prosternum tuberculiform and raised anteriorly, metasternum also raised and truncate in front.

Hab. Marcapata, Peru.

The elytral punctures are extremely closely placed, and the sutural band is rather abruptly truncate immediately below the base and greatly narrowed round the scutellum, gradually so towards the apex; the marginal stripe does not quite touch the sutural one at the apex, and extends to the base but not to the basal margin. Three specimens are contained in my collection, one of which has the head and thorax fulvous.

DESMOGRAMMA INCLUSA, sp. nov.

Æneous, the labrum flavous, the antennæ and tarsi dark fulvous; thorax with the anterior margin and two oblique stripes flavous; elytra strongly punctured anteriorly, flavous, the base with a broad transverse æneous band, including a flavous spot.

Length 12 millim.

Head æneous, with a few fine punctures; labrum flavous, palpi and antennæ fulvous, the latter with strongly-dilated terminal joints; thorax with the lateral margins straight, the disc very sparingly punctured, greenish æneous, this colour divided into three spots by two oblique narrow flavous stripes which join the similarly-coloured anterior margin, the darker portions are in the shape of a subquadrate spot at each side and a larger —-shaped spot at the middle; elytra slightly wider at the base than the thorax, strongly punctate-striate at the base, more finely so and irregularly at the lower portion, flavous, the extreme sutural margins and a broad transverse band at the base, not extending to the lateral margins and including a flavous spot near the scutellum, greenish æneous; elytral epipleuræ flavous; underside æneous, legs fulvous, prosternum truncate and raised anteriorly.

Hab. Rio Janeiro, Brazil?

The thorax in colour and pattern agrees with that of *D. parvita* St., but the sculpturing and markings of the elytra are different, the markings somewhat resembling those of *D. fenestrata* St.

DESMOGRAMMA DECEMPUSTULATA, sp. nov.

Black, the antennæ, tibiæ, and tarsi fulvous; head and thorax

minutely punctured, elytra strongly punctate-striate, each with five flavous or fulvous round spots, 2, 2, 1.

Length 10 millim.

Head with a greenish tint, opaque, minutely punctured; labrum and palpi fulvous; antennæ extending below the base of the elytra, fulvous, terminal joints gradually transversely widened; thorax about twice as broad as long, the sides straight, the surface coloured like the head, black, with a greenish tint, finely but not very closely punctured; scutellum black; elytra wider at the base than the thorax, black, rather strongly and regularly punctate-striate, the punctures arranged in double rows at the sides, each elytron with five flavous spots, of these, two are placed at the base (on the shoulder and near the scutellum), the outer one being larger than the other, two at the middle, placed transversely, and one at the apex; underside blackish, the femora near the base, the tibiæ almost entirely, and the tarsi fulvous, the last abdominal segment with a fulvous spot at each side, the prosternum tuberculately truncate anteriorly.

Hab. Espirito Santo, Brazil.

I received a single specimen of this species from Mr. Fruhstorfer.

COSMOGRAMMA UNICINCTA, sp. nov.

Black, with a slight bluish gloss; head and thorax finely and sparingly punctured; elytra regularly punctate-striate, black, with a violaceous tint, the basal margin and a sublateral narrow band bright flavous.

Length 6 millim.

Head finely and rather closely punctured; antennæ black, the terminal joints thickened but rather long, the lower two joints flavous below; thorax with the anterior angles produced into a small tooth, the sides straight, the surface finely and sparingly punctured, the punctures not stronger at the sides; scutellum black; elytra with a slight purplish or violaceous tint, finely and regularly punctate-striate, the tenth interstice and the basal margin bright flavous, the last interstice and the epipleuræ of the ground-colour; claw-joint unarmed, the metasternum truncately produced.

Hab. Peru.

The single flavous lateral stripe separates this species from most others placed in this genus, from which it further differs in the non-dentate claws; *C. patricia* Erichs. is, however, of similar coloration, but dull black, opaque, and with scarcely perceptible elytral punctuation.

COSMOGRAMMA PERUANA, sp. nov.

Black, the thorax closely and strongly punctured; elytra opaque, finely punctate-striate, the third and the last interstice, as well as the basal margin, golden yellow, the marginal band with a row of dark punctures.

Length 7 millim.

Head finely punctured, black, the last joint of the palpi larger than the preceding one; antennæ black, the lower two joints fulvous below, the terminal joints wanting; thorax only about one-half broader than long, the sides straight, the anterior angles almost rectangular, not produced, the disc rather convex, closely and rather strongly punctured, black, shining; elytra opaque, with fine but distinct rows of punctures, which are less regular at the sides, black, with two narrow bright flavous bands placed on the third and last interstice and joined at the apex, the lateral band with a single row of punctures and gradually narrowed posteriorly, where the black margin assumes a wider shape than at the base, the bands are connected at the base by a narrow transverse stripe; metasternum slightly transversely raised, the claw-joint dentate, claws separated.

Hab. Peru.

The present species differs from its allies placed in *Cosmogramma* by the distinctly punctate-striate elytra, the rather narrow and closely-punctured thorax, and the colour of the elytral bands; *C. fulvocincta* St. has fulvous antennæ and legs, similarly coloured elytral bands, and a differently sculptured thorax.

CALLIGRAPHA ANNULATA, sp. nov.

Metallic dark green, the basal joints of the antennæ fulvous; thorax strongly punctured at the sides only; elytra dark fulvous, finely and irregularly punctured, a sutural narrow band, two spots at the base, three before the middle, a ring-shaped mark below the latter, and two other small spots at the apex metallic green.

Var. One or more spots at the anterior portion wanting, the ring-shaped mark interrupted.

Length 6 millim.

Of narrow and elongate shape, metallic dark green, the head with a few fine punctures, the antennæ with strongly thickened terminal joint, black, the lower three joints fulvous, the basal joint æneous above; thorax rather short, metallic green, strongly punctured at the sides only, the disc nearly impunctate; scutellum æneous; elytra finely and irregularly punctured except near the suture, where two rows of punctures accompany the metallic-green stripe; the latter is gradually and slightly narrowed towards the apex; of the spots one is placed on the shoulders, another near the scutellum, both of elongate shape; these are followed by three small spots (when present) placed triangularly; below the middle is an irregular metallic-green ring, sometimes interrupted, and at the apex two small spots are situated.

Hab. Bolivia.

I know of no other similarly marked species which is less convex and rounded than most of its congeners; in the variety, of the three spots placed in a triangle, only the outer one is present.

PROSICELA MACULATA, sp. nov.

Metallic blue or green; thorax finely and irregularly punctured; elytra flavous, strongly punctured in very irregular rows, the suture narrowly, a spot on the shoulders and another below the middle, metallic blue.

Var. The humeral spot absent.

Length 8–10 millim.

Head remotely punctured, antennæ nearly extending to the middle of the elytra, black, the last joint elongate; thorax irregularly and finely punctured, more closely so near the base; scutellum smooth; elytra wider at the base than the thorax, strongly punctured, the rows irregular and often doubled, the suture (to the extent of the first row of punctures) metallic blue, gradually narrowed towards the apex, the shoulders with a small blue spot, the disc below the middle with another short, somewhat obliquely placed, elongate spot.

Hab. Marcapata, Peru.

Closely allied to *P. flavipennis* Erichs., but with more strongly and more irregularly punctured elytra bearing two spots each, which are absent in Erichson's species.

PROSICELA INORNATA, sp. nov.

Metallic dark green, the antennæ black, elongate; thorax very finely and subremotely punctured; elytra pale fulvous, finely and rather closely geminate punctate-striate.

Length 10 millim.

Very closely allied to the preceding species, but the thorax more finely punctured; the elytra geminate-punctate and without any metallic sutural stripe or spots; the sides of the thorax are perfectly straight.

Hab. Prov. Huallaga, Peru.

Similar in coloration to *P. simplicipennis* Jac., but the thorax much more transverse, and the elytra more strongly punctured and in double rows.

ZYGOGRAMMA INTERSTITIALIS, sp. nov.

Greenish æneous; thorax very strongly punctured at the sides, less so at the middle, lateral margins flavous; elytra very strongly punctate-striate, interstices finely punctured, basal margin, third and last interstice flavous, joined at the apex.

Var. Antennæ and tibiæ more or less fulvous.

Length 6 millim.

Head finely punctured, the labrum fulvous; antennæ with the lower four or five joints fulvous, the rest black, strongly transversely widened; thorax with flavous lateral margins, very strongly but sparingly punctured at the sides, somewhat closely but less strongly so at the disc; elytra with deep and rather remotely placed punctures regularly arranged, the sutural rows finer, the third and tenth interstices flavous, the latter with a deep

row of punctures, joined to the third row at the apex, the basal margin likewise flavous, the rest of the interstices finely punctured and transversely wrinkled; claws joined at the base, the third joint dentate at the apex.

Hab. Brazil.

I know of no other species of *Zygogramma* with flavous thoracic margins in which the elytra are so strongly punctured or the interstices finely so; the subsutural flavous stripe gradually approaches the suture towards the apex: in the variety the antennæ and legs are fulvous, and the femora are spotted with æneous, but other differences I cannot find. The punctuation of the thorax varies much in depth and number of punctures, and the elytral wrinkles are also more or less distinct in different specimens.

ZYGGRAMMA ARGENTINENSIS, sp. nov.

Dark greenish, the antennæ black; thorax minutely punctured, the sides more strongly so; elytra with three narrow fulvous vittæ, the discoidal ones joined at the apex, the marginal one with a row of punctures, the subsutural rows geminate.

Length 9 millim.

Larger than any of the species placed in this genus described by Stål, of an opaque greenish colour, the head minutely punctured, the terminal joint of the palpi larger than the preceding one; antennæ black, the basal two joints flavous below, terminal joints widened; thorax very finely punctured, the sides more strongly so; scutellum impunctate; elytra regularly punctate-striate, the subsutural row double (the first row consisting of a few punctures only), the third, fifth, and ninth interstices flavous, the discoidal bands joined at the apex, the fourth interstice rather wider than the others, the marginal flavous vitta with a row of piceous punctures, elytral epipleuræ greenish; claw-joint dentate, claws joined at the base.

Hab. Salta, Argentine Republic.

The larger size, greenish coloration, and the wider fourth interstice separates this species from its allies; the flavous bands are, as usual, joined together by the similarly coloured flavous basal margin. There are three specimens before me.

ZYGGRAMMA CURVATO-LINEATA, sp. nov.

Dark fulvous, the breast greenish æneous; thorax finely and sparingly punctured; elytra flavous with a metallic lustre, each elytron with the following black markings: three short stripes at the base, the inner two joined at the apex, a semicircular band below the middle, another one within the outer band, and a V-shaped mark near the apex; legs fulvous.

Length 8 millim.

Head impunctate, fulvous; antennæ with the terminal joints moderately thickened, longer than broad, entirely fulvous; thorax very sparingly and finely punctured at the base and sides, fulvous; scutellum black; elytra punctate-striate near the suture, finely

and irregularly punctured at the flavous portion, the dark markings also surrounded or bounded by deeper punctures, the suture, to the extent of the second row of punctures, black, in shape of a narrow, anteriorly widened stripe which does not quite extend to the base; of the dark markings three short longitudinal slightly curved stripes are placed at the base, of which the inner two are joined at the apex, these stripes do not extend to the basal margin but the inner ones nearly reach the middle, they are followed by a crescent-shaped narrow band at the sides, within which a smaller nearly ring-shaped mark is placed, near the apex another V-shaped spot is situated, at the middle of the lateral margins there is another smaller black spot, and the elytral epipleuræ are of the same colour; the abdomen and the legs are fulvous; claws united at the base.

Hab. Costa Rica. (In my collection and that of the British Museum.)

The peculiar elytral markings differ from those of any other species of the genus; the flavous ground-colour has a golden hue, which is probably more brilliant in the living insect.

ZYGOGRAMMA BRASILIENSIS, sp. nov.

Reddish fulvous; thorax strongly punctured at the sides, minutely at the disc; elytra finely punctate-striate, black, the third, fifth, and the ninth and tenth interstices, as well as the epipleuræ, flavous, the two inner flavous stripes connected at the apex.

Length 6 millim.

Closely allied to *Z. flavolorata* Stål and *Z. myops* Stål, and to a few other species with flavous elytral stripes and epipleuræ, but at once distinguished from them by the fulvous head, thorax, and legs; the head impunctate; antennæ short, fulvous, the apical five joints black, strongly transverse; thorax strongly transverse, closely and strongly punctured at the sides, fulvous, the basal margin sometimes piceous; scutellum black; elytra finely and regularly punctate-striate, the basal margin and three narrow longitudinal stripes flavous, the discoidal ones joined near the apex, occupying the third and fifth interstices, the outer stripe with a row of punctures, the extreme lateral margins black, the epipleuræ flavous.

Hab. Espirito Santo, Brazil.

Three exactly similar specimens are contained in my collection.

ZYGOGRAMMA BURMEISTERI, sp. nov.

Greenish black; thorax narrowed anteriorly, strongly punctured at the sides; elytra striate-punctate, the interstices slightly convex, the base of the first, the third and fifth entirely, and the tenth flavous.

Length 7 millim.

Head very minutely punctured; antennæ with short, transverse terminal joints, broader than long, black, the basal two or three

joints fulvous; thorax with the sides straight, obliquely narrowed anteriorly, greenish, the sides strongly and closely, the disc minutely punctured; scutellum ovate, black; elytra with deep and regular striæ which are closely and finely punctured, those near the suture impunctate, the basal margin and three longitudinal bands, as well as a short subsutural stripe, fulvous, the two inner stripes joined at the apex and connected at the same place with the lateral stripe, which has a row of black punctures.

Hab. Salta, Argentine Republic.

Readily distinguishable from any other species by the anteriorly narrowed thorax, the convex elytral interstices, and the punctured striæ (not punctured rows), also by the additional short subsutural flavous stripe at the first interstice near the base.

ZYGOGRAMMA CÆRULEO-VITTATA, sp. nov.

Dark fulvous, the breast and abdomen greenish piceous, apical joints of the antennæ black; thorax strongly punctured at the sides only; elytra with three dark blue and three flavous longitudinal bands each, the dark bands closely punctured, the flavous ones joined at the apex.

Length 7 millim.

Head finely and sparingly punctured, dark fulvous, labrum flavous, mandibles robust, strongly punctured and pubescent; antennæ black, the basal six joints fulvous, terminal joints strongly dilated, the last one oblong-ovate; thorax more than twice as broad as long, the sides straight, closely and strongly punctured, the disc very finely punctate; scutellum fulvous; elytra with two regular rows of punctures near the suture, the latter and two longitudinal stripes dark blue, the discoidal stripe abbreviated posteriorly, the alternate interstices flavous, impunctate, joined at the apex, the basal margin also flavous, the marginal flavous band with a single row of punctures, the elytral epipleuræ æneous, except near the apex; legs fulvous, claws united at the base.

Hab. Paraguay.

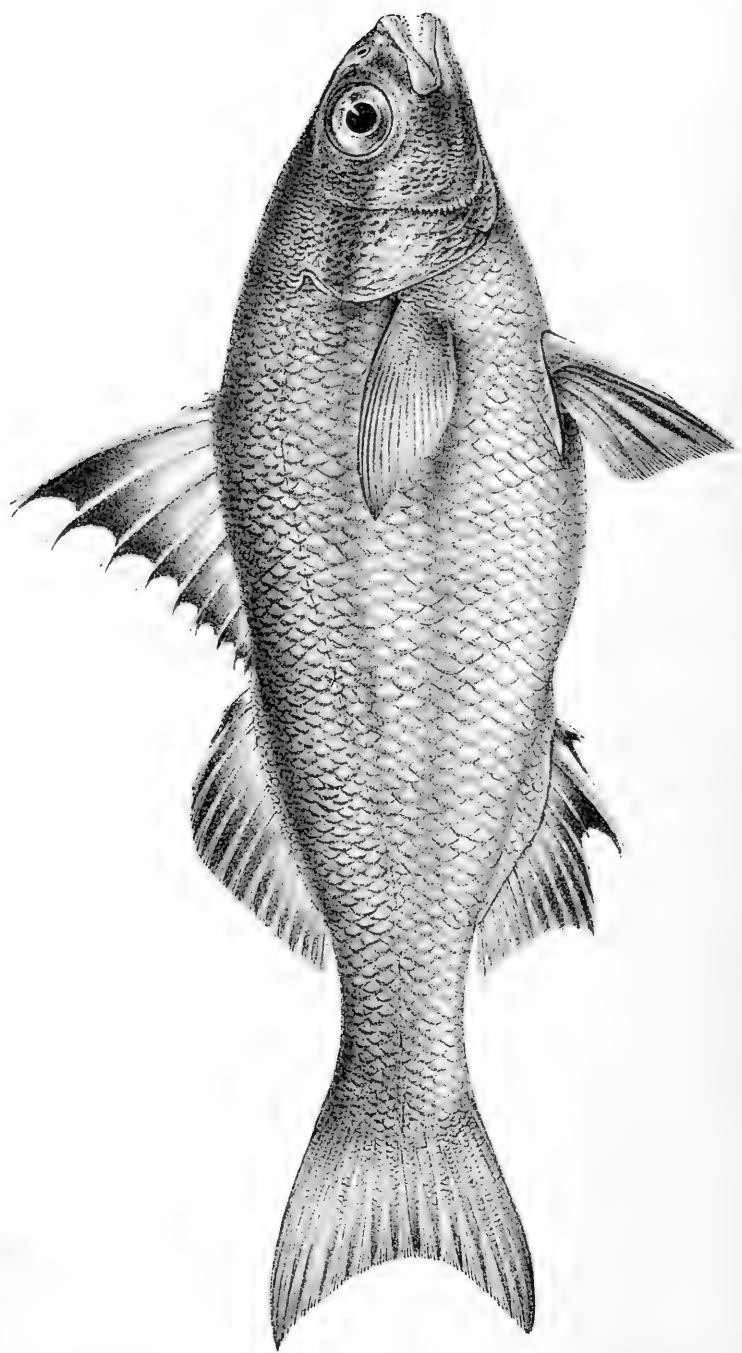
The colour of the antennæ and the blue elytral bands principally distinguish this species, which has its most nearly allied form probably in *Z. 5-virgata* Stål, from which it differs in the details given above.

LEPTINOTARSA PARAGUAYENSIS, sp. nov.

Metallic green, the labrum and antennæ fulvous; head and thorax impunctate, subopaque; elytra regularly punctate-striate, the interstices slightly convex and finely aciculate.

Length 9 millim.

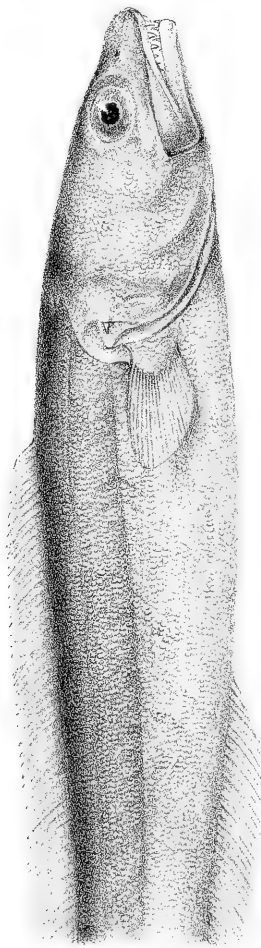
Head entirely impunctate, of silky appearance, the labrum fulvous; the antennæ with the terminal five joints widened, entirely fulvous; thorax with strongly rounded sides, rather convex, the angles not produced, the surface sculptured like the head, without a trace of punctation; scutellum shining; elytra



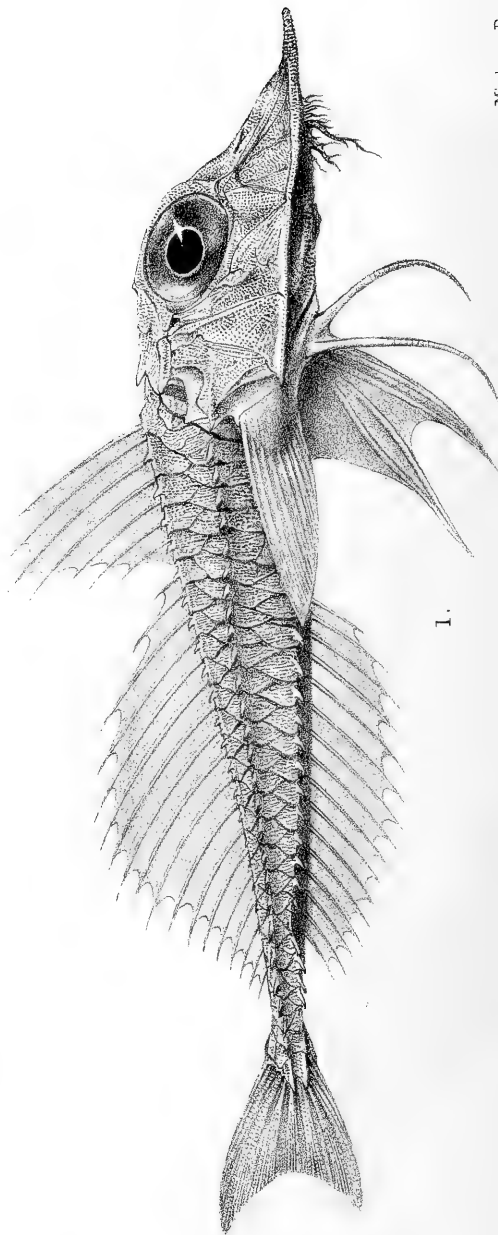
J. Green del et lith.

MYLACRODON GOELDI.

Mintern Bros imp.



2.



1.

with the usual ten rows of extremely closely placed punctures, the sutural row short, the interstices feebly convex and finely transversely aciculate; the underside more metallic, the tarsi fulvous below, mesosternum scarcely raised, its epipleuræ smooth; claw-joint simple, tibiæ with longitudinal sulcus.

Hab. Paraguay.

This species is placed in the genus *Leptinotarsa* on account of the sulcate tibiæ, which have the sulcus extending to half their length; the colour of the antennæ and the slightly convex elytral interstices will easily distinguish the species.

ELYTHROSPHERA CUPREATA, sp. nov.

Ovate, pointed posteriorly, cupreous, variegated with metallic green; antennæ black; thorax deeply and irregularly punctured; elytra deeply foveolate punctate, the punctures arranged in rows, cupreous, the suture metallic green.

Length 10 millim.

Apterous; the head finely punctured, with a central fovea, the vertex metallic green, the lower portion reddish cupreous; labrum and palpi black; antennæ rather long, black, the terminal two joints elongate, thickened, the basal joint metallic green; thorax one-half broader than long, the sides straight, the disc deeply foveolate and partly confluent punctured, cupreous, with a metallic green band at each side; elytra very convex, widened at the middle, the apex pointed, each elytron with ten rows of foveæ, regularly placed, the sutural and lateral margins green, the disc cupreous; underside coloured like the upperside, the tibiæ metallic green, the tarsi black.

Hab. Rocco Nova, Parana, Brazil.

Of this very distinct species a single specimen is contained in my collection.

4. On a Collection of Fishes made by Dr. Goeldi at Rio Janeiro. By C. TATE REGAN, B.A.

[Received April 28, 1903.]

(Plates VII. & VIII.*)

The collection of Fishes made at Rio Janeiro by Dr. Goeldi contains examples of one hundred and twenty-five different species, four of which are described below as new to science, one of these belonging to a new genus. As most of the species represented have been recorded either from Rio Janeiro or from not very distant points on the Atlantic coast of S. America, it would be superfluous to give the full list; in a few cases, however, the occurrence of a species at Rio Janeiro has been thought worth special notice, and the opportunity has been taken to add some notes and to give diagnoses where it seemed useful. Dr. Goeldi

* For explanation of the Plates, see p. 68.

has presented the types of the new species and other desiderata to the British Museum, whilst the greater part of the collection has been sent to the Museum at Berne.

RAIIDÆ.

RAIA CYCLOPHORA, sp. nov.

Snout with an obtuse triangular projection of moderate length. Anterior border of pectoral emarginate. Eye-diameter $3\frac{1}{2}$ –4 times in the distance from their anterior margin to the tip of snout and equal to interorbital width. Mouth strongly curved, 36–38 rows of teeth in the upper jaw. Body smooth, except for a series of 10–11 spines on the dorsal surface of the tail, and, in the male, a double series of curved spines on each pectoral.

Male with claspers extending to below first dorsal fin.

Uniform brownish, with a conspicuous black circle on each pectoral near the middle of its base.

Description based on two examples from Rio Janeiro—a female, 480 mm. in total length, and a male, measuring 410 mm.

MURÆNIDÆ.

MURÆNA HELENA Linn.

Five specimens from Rio Janeiro are all dark brown in colour, with numerous small white spots on the head, body, and fins. Examples from the Mediterranean in the British Museum Collection are similarly coloured, and it seems probable that *M. insularum* Jordan & Davis, from the Galapagos Is., which is said to differ from *M. helena* in having this system of coloration, in reality may not be distinct.

ATHERINIDÆ.

ATHERINICHTHYS BRASILIENSIS Quoy & Gaim.

Of two examples one has four dorsal spines, the other five. In the original description it is stated that the lower jaw is shorter than the upper, so that Messrs. Jordan and Evermann are incorrect in referring this species to *Chirostoma*, which is distinguished by "the very long and strong mandible, which protrudes beyond the upper jaw." The *Atherinichthys* brought from Mexico by Sallé and named *A. brasiliensis* by Dr. Günther, is a distinct but allied species, which I propose to name *A. sallei**.

* *ATHERINICHTHYS SALLEI*, sp. nov. :—Depth of body rather less than length of head, 5 times in total length. Snout much shorter than eye, the diameter of which is $2\frac{2}{3}$ times in length of head and equal to interorbital width or length of post-orbital part of head. Lower jaw somewhat shorter than upper; maxillary extending to vertical from anterior margin of eye. Sc. 43/10. D. IV, I 8; A. II 19. Spinous dorsal commencing above origin of anal; anterior rays of soft dorsal and anal produced, longest anal rays equal to depth of body; pectorals falcate, as long as head; origin of ventrals equidistant from posterior opercular margin and first anal ray; caudal emarginate. A sharply defined silvery lateral band as broad as a scale. Description based on a single example, 75 mm. in total length, from Mexico.

This species agrees in every respect with Messrs. Jordan and Evermann's definition of *Menidia*. It resembles *A. brasiliensis* in the disposition of the fins and number of rays, but the latter species has a much longer head, longer snout, smaller eye, &c., and very indistinct lateral band.

SERRANIDÆ.

Many authors have regarded *Serranus flaviventris* Cuv. & Val. as the female of *S. auriga* Cuv. & Val. Messrs. Jordan and Evermann give descriptions of three species, viz.: *S. dispilurus* Günther, *S. subligarius* Cope, and *S. auriga* Cuv. & Val., adding *S. flaviventris* to the synonymy of the last; but in a footnote they state that very probably these three species are identical. I have arrived at the conclusion that *S. dispilurus* and *S. subligarius* belong to the synonymy of *S. flaviventris*, which is very different from *S. auriga*, as may be seen from the short diagnoses given below.

SERRANUS AURIGA Cuv. & Val.

Depth of body about equal to length of head, $2\frac{3}{4}$ – $2\frac{3}{4}$ times in total length. Snout as long as eye, the diameter of which is $3\frac{1}{2}$ – $3\frac{3}{4}$ times in the length of head and twice the interorbital width. Maxillary not extending to below middle of eye, the width of its distal extremity $\frac{1}{2}$ the diameter of eye. Præoperculum with vertical posterior and horizontal inferior limb, the angle rounded; lower opercular spine stronger and further back than upper. D. X 12–13, commencing slightly in advance of axil of pectoral, third spine very elongate. A. III 7, second spine not, or but little, longer than third, its length about $2\frac{1}{5}$ times in that of head. Sc. 48–52 $\frac{6-7}{15-17}$, not extending on to upper surface of head; $5\frac{1}{2}$ rows between soft dorsal and lateral line. Two dark blotches on lower half of body, the anterior including ventrals, the posterior extending on to anal, a light area between them.

Diagnosis based on four examples from Rio Janeiro, the largest 150 mm. in total length.

SERRANUS FLAVIVENTRIS Cuv. & Val.

Dules flaviventris Cuvier & Valenciennes, iii. p. 113 (1829).

Centropristis brasiliensis Brisout de Barneville, Rev. Zool. 1847, p. 131.

Centropristis dispilurus Günther, Proc. Zool. Soc. 1867, p. 99.

Centropristis subligarius Cope, Proc. Ac. Philad. 1870, p. 120.

Dules auriga Steindachner, Sitzb. Ak. Wien, xcvi. I. 1888, p. 57, pl. i. fig. 2.

Serranus auriga (part.) Boulenger, Cat. i. p. 287 (1895).

Depth of body about equal to length of head, $2\frac{1}{2}$ –3 times in total length. Snout as long as or a little longer than eye, the diameter of which is 4 – $4\frac{1}{2}$ times in the length of head and $1\frac{1}{3}$ – $1\frac{1}{2}$ times the interorbital width. Maxillary extending to well beyond middle of eye, the width of its distal extremity $\frac{1}{2}$ the diameter of eye. Præoperculum evenly rounded in the whole extent of its posterior margin; lower opercular spine not stronger and not further back than upper. D. X 12–13, commencing somewhat behind axil of pectoral, third spine not elongate, fourth or fifth highest. A. III 7, second spine stronger and longer than third, its length

about $2\frac{1}{5}$ times in that of head. Sc. 43-46 $\frac{5}{12-14}$, extending on head to posterior margin of eye, 4 rows between soft dorsal and lateral line. 5-7 dark vertical bars on upper part of body, extending on to dorsal fin; a light area on lower part of body in front of anal; a pair of conspicuous black spots on base of caudal.

Diagnosis based on four examples (including the types of *C. dispilurus*) from the W. Indies, the largest 98 mm. in total length. The smaller size of the specimens described makes it still more notable that the eye is smaller and the mouth extends farther back than in *S. auriga*, whilst other differences are sufficiently numerous.

PRISTIPOMATIDÆ.

Diagramma cavifrons Cuv. & Val., from the coast of Brazil, has been redescribed by Boulenger as *D. goeldii*; this was doubtless due to Günther having erroneously placed this species in *Pristipoma*, so that it appears from the British Museum Catalogue that the genus *Diagramma* is exclusively Indo-Pacific. The synonymy of this species is as follows:—

Diagramma cavifrons Cuvier & Valenciennes, v. p. 290, pl. 123 (1830).

Pristipoma cavifrons Günther, Cat. i. p. 286 (1859).

Genyatremus cavifrons Gill, Proc. Ac. Nat. Sci. Philad. 1862, p. 256.

*Genyatremus luteus** Jordan & Fesler, Proc. Ac. Nat. Sci. Philad. 1889, p. 504; Jordan & Evermann, Fishes N. Am. ii. p. 1342 (1898).

Diagramma goeldii Boulenger, Ann. Mag. Nat. Hist. (6) xx. 1897, p. 294.

MYLACRODON, gen. nov.

Body compressed. Scales moderate, cycloid; lateral line complete, concurrent with the dorsal profile, the tube straight, not extending the whole length of the scale. Mouth moderate, protractile; the maxillary slipping for most of its length under the præorbital, exposed distally, without supplemental bone. A series of conical teeth in each jaw, posteriorly becoming shorter, rounded and molar-like; internal to these anteriorly one or two series of small rounded molars; no teeth on tongue or palate. Head scaly; nostrils close together, rounded, the anterior largest; no pit below the chin; præoperculum serrated; operculum not spinate. Gill-membranes united far forward, free from the isthmus; seven branchiostegals; pseudobranchiæ present; gill-rakers rather short. Two dorsals continuous at the base, with XI, I 13 rays; anal with III 10 rays; both with a scaly sheath at the base. Pectorals asymmetrical, with 18 rays, the upper rays longest; ventrals below pectorals, each with a strong spine and a scaly axillary process; caudal emarginate.

* The identity of this species with *Lutianus luteus* Bloch is extremely doubtful.

Air-bladder large, with two long lateral horns anteriorly and with a series of compartments along each side: anteriorly attached by a strong unpaired muscle running forward above the œsophagus.

MYLACRODON GOELDII, sp. nov. (Plate VII.)

Depth of body $2\frac{2}{3}$ – $2\frac{4}{5}$ times in total length, length of head $3\frac{1}{2}$ – $3\frac{3}{5}$ times. Snout as long as eye, the diameter of which is 4 times in the length of head, interorbital width $3\frac{1}{4}$ times. Lower jaw included within the upper; maxillary extending to below anterior quarter of eye; præorbital entire. 12–13 gill-rakers on lower part of anterior arch. Sc. 55–60 $\frac{7-8}{16-18}$; upper part of head, cheeks, and opercles scaly; snout, jaws, and præorbital naked. D. XI, I 13, commencing somewhat behind the axil, first spine very small, second short, third longest and equal to $\frac{3}{4}$ – $\frac{5}{6}$ the length of head, thence decreasing; anterior soft rays longest, equal to seventh spine. A. III 10, first spine short, third $\frac{2}{3}$ – $\frac{3}{4}$ of the length of second, which is equal to half the length of head. Pectorals scaly at the base, $\frac{2}{3}$ – $\frac{3}{4}$ the length of head, ventrals a little longer, not extending to vent; caudal strongly emarginate. Dark grey above, silvery below, fins blackish.

Description based on two examples from Rio Janeiro, 225 and 230 mm. in total length.

GERRIDÆ.

The East Indian genera *Gazza* Rüppell and *Liognathus* Lacep. (*Equula* Cuv.), until now placed with or near the Carangidæ, are without doubt very nearly allied to *Gerres*, which they most closely resemble not only in external features but also in their internal anatomy. The relations of the genera of this family are shown in the subjoined key:—

- | | |
|---|--------------------------------|
| A. Scales moderate or large; gill-membranes free from the isthmus. | |
| D. IX–X 10; A. II–III 7–9 | 1. <i>Gerres</i> Cuvier. |
| D. IX–X 15–16; A. V 13–14 | 2. <i>Pentaprion</i> Bleeker. |
| B. Scales small; gill-membranes narrowly joined to isthmus; D. VIII 15–16. A. III 14. | |
| Teeth in jaws minute | 3. <i>Liognathus</i> Lacepède. |
| Teeth in jaws rather strong, compressed, pointed... | 4. <i>Gazza</i> Rüppell. |

The distinction of the species of the genus *Gerres* is a matter of some difficulty. Dr. Goeldi's collection includes examples of a *Gerres* belonging to the section with præoperculum and præorbital serrated and with dark longitudinal lines along the rows of scales, and which I identify with *G. patao* Poey. Nearly all the American species of this section resemble each other very closely in proportions of the head and body, size of the eye, extent of the mouth, and number of scales and fin-rays; and it appears that the most constant characters which can be used for specific distinction are the number of gill-rakers, the length of the second

dorsal and anal spines and of the pectoral, the number of rows of scales between the lateral line and the sheath at the base of the dorsal fin, and the number of anal rays, III 7 or III 8. Messrs. Jordan and Evermann give the number of anal rays for one species as III 7-8, but I have been unable to find a single case throughout the genus where the number of anal rays is variable in a species, and there is good reason for supposing that in this instance two different species have been confounded. The same authors regard *G. patao* Poey as identical with '*G. brasiliensis* Cuv. & Val., which is said to be only doubtfully distinct from *G. lineatus* Humboldt, in the synonymy of which *G. axillaris* Günther is included. Other species regarded by them as valid are *G. brevimanus* Günther, *G. plumieri* Cuv. & Val., *G. embryx* Jordan & Starks, and *G. mexicanus* Steind.

After examining all the available material in the British Museum Collection and referring to the original descriptions, I have arrived at conclusions somewhat different from those of the authors above mentioned, and the relations of the American species of this section which I regard as valid are shown in the following key and short revision:—

Præorbital and præoperculum serrated; dark longitudinal lines along the rows of scales.

I. Anal with III 8 rays.

A. Pectoral $\frac{3}{5}$ length of head 1. *G. brevimanus* Günther.

B. Pectoral as long as or a little longer than head.

a. Second dorsal spine as long as or a little longer than head.

Second anal spine $\frac{3}{5}$ length of second dorsal spine ... 2. *G. plumieri* Cuv. & Val.

Second anal spine $\frac{2}{3}$ length of second dorsal spine ... 3. *G. mexicanus* Steind.

b. Second dorsal spine $\frac{3}{5}$ — $\frac{2}{3}$ length of head.

About 15 gill-rakers on lower part of anterior arch... 4. *G. lineatus* Humboldt.

About 12 gill-rakers on lower part of anterior arch... 5. *G. axillaris* Günther.

II. Anal with III 7 rays 6. *G. patao* Poey.

GERRES BREVIMANUS Günther.

This species is at once distinguished by its short pectoral; the body is a little less elevated than in its allies; second anal spine $\frac{4}{5}$ the length of second dorsal spine, which is $\frac{4}{5}$ the length of head; 11 very short gill-rakers on lower part of anterior arch.

A single example from Chiapas, West coast of Mexico.

GERRES PLUMIERI Cuv. & Val.

The elongate second dorsal spine and the second anal spine nearly as long are diagnostic; pectoral as long as head or a little longer; 13-14 very short gill-rakers on lower part of anterior arch.

Atlantic coasts of Tropical America. Lake Yzabal.

GERRES MEXICANUS Steindachner.

This species, from the R. Teapa, apparently differs from the preceding only in the shorter second anal spine.

GERRES LINEATUS Humboldt.

The British Museum possesses only a single example of this species, from Mazatlan. The pectoral is a little longer than the head; the second anal spine nearly equals in length the second of the dorsal, which is a little less than $\frac{3}{4}$ the length of head. 15 very short gill-rakers on the lower part of anterior arch; 6 scales between first dorsal spine and lateral line, and 4 rows of scales between dorsal sheath and lateral line for nearly the whole length of the dorsal fin.

Apparently this species occurs also on the Atlantic coasts of Tropical America, whence it has been described as *G. brasiliensis* Cuv. & Val. and *Gerres embryo* Jordan & Starks. There is nothing in the descriptions of these species which does not apply to *G. lineatus*, except that Messrs. Jordan and Evermann give the number of gill-rakers on the lower part of the anterior arch as 11 for *G. brasiliensis*, but probably this number has been taken from specimens with 7 soft rays in the anal, which are here regarded as belonging to another species, viz. *G. patao* Poey.

GERRES AXILLARIS Günther.

Three examples of this species from Chiapas agree in having 5 scales between the first dorsal spine and the lateral line, and only 3 rows of scales between the dorsal sheath and the lateral line for the whole extent of the sheath. There are 12 gill-rakers on the lower part of the anterior arch, which, although short, are longer than in *G. lineatus* and nearly equal to $\frac{1}{4}$ the diameter of eye. In other characters similar to the preceding species.

GERRES PATAO Poey.

The resemblance of this species to *G. lineatus* is most remarkable, and it is only to be separated from it by the anal with III 7 rays, and the fewer and somewhat longer gill-rakers, of which there are about 11 on the lower part of the anterior arch, about $\frac{1}{5}$ the diameter of eye in length. Some examples have the premaxillary groove densely covered with small scales as far forward as the anterior margin of the eye, but in others these are deciduous, and in some even the premaxillary groove shows no trace of having been scaly, so that this is an unsafe character to use in specific diagnoses.

Hab. Atlantic coast from Cuba to Bahia.

TRIGLIDÆ.

PRIONOTUS BEANII Goode.

This species has hitherto been known only from one specimen, from off Trinidad, and the taking of another at Rio Janeiro seems worth recording.

PERISTEDION ALTIPINNIS, n. sp. (Plate VIII. fig. 1.)

Depth of body $5\frac{1}{2}$ – $5\frac{2}{3}$ times in total length, length of head
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about $2\frac{2}{5}$ times. Snout, including processes, $1\frac{2}{3}$ times as long as eye, the diameter of which is 4 times in the length of head, interorbital width $4\frac{2}{3}$ times. Interorbital space concave; no spines on snout. Anterior processes longer than broad, flat, rounded, with denticulated edges; from each a ridge running backwards, ending in a rather broad, flat, somewhat obtuse præopercular spine; a short ridge below eye, without spine; a short feeble spine above posterior part of eye, a stronger one behind it near posterior margin of head, below which another, somewhat weaker; operculum with well-developed spine. Margin of lower jaw with groups of short tentacles and a pair of longer fringed tentacles which extend back scarcely beyond the cleft of mouth. Gill-rakers moderate, about 16 on lower part of anterior arch. 27 scutes in 4 longitudinal series, the 3 upper series with strong recurved spines, the spines of the lower series quite rudimentary. D VIII, 17, the spines slender, the third longest and equal to $\frac{3}{5}$ the length of head, thence decreasing; soft rays increasing in length to about the sixth, which is as long as the longest spine, thence decreasing. A I 16, about $\frac{3}{2}$ the height of dorsal; pectoral half as long as head; ventrals extending to anal; caudal emarginate. Greyish (in spirit); pectorals dark.

Description based on two examples from Rio Janeiro, the larger 190 mm. in total length.

This species is very distinct from others so far described, and it is difficult to say which should be considered its nearest ally.

CARANGIDÆ.

The American species of the genus *Scombroides* Lacep. (*Chorinemus* Cuv. & Val.) belong to the section *Oligoplites* Gill, distinguished by having 4-5 dorsal spines, no pterygoid teeth, cheeks with sclerous plates attached to the suborbitals, and linear scales. There has been considerable difference of opinion as to the number of species which ought to be recognised.

Three examples of *S. saliens* Bloch from Rio Janeiro agree in every particular with others in the British Museum Collection from the Pacific Coast of Mexico and Ecuador. This species is readily distinguished by the anterior dorsal with 4 spines, the deep body (depth $2\frac{3}{4}$ -3 times in total length), and the wide mouth (the maxillary extending well beyond the eye). *S. palometa* Cuv. & Val., hitherto regarded as a variety or subspecies of *S. saliens*, is really quite distinct, the depth of the body being contained about $3\frac{2}{3}$ times in the total length and the maxillary only extending to below the posterior margin of the eye, or a little beyond. This species has hitherto been recorded only from the fresh or brackish waters of Lake Maracaibo, Venezuela, but the British Museum Collection contains a small example from Lake Yzabal, a large inland lake communicating by the Rio Dulche with the Bay of Honduras. *S. altus* Günther and *S. saurus* Bl. Schn. each has five spines in the anterior dorsal; in the former the body is deep,

as in *S. saliens*, and the maxillary extends to below the posterior margin of the eye; the latter has a more slender body than any other species of this section, and the maxillary not reaching the posterior margin of the eye; like *S. saliens*, it occurs on both the Atlantic and Pacific coasts. A fifth species, *S. mundus* Jordan & Starks, from the Pacific Coast of Central America, is said to differ from *S. altus* in having a larger mouth; an example received from Dr. Jordan under this name has only four spines in the anterior dorsal, and is identical with *S. saliens*: it may be that the number of spines is variable in this species.

SCOMBRIÆ.

American ichthyologists distinguish between *Scombromorus regalis* Bloch and *S. maculatus* Mitchill; but the supposed differences are so few, so trivial, and, judging by the few specimens I have been able to examine, so inconstant, that there can be but little doubt that the two are not distinct, and that the latter should be added to the synonymy of the former. American authors also agree in considering *Cybium immaculatum* Cuv. & Val. to be a synonym of *Scombromorus cavalla* Cuv. & Val. I am inclined to think, however, that two small examples in the British Museum Collection should be referred to *S. immaculatus*, and that they are specifically distinct from *S. cavalla*, two large examples of which are included in Dr. Goeldi's collection. The number of fin-rays is the same and the course of the lateral line similar in both species, and the differences will be apparent from the following short comparison:—

SCOMBROMORUS CAVALLA Cuv. & Val.

Depth of body $5\frac{1}{2}$ – $5\frac{2}{3}$ times in total length, length of head $4\frac{2}{3}$ times; depth of head (at level of upper angle of gill-opening) $1\frac{2}{3}$ times in its length, diameter of eye 6 – $6\frac{1}{2}$ times. Gill-rakers nearly equal to $\frac{1}{3}$ eye-diameter, 8 on lower part of anterior arch. Jaws with about 15 teeth on each side. Body dark above, silvery below, with traces of dark oval spots on the sides.

Two specimens, 560 and 620 mm. in total length, from Rio Janeiro.

SCOMBROMORUS IMMACULATUS Cuv. & Val.

Depth of body $3\frac{1}{5}$ –4 times in total length, length of head 5 times; depth of head $1\frac{1}{3}$ times in its length, diameter of eye $4\frac{1}{2}$ – $4\frac{4}{5}$ times. Gill-rakers knob-like rudiments, 8–9 on lower part of anterior arch. Jaws with 8–10 teeth on each side. Body dark above, silvery on sides and below, without spots.

Two specimens, 150 and 185 mm., from San Domingo.

OPHIDIIDÆ.

The genus *Genypterus* Philippi is distinguished from *Lepophidium* Gill by the stronger dentition, the outer series of teeth

in the jaws being large and pointed, and the palatines having a single series of strong teeth. The scales are small, regularly arranged, deciduous; all the species have a strong opercular spine, and in none is a spine on the snout developed.

GENYPTERUS BRASILIENSIS, sp. n. (Plate VIII. fig. 2.)

Depth of body about 7 times in total length, length of head about $4\frac{1}{2}$ times. Snout a little longer than eye, the diameter of which is 5-6 times in the length of head, interorbital width about 7 times. Lower jaw shorter than upper; maxillary extending beyond posterior margin of eye, the width of its distal extremity equal to diameter of eye. Scales on upper surface of head extending as far as posterior margin of eye; cheeks and opercles scaly; interorbital space, snout, and jaws naked; 15-18 rows of scales between anterior dorsal rays and lateral line. About 8 gill-rakers on lower part of anterior arch, the upper of moderate length, graduating to rudiments below. Dorsal beginning above posterior third of pectoral when laid back; pectoral 3 times in length of head, posterior ray of ventral twice. Greyish above, silvery below.

Description based on five examples from Rio Janeiro, the largest 440 mm. in total length.

Apparently no species of this genus has hitherto been described from the Atlantic coast of America. In all other species the dorsal commences above the middle of the pectoral when laid back.

PLEURONECTIDÆ.

SOLEA FONSECENSIS Günther.

The occurrence of this species at Rio Janeiro is interesting, as it has been previously recorded only from the Pacific coast of Mexico and Central America. I have carefully compared the single example in Dr. Goeldi's collection with others from the Gulf of Fonseca and the Rio Presidio, and am unable to detect the least difference between them.

LOPHIIDÆ.

LOPHIUS PISCATORIUS Linn.

A small specimen from Rio Janeiro is exactly similar to others of this species from both sides of the North Atlantic.

EXPLANATION OF THE PLATES.

PLATE VII.

Myliacodon goeldi ($\times\frac{3}{4}$), p. 63.

PLATE VIII.

Fig. 1. *Peristedion altipinnis* ($\times\frac{3}{4}$), p. 65.

2. *Genypterus brasiliensis* ($\times\frac{1}{2}$), p. 68.

May 26, 1903.

G. A. BOULENGER, Esq., F.R.S., Vice-President,
in the Chair.

The following papers were read :—

1. List of the Batrachians and Reptiles collected by M. A. Robert at Chapadá, Matto Grosso, and presented by Mrs. Percy Sladen to the British Museum. (Percy Sladen Expedition to Central Brazil.) By G. A. BOULENGER, F.R.S., V.P.Z.S.

[Received April 25, 1903.]

BATRACHIA.

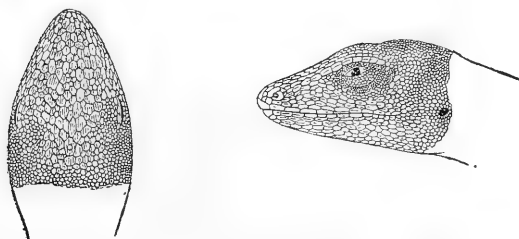
1. BUFO TYPHONIUS L.
2. EUPEMPHIX NATTERERI Stdr.
3. HYLAS NASICA Cope.
4. HYLAS SENICULA Cope.
5. HYLAS VENULOSA Laur.
6. LEPTODACTYLUS TYPHONIUS Daud.
7. PALUDICOLA SIGNIFER Gir.
8. CERATOPHRYS CRISTICEPS F. Müll.
9. HYLAS GOLLMERI Ptrs.

REPTILIA.

LACERTILIA.

1. NOROPS SLADENIÆ, sp. n. (Text-fig. 2.)

Text-fig. 2.



Upper and side views of head of *Norops sladeniæ*, enlarged two diameters.

Very closely allied to *N. auratus* Daud., but less slender in

form; head broader, less than twice as long as broad; scales on the snout tri- to quinecarinate, upper labials more numerous (6 or 7 to below centre of eye), scales on the body smaller (84 to 88 round the middle of the body), and the dorsals relatively smaller and passing more gradually into the laterals. The hind limb does not reach beyond the ear. Greyish or coppery brown above, with an ill-defined lighter vertebral line, which may be flanked on each side by a series of small blackish, oblique transverse spots; belly pale golden, gular region bright yellow.

	millim.		millim.
Total length	172	Fore limb	23
Head	14	Hind limb.....	37
Width of head	8	Tibia	11
Body	43	Tail	115

Three female specimens.

2. *POLYCHRUS ACUTIROSTRIS* Spix.
3. *LIOCEPHALUS CADUCUS* Cope.
4. *TROPIDURUS SPINULOSUS* Cope.
5. *HOPLOCERCUS SPINOSUS* Fitz.
6. *AMEIVA SURINAMENSIS* Laur.
7. *MABUIA AURATA* Schn.
8. *MABUIA FRENATA* Cope.

OPHIDIA.

9. *LIOPHIS ALMADENSIS* Wagl.
10. *APOSTOLEPIS ASSIMILIS* Reinh.

2. Note on some Mollusks of the Family *Bulimulidæ* from Matto Grosso. (Percy Sladen Expedition to Central Brazil.) By EDGAR A. SMITH, I.S.O., F.Z.S.

[Received April 25, 1903.]

Some specimens of *Bulimulidæ*, all of which are in perfect condition, have recently been presented to the British Museum by Mrs. Percy Sladen. They were collected at Corumba, Matto Grosso, by Mr. A. Robert, and two of the species are useful as coming from a locality different from that whence the specimens already in the Collection were obtained, and the third is of interest as being new to the Museum.

BULIMULUS MONTIVAGUS d'Orbigny.

Bulimulus montivagus d'Orbigny; Pilsbry, Man. Conch. ser. 2, vol. xi. p. 90, pl. xi. figs. 29, 30, pl. xiv. figs. 14, 15; vol. xiv. p. 147.

Only a single specimen was obtained by Mr. Robert. It agrees exactly with the figs. 14 and 15 above cited, the shell there depicted also having been collected at Corumba. On comparing this specimen with d'Orbigny's types, I have come to the conclusion, in agreement with Mr. Pilsbry, that the change of name proposed by M. Ancey for this shell was not necessary.

BULIMULUS CORUMBAENSIS Pilsbry.

Bulimulus corumbaensis Pilsbry, Man. Conch. ser. 2, vol. xi. p. 68, pl. xiv. figs. 3-8.

The colour, as described by Pilsbry, is fairly typical, but the ground-colour may vary from "opaque white" to a vinous tint, and "the dark brown or corneous longitudinal streaks" are sometimes replaced by pellucid stripes. The form also is variable, some specimens being broader and more robust than others. Mr. Pilsbry described this species from specimens collected at Corumba by Mr. Herbert H. Smith.

DRYMÆUS PÆCILUS d'Orbigny.

Drymæus pæcilus, Pilsbry, Man. Conch. ser. 2, vol. xi. p. 285, pl. xlix. figs. 49-57.

This species varies considerably in size, form, and colour. Six of the seven Matto Grosso specimens are whitish or yellowish, and most have upon the body-whorl seven more or less interrupted dark zones, the four uppermost being sufficiently disconnected to appear like rows of spots, whilst the three lower ones are but very slightly interrupted. Pilsbry's figure 50 represents this form, except that the spire is hardly acuminate enough. His fig. 53 is rather like the seventh specimen, which, however, is still more darkly coloured.

3. The Present State of Knowledge of Colour-heredity in Mice and Rats. By W. BATESON, M.A., F.R.S., F.Z.S., Fellow of St. John's College, Cambridge.

[Received May 26, 1903.]

With the revival of interest in the experimental study of variation and heredity which has followed the discovery of Mendel's work, Mice have naturally been chosen by several investigators as a subject for experiment. To the breeder mice offer attractions from their small size, cheapness, healthiness, and rapid rate of multiplication. They have further the great advantage that the same male can be simultaneously tested with several females. They are, however, short-lived, $1\frac{1}{2}$ years being a high limit of the breeding age. There are also more serious drawbacks. They are extremely addicted to eating their young. It is not easy to label a live mouse in a permanent fashion, and special

methods have to be adopted for tracing the identity of the individuals, which in such work is indispensable. Another difficulty arises from the fact that mice present few readily estimable features of structure. Also, though there are now many types of colour, few of them as yet exist as pure strains, and hence it is not easy to obtain reliable material with which to begin the experiments. Nevertheless, in spite of these drawbacks, the subject is a good one, and there can be no doubt that our knowledge of heredity can be rapidly extended by experiments on mice. As regards Rats the case is similar, save in one respect, in which there is a very remarkable difference, namely that the colour-types of fancy rats are as yet extremely few. For this reason, though the scope of experiment is reduced in the case of rats, some serious complications are eliminated, and certain fundamental questions, as, for example, the relation of pied to self-coloured varieties, could probably be studied more easily in rats than in mice.

As a great deal of work on these species is now being done, it has seemed to me useful to codify the chief information already at our disposal, and to state as carefully as is yet possible some of the more immediate problems presented by the existing facts.

It would greatly assist discussion of these problems if uniform names could be used for the colour-types. An attempt is therefore made to suggest such names, and to indicate how the types may be recognised. The specimens examined for this purpose have been obtained chiefly from Mr. J. Wilson Steer, of 45 Raleigh Road, Hornsey, N., and from Mr. Atlee, of Royston, Cambs., and I am greatly indebted to both of these well-known breeders of mice for information and assistance. The microscopical examination and discrimination of the types was carried out by Miss F. M. Durham. This work is only in a preliminary stage and, it is hoped, will form the subject of a separate communication.

Microscopical examination shows the hairs of mice to contain numerous minute medullary spaces separated from each other by bridges of keratin. These spaces are arranged in longitudinal rows, the number of which varies from one to four (perhaps five), thick hairs having usually more rows than thin hairs. The pigment is deposited in two ways:—(1) massed in the proximal walls of the medullary spaces, and (2) scattered in the external cortex. Since air bubbles out of the spaces when reagents are applied, the spaces probably open to the exterior.

The pigments in wild *M. musculus* or *sylvaticus* are readily seen to be of three kinds:—(1) Densely opaque *black*. (2) Less opaque *brown*. (3) Transparent *yellow*. The chemical nature of these pigments and their possible relations to each other seem to be quite obscure. If the hairs are cleared of air, the three kinds of pigment can be recognised. On treating with 40 per cent. aqueous solution of potash, the yellow dissolves at once. The brown disappears much more slowly, but is rather more soluble than the black, which can

withstand the treatment more than 24 hours, though ultimately it also (and the keratin) disappears.

The brown may be present in both medulla and cortex; the black is chiefly deposited in the medulla, but may be cortical also, while it is doubtful whether the yellow is ever present except in the medulla.

All these pigments may coexist in the same hair; but hairs are found with only black and brown, others containing only black and yellow. Other types possibly occur. The lighter colour is mostly peripheral (in hairs which contain other colours), but brown often is present in the cortex at levels where the medulla contains black.

In *M. sylvaticus* the condition is similar, but the amount of black is less.

The different colour-types of fancy mice are due to the presence or absence of one or more of these pigments in various amounts. Both the yellow and the brown may exist separately, without any other pigment being discoverable, but, so far, no mouse has been seen having *black* only, some brown being always associated with black.

Each chief type of coloration, black, brown, and yellow, exists in at least two forms—the one more *intense*, the other more *dilute*. The dilution, which affects both medulla and cortex, seems to be due to greater scarcity of the pigment-granules, not to diminution in their size.

The following list includes all the types examined, though some probably remain to be seen. Waltzing mice, so far, have not been examined. The fanciers' names are generally retained, as on the whole distinctive and practical. Owing, however, to the ambiguity in the use of the term "fawn" to denote both "yellow" and colorations containing other pigments, the term "yellow" is used for the type containing yellow pigment only.

1. *Ordinary Cinnamon* (or *Agouti*). The colour of *M. musculus*, having same *three* pigments. Exists in at least two strains, one rather darker than the other. This is doubtless the "grey" of most writers. Pied forms and strains common.

2. *Golden Agouti*. Like (1) but yellower. Contains *brown* and *yellow*, without black.

3. *Sable*. This rather striking type is like (1) on the back, but with yellow hairs interspersed at sides. Flanks almost wholly yellow. Pied with white this colour gives the so-called "tricolor."

4. *Blue-and-tan*. Not examined microscopically. [Probably sable in which black is diluted.]

5. *Chocolate* = *Plum*. Contains brown alone. May be pied.

6. *Silver-fawn*. A diluted form of (5). Many hairs have colourless tips.

7. *Yellow*. Contains yellow only. Often called "fawn," though this term is also applied sometimes to colour containing brown or black. When dark pigment is present in association with predominant yellow the colour is spoken of as "dingy" or "sooty fawn."

8. *Cream*. Diluted yellow.

9. *Black*. Both black and brown present, without yellow. The bases of the hairs are the darkest, and the black does not extend to the tips of the large contour hairs, which are brown. Hairs behind the ears or on belly are a still lighter brown. Complication arises from the fact that at least two kinds of black exist, known as "black" and "sable-bred black," viz. thrown by sables. These two kinds probably differ in their hereditary properties. Pied forms common.

10. *Blue*. Diluted form of (9); both black and brown pigments coexisting. Blues may be thrown by the "blacks" (not sable-bred) and then breed true. Pied forms exist.

11. *Albino*. No pigment in any part. As albinos, however produced, breed true to the albino character generally, if not universally, individuals of dissimilar origins are often mixed together. One strain at least, that of Mr. Atlee, is recognised in the fancy as having special features of size and shape, and has been kept distinct for many generations.

12. *Black-eyed white*. Strains of this type have been independently produced twice, perhaps oftener. The degree of pigmentation in the eye varies in at least one strain, some eyes being full black, others looking blackish red. Whether the type ever breeds quite true we cannot say. In our experience offspring with small black marks occur (compare phenomenon seen in albino Guinea-pig, p. 76).

13. *Variegated*. In these, irregular *small* spots of black or chocolate occur on a white ground. Such forms are quite distinct from the ordinary piebald and Dutch-marked (viz. like the Dutch rabbit) combinations of colour with white.

In comparing colours care must be taken that specimens are of similar age and in similar moult-stages. Differences of intensity of colour are of course characteristic of different strains, and probably intermediates can be found; but there is no doubt of the practical distinctness of each of the forms enumerated. "Brindling," viz. lighter or even white hairs distributed as ticking, occurs in some of the coloured varieties, as in rabbits, but we have not been able to examine specimens.

As to the age and mode of origin of the several forms little is known certainly. Several conditions are plainly due to resolution of compound characters, such as often follows crossing in animals and plants. The blue, the black-eyed white, and the variegated are certainly productions of the last few years; the rest (? sable) have existed for a long time.

The question how far *M. sylvaticus* has been used in the production of the varieties is a very important one. The experiment was suggested many years ago in 'Fancy Mice' and has probably been often tried. Mr. Atlee has given me a most circumstantial account of a cross with this species made by him nine years ago on black-and-white does, and I feel no reasonable doubt that it

was actually made. The first generation were "agoutis" of very large size. Later generations gave amongst others a strain of blue, and of black-eyed white. A strain of agouti has also been saved from it. He tells me that this formerly had the *white feet*, a character he carefully bred out. Such a cross may have affected the whole race of fancy mice at the present day. Our search for structural characters referable to *sylvaticus*, however, has failed to show any case of *one* pair of pectoral mammae (as in *sylvaticus*) or any case of *long* hind foot. All specimens examined were pure *musculus* in these features. On the other hand, a feature sometimes seen in fancy mice, and greatly valued by exhibitors, is a *large eye*, much exceeding the size in an ordinary *musculus*. But this eye, though large, is still smaller than that of *sylvaticus*. Nevertheless the large eye is a modern feature in the fancy, and I think it not impossible it may have been derived from a *sylvaticus* ancestor. Further experiment alone can decide this question.

In order to appreciate what follows, the reader must have some acquaintance with at least the outline of the Mendelian principles of heredity. In their simplest expression these principles, as they are exhibited for instance in the experiments of Cuénot (12), are easily comprehended; but when we pass from these simplest phenomena to the more complex facts elsewhere witnessed, we soon reach difficulties which our experimental evidence is as yet only adequate to elucidate tentatively and in part.

Cuénot experimented by making reciprocal crosses between albino, pink-eyed, fancy mice, and wild grey mice (*M. musculus*). He was careful to use *wild* mice in order to be sure that his coloured form was pure. As a result he obtained always and without exception grey mice. In Mendelian terms, grey is therefore *dominant* over albinism, which is called by contrast *recessive*. The first filial generation thus produced, which we may conveniently call F_1 , when bred *inter se*, gave a total of 198 greys and 72 albinos, constituting the second filial generation, or F_2 . The ratio of dominants (D) to recessives (R) is here 2.75 to 1, a fairly near approach to the ratio 3:1, which on the simplest form of the Mendelian hypothesis is to be expected. In other words, the facts are, as Cuénot stated*, in agreement with the supposition that in the formation of the gametes of the hybrid F_1 , there is complete segregation of the grey colour from albinism, and that in both male and female hybrids there are on an average equal numbers of gametes produced bearing each of these two characters.

According to the same hypothesis, the grey mice in F_2 should consist of pure or *homozygous* greys (DD) and of *heterozygous* greys (DR) in the proportion of 1:2.

Cuénot tested this to some extent by breeding the F_2 dominants

* Cuénot's paper seems to be the earliest application of Mendelian principles to animals.

inter se, and found that some pairs gave the expected mixture, while others gave dominants only. Qualitatively therefore the result is the normal one. It is not stated that the "extracted" albinos were tested, but there is little doubt that, in accordance with *almost* universal experience, they would have produced nothing but albinos.

A leading fact illustrated by Cuénot's experiments, viz. the recessive nature of albinism, is borne out by the whole series of experiments under review. The fact is true of albinos in mice, rats, guinea-pigs * (Cumberland, 13; Castle, 7), and rabbits (Castle), so far as experiments have reached. Cases of the production of albinos by coloured rabbits (*e.g.* Polish by Dutch, albinos by silver-greys) are frequent in the fancier's literature. The contrary, the production of coloured animals by albinos, is not, so far as I know, illustrated by a single case, with the following exception. In the later editions of 'Fancy Mice' (Upcott Gill), Dr. Carter Blake, formerly secretary of the Anthropological Institute, commenting on the statement that albino mice of whatever parentage produce nothing but albinos, writes (p. 16) that a pair of albinos produced some brown-and-white, some plum, some grey, and some albinos. If this result occurred under all precautions, it stands alone.

Nevertheless we should be cautious in declaring the result impossible, for in Mendelian experiments the observer must be on the look out for the appearance of a character, elsewhere a definite dominant, *as the consequence of crossing two dissimilar recessives*. Not only may a dominant colour be produced by crossing two forms having a recessive colour,—*e.g.*, purple flowers by crossing the white *Datura lewis* with white *D. ferox*; purple flowers in Sweet-Pea by crossing white "Emily Henderson" round-pollened form with the long-pollened form of the very same white variety; purple flowers in the Stock by crossing two white varieties:—but also a dominant *structural* character, hoariness, may be produced by crossing glabrous (recessive) stocks of different colours, *e.g.*, red and cream, or red and white †. In each of these cases the appearance of an atavistic character occurs as a consequence of the union of gametes bearing dissimilar characters; but the character in which the reversion appears is of a class different from that in which the parental differentiation was seen.

The same may very possibly be true of animals also. But in each of the cases known, the two varieties united, though alike bearing the same recessive character, differ obviously in some other respect; and we know that the cross-bred raised by their union is a heterozygote, *i.e.* a zygote formed by the union of dissimilar gametes. It is, I think, scarcely likely that Carter Blake's case of the mice is really to be so regarded, and on the whole the hypothesis of error is more probable; but the possibility

* Small "smudges" are said to occur irregularly in albino cavies, however pure.

† This statement is based on results of experiments made by Miss E. R. Saunders, as yet unpublished.

that colour may be influenced by structure, and structure by colour, must be remembered.

Naturally we may inquire whether albinism in Man is not a similar recessive. Castle has given evidence pointing in this direction. The occurrence of albinism in the families of first cousins (see Day, Seligmann, &c.) is consistent with this view; but there are a few recorded cases of the occurrence of albinos in the offspring of albinos breeding with normal parents, where the hypothesis that the normal parent was DR is not at all easily admissible. No case of the union of two human albinos is known to me. The matter cannot here be further discussed, and the reader must refer to the literature, the most important paper being that of Cornaz*.

There are a few cases on record where the production of albino offspring by animals and plants must almost certainly be regarded as the occurrence of a new and original variation, though the cause of such sporting is entirely unknown.

We here encounter the first problem calling for experimental study. What is an albino? We know that it appears to form no pigment; but such a body has other characteristics also. While the blood of pigmented animals shows intravascular clotting on the injection of nucleo-proteids, that of the albino is declared to be unaffected. The mountain hare is said in this respect to behave as a normal in its summer coat, but as an albino after the winter change. How these differences are related to the want of pigment we do not know. Such an inquiry offers a wide field for experiment. In particular, we ought to know how the albino or the normal behaves towards the nucleo-proteids of an *albino*, and so forth. However this may be, there seems to be but little doubt that the albino-bearing gametes can generally segregate that character entire, as they divide from the colour-bearing gametes of the hybrid zygote of any colour; and if we knew more clearly what is the real physiological difference between colour-secreting and albino organisms, we might get a clearer conception of the nature of such segregation.

We may consider next the work of Crampe, which is on a large scale and relates entirely to Rats. His latest paper is dated 1885 (10), and consequently is pre-Mendelian in treatment. He bred nearly 14,000 rats, and made elaborate records and tables of conclusions. Many of these observations are readily available so far as they provide simply qualitative as opposed to quantitative evidence; but after many attempts I have not succeeded in unravelling the material enough to group the statistics in Mendelian form †. Though only a sketch can be here given, many of

* The student of albinism who refers to the paper of Legrain (Bull. Ac. Méd. Bruxelles, ix. 1866) should remember that it is the curious instance cited by Darwin (Life and Letters, i. p. 106) as a deliberate invention.

† The figures given (10) pp. 555 & 612 are the likeliest, but even these obviously contain certain heterogeneous elements now not distinguishable with confidence.

these qualitative observations are of great value and will provide a basis for future work.

In rats the Mendelian rules, in their simplest form, are plainly inadequate to express the facts, and we soon meet a number of deductions of specific application, each needing full investigation. Crampe's account is long and difficult to follow. At first sight also it seems not wholly consistent in certain particulars, but the conclusions here summarised seem well established.

Breeding albino rats with wild *M. decumanus*, Crampe found that F_1 might have *one of two forms*, being either a self-grey like the wild type, or grey with white marks. Unfortunately no precise description of this and of the other broken-coloured rats is given, and we do not know the precise extent and distribution of the white*. According as F_1 presented the first or second form, the subsequent offspring produced from F_1 bred *inter se*, differed. The whole series of colours presented by such offspring is arranged by Crampe in seven types, thus:—

1. Self-grey.
2. Grey with white marks.
3. White and grey.
4. White (albino).
5. Black-and-white.
6. Black with white marks.
7. Black without marks.

The self-coloured grey in F_1 gave in their posterity all the types *except 3 and 5*, but F_1 of type 2 gave all seven types.

The nature and cause of the heterogeneity in F_1 is as yet unexplained. Such an occurrence is, however, not rare. In my own poultry experiments for example, the dark feathers scattered in the white F_1 raised between a brown and a white breed may be either chequered or plain black. According as one or the other form appears in F_1 the posterity probably differ, though this point is not yet established in the case of poultry.

The existence of two classes in F_1 indicates in all probability the existence of two classes of gametes, either in the wild *decumanus* or in the albinos, but in which we cannot say. From the evidence, it seems that both forms of F_1 could be produced by the same pair of parents, but I cannot find the fact explicitly stated. Both forms occurred in F_1 not only when *decumanus* was crossed with albino, but also when it was crossed with type 3 and with type 5.

Only the albino could cause all seven types to appear in progeny (F_2 &c.) raised from a cross with the wild type.

The albino was recessive to all the other six types, and albinos of whatever parentage gave nothing but albinos when bred

* First crosses shown me by Miss Douglas were grey except for an irregular but small amount of white on the chest and belly. I take this to be Crampe's type 2.

inter se. This point was elaborately tested. Crampe states that albinos true-bred for some generations behaved differently from extracted albinos, the former being, as he says, merely "absorbed," *i. e.* recessive, on crossing with colour; while extracted albinos gave, as I understand him, a mixture of ancestral forms when they were crossed with other types. This part of his paper (10. pp. 573-5) is difficult to follow; and I cannot find any example showing precisely the nature of the distinction he means to emphasise so far as *albinos* are concerned. We must here await fresh experiments. We readily see, however, that though in respect of its albinism we may regard the albino as always the same, it may obviously be retaining other characters derived from various progenitors. Accordingly we find, as will appear, albinos apparently of the same species manifesting different properties in crossing. I suspect, however, that Crampe is here extending to the albino a generalisation really based on a mistake arising from misconception respecting the phenomenon of dominance. [See note added p. 97.]

We may now, though the evidence is imperfect, consider the significance of the appearance of these many new forms in F_2 . This phenomenon is a most usual result of a cross between distinct varieties. It is the source of the majority of our new garden varieties, and of many at all events of the *colour*-varieties of domestic animals. In general terms we can declare that the result of the cross—the "asymmetrical fertilisation," to speak strictly—is the production of a diversity of gametes. Pending histological research, we cannot tell the origin of the characters borne by these gametes; but from many circumstances it seems inevitable that they must be regarded as created in such a case partly by *resolution* of the character brought in by the dominant—which we therefore call a *compound* character, and partly by the imperfect segregation of that compound or of its components from the recessive character (and its components if it be also resolvable). In most cases the process of resolution is not complete for *all* the gametes; and some of the gametes are bearers of the wholly or partly unresolved character, just as *all* the colour-bearing gametes were in Cuénot's simpler case. The Mendelian hypothesis leads us to believe that the actual numbers of each type of gamete will be on the average definite, and that the union of any two of them will give rise to a zygote of definite character.

The number of types of gametes and their several properties can only be determined on a minute analysis of each member of the series of zygotes by exhaustive breeding. No such evidence is yet complete in any one case, but we see already in certain cases that some of the F_2 are homo- and some hetero-zygous, and we are beginning to suspect the ratios of the gametic forms in a few simple cases.

Returning to Crampe's evidence, though the ratios are quite uncertain, we find that the several types had different properties.

On breeding specimens of each type *inter se* he found the following behaviour:—

Type 1 might give	Types	1	2	4	6	7
" 2 "	" "	1	2	3	4	5
" 3 "	" "			3	4	5
" 4 "	" "				4	
" 5 "	" "				4	5
" 6 "	" "				4	5
" 7 "	" "				4	5
					6	7
					6	7

In other words, each type is dominant to albino and the wild type is dominant to all. The grey forms are dominant to the black. The black-and-white of type 5 is recessive to type 6, (black with white markings), but the self-coloured black does not contain type 5. These are some of the deductions from the table. The peculiarities of types 3 and 5 are especially noteworthy and call for fresh experimental study.

It appears that types 3 and 5 could be ultimately bred true. As to 6 and 7 the evidence is not very clear; but as I understand the account, neither was completely freed from throwing the other. The breeding in these types was the least successful and extensive. Possibly they are illustrations of the *Mittel-rassen* of de Vries. It is especially noteworthy that the grey-and-white type 3 and the black-and-white type 5 do not give rise to self-grey gametes or to self-black gametes, a fact found again in mice. We see therefore that there are gametes for black-and-white and for grey-and-white, each of which may behave as a single character and dominate over albino.

Similarly when pure black-and-white was crossed with the wild species, all the coloured types might appear in F_2 but no albinos (10. pp. 555–6). Therefore, in this very important case, when black-and-white of type 5 appeared in the posterity of such a cross, they were *all* homozygotes and produced only their own type (p. 555). This fact may furnish a useful basis for a new experiment. In strict accordance with our expectation, Crampe found that black-and-whites which gave albinos when bred *inter se*, gave albinos if crossed with albinos; but when they did not produce them themselves, they did not when bred with albinos.

The similar variety, grey-and-white (type 3), is always homozygous except when it appears as a dominant containing types 4 or 5. But if I rightly understand Crampe's use of the word "*constant*," type 5 is not produced by crossing type 3 with the wild form, unless it was already brought in as recessive to type 3. On the other hand, type 3 can be produced (in F_2) by crossing type 5 with the wild form. It is most desirable that the properties of these two types (3 and 5) should be fully explored. They give a chance of investigating the resolving powers of a recessive that is not albino, and free from several complications attending the use of the latter.

When we try to picture what is taking place in the resolution

effected by types 3 and 5, Crampe's figures, though too imperfect and irregular to justify a positive statement, show pretty clearly that these particular recessives do not appear nearly so often as 1 in 4; and consequently it is *prima facie* likely that some of the new types of gametes are formed by imperfect segregation, and are combinations containing elements of both the dominant and the recessive—a phenomenon indicated by experiments with other forms of animals and plants (*cf.* de Vries' resolutions of *Antirrhinum*).

These are some of the chief deductions apparent from Crampe's work. Many others will strike a careful reader and are indeed given by the author, but for these reference must be made to the original.

From the want of details the important question of the identity of the several types is not easy to settle, but I think that we may allot Crampe's varieties among the well-known types of rats, with fair confidence, as follows:—

1. The wild *decumanus*.
2. Like *decumanus*, but with a more or less sharply defined white area on the ventral surface (together perhaps with white on the feet).
3. Head and shoulders wild colour, forming the "hood" of the fanciers. This is continued in a broad *stripe* down the middle of the back to a *patch* on the rump. The rest of the body is white. The coloured area may be considerably extended on to the flanks, and more rarely* the dorsal stripe may be broken.
4. Albino.
5. Like 3, but black being substituted for wild colour.
6. Like 2, but black instead of wild colour. This type is known in the fancy as the "Irish" variety.
7. Self-coloured black.

With respect to the kinds of pigments in rats I have as yet no information. The distinction between black and the wild colour is apparently less sharp than in mice, and both black and black-and-white rats have a good deal of dark brown hair, especially in the edges of the black patches of the parti-coloured, and on the belly of the self-coloured black.

No doubt there is also some change with age, moulting, &c.†

Crampe (9. p. 393) mentions the black stripe in his black-and-whites, and there is practically no doubt that his var. 3 and var. 5 are correctly referred to the hooded and striped types. He remarks that by selecting those with stripes so wide that the rats were more black than white, he got no nearer to breeding blacks. Similarly whites could not be bred from the whitest grey-and-

* This is Miss Douglas' experience. In this respect strains doubtless differ, for Mr. F. Swann tells me he formerly kept a strain in which the stripe was generally broken.

† Crampe records (9. p. 395) changes with age in piebalds from "grey" to black and *vice versa*, both colours appearing together in the transition. The change in the direction of darkening seems to be normal as the adult fur grows. In the same place he mentions a rat as "*Gelb-grau*."

whites. The types are in fact definite, and cannot be built up by cumulative selection.

I am indebted to Miss Douglas for much information as to the varieties of rats and for the loan of specimens. She tells me that rats coloured otherwise than the varieties named are exceedingly rare. Irregularly piebald or spotted rats occasionally occur, but she has tried recently to obtain such rats from fanciers without success. In her experience the type 6 breeds true or nearly so. Of the blacks examined by me this type had less of the brown hair than type 7.

A striking feature appears from the rat-evidence, namely the absence of yellow, blue, chocolate, and indeed most of the varieties so familiar in fancy mice. On superficial examination, the colour of a wild rat is not very greatly different from that of a wild mouse. In rabbits also the yellow as well as the black forms are common. Yellows or yellow-and-whites are also familiar in guinea-pigs, fowls (buff, and "pile"), and pigeons. Miss Douglas has heard of a pair of cream-coloured rats, but otherwise I can find no records of any kind of yellow in the fancy. As blacks are so easily produced by resolution in the rat, the absence of the corresponding yellow and chocolate is remarkable. One is tempted to inquire whether the existence of black gametes does not suggest that yellow or at least chocolate gametes must also exist. The problem of their disappearance raises many important questions as to selective union between gametes, and others too elaborate to develop now. As there are no yellows, so also there are no chocolates.

Another noteworthy fact is the complete absence of blue rats. This particular stage in the diminution of the amount of dark pigment is well known in mice, rabbits, cats, and several birds, but it is unknown in rats. There is of course no question that such forms would have been preserved if they had been seen by fanciers. Either yellow or blue rats would be worth several pounds. We may take it therefore that these particular resolutions, or perhaps mutations, cannot be produced by any of the means by which they have been produced in other forms. Conceivably, if some distinct species were crossed with our fancy rats, some of these forms might be created. Similarly there are no "Himalayan" rats, *i. e.* pink-eyed with patches of colour (blackish or yellow), forms well known in rabbits, guinea-pigs, and in the "Japanese" waltzing mice.

To sum up the evidence as to rats, we have clear proof of the segregation of certain types of gamete—the albino, the black-and-white, and the grey-and-white, though the ratios in which they are produced by heterozygotes are not yet determined. Further, there is proof that certain of the colour-types exhibit definite valency (*Werthigkeit* of Tschermak) and dominate over each other according to a regular system. Of the other colour-types one, *viz.*, type 2, is almost certainly a definite heterozygote form, and is probably incapable of being made into a pure race.

We may next consider the further evidence regarding mice. By the great kindness of Mr. F. G. Parsons, I am permitted to include in this paper notes of 50 matings made by Mr. Parsons in conjunction with Dr. S. M. Copeman. These experiments were made with other objects in view and are still in progress, but as they stand they are a valuable contribution to the question of the inheritance of colour. The notes which Mr. Parsons has placed at my disposal are here given exactly as they were received. I have merely inserted the letters DR and DD according as the results show that the individual in question was a heterozygote containing albino, or that it was free from the albino character. Those not thus distinguished cannot be discriminated by the existing evidence.

The following abbreviations are used: *bl.*, black; *br.*, brown = chocolate; *blw.*, pied-black; *brw.*, pied-brown; *w.*, albino.

Experiments made by Mr. F. G. Parsons.

<i>Mating.</i>	<i>Offspring.</i>
(1) w. ♀ A × blw. ♂ <i>a</i> (DR)	1 blw. 3 w.
(2) " × w. ♂ <i>β</i>.....	..... 7 w.
(3) " × brw. ♂ (B × <i>a</i>) (DR)	1 brw. 3 w.
(4) w. ♀ B × blw. ♂ <i>a</i> (DR)	2 blw. 1 brw. 4 w.
(5) " × w. ♂ <i>β</i>.....	..... 5 w.
(6) " × brw. ♂ <i>γ</i> (B × <i>a</i>) (DR)	..... 5 w.
(7) " × "	4 brw. 1 w.
(8) blw. ♀ C (? DD) × blw. ♂ <i>a</i> (DR)	3 blw. 1 brw. (1 eaten ?).
(9) " × w. ♂ <i>β</i>	2 blw. 1 brw.
(10) w. ♀ D..... × blw. ♂ <i>a</i> (DR)	2 bl. 1 br. 1 w.
(11) " × w. ♂ <i>β</i>.....	..... 5 w. (1 eaten ?).
(12) " × brw. ♂ <i>γ</i> (B × <i>a</i>) (DR)	2 br. 6 w.
(13) " × "	2 bl. 2 br. 4 w.
(14) " × blw. ♂ <i>a</i> (DR)	3 bl. 1 br. 2 w.
(15) w. ♀ E × blw. ♂ <i>a</i> (DR)	2 blw. 2 brw. 4 w.
(16) w. ♀ F × blw. ♂ <i>a</i> (DR)	1 blw. 1 brw. 2 w. (5 eaten ?).
(17) " × w. ♂ <i>β</i>.....	..... 7 w.
(18) w. ♀ B ¹ (B × <i>a</i>) × blw. ♂ <i>a</i> (DR)	2 blw. ... 3 w. (2 eaten).
(19) w. ♀ B ² (B × <i>a</i>) × "	2 blw. ... 1 w. (3 eaten).
(20) " × w. ♂ <i>ε</i>.....	..... 8 w.
(21) w. ♀ B ³ (B × <i>a</i>) × blw. ♂ <i>a</i> (DR)	4 blw. ... 3 w. (1 eaten ?).
(22) " × w. ♂ <i>ε</i>.....	..... 9 w.
(23) " × blw. C ²⁻¹ (C ² × <i>a</i>) (DR)	5 blw. ... 2 w.
(24) blw. ♀ C ¹ (C × <i>a</i>) (? DD) × blw. ♂ <i>a</i> (DR)	7 blw.
(25) " × w. ♂ <i>ε</i>	2 bl. 4 blw. (1 eaten ?).
(26) brw. ♀ C ² (C × <i>a</i>) (DR) × blw. ♂ <i>a</i> (DR)	1 brw. 1 w.
(27) " × "	2 blw. 2 brw. 2 w. (3 eaten).
(28) " × w. ♂ <i>ε</i>	1 blw. 4 brw. 1 w.
(29) " × brw. ♂ C ²⁻² (DD)	... 7 brw.
(30) " × "	... 6 brw.
(31) " × "	... 7 brw.
(32) bl. ♀ D ¹ (D × <i>a</i>) (DR) × blw. ♂ <i>a</i> (DR)	5 bl. 2 w.
(33) " × blw. ♂ C ²⁻¹ (DR) (C ² × <i>a</i>)	7 bl. 1 blw.

<i>Mating.</i>	<i>Offspring.</i>
(34) bl. ♀ $D^2(D \times a)(DR) \times$ blw. ♂ $a (DR)$	2 bl. 1 br. 2 blw.
(35) " " \times w. ♂ ϵ	1 bl. 1 br. 3 blw. 2 w. (4 eaten).
(36) " " \times brw. ♂ $C^{2-2}(DD)(C^2 \times a)$	3 bl. 2 br. 1 blw. (3 eaten).
(37) br. ♀ $D^3(D \times a) (DR) \times$ blw. ♂ $a (DR)$	2 bl. 1 br. 3 w.
(38) " " \times brw. ♂ $\gamma (DR)$	3 br. 2 brw. 3 w.
(39) " " \times w. ♂ ϵ	1 bl. 1 blw. 1 brw. 2 w.
(40) w. ♀ $B^{2-1}(B^2 \times a) \times$ blw. ♂ $a (DR)$	... 2 blw. 3 w. (3 eaten).
(41) " " \times " "	... 5 w.
(42) blw. ♀ $C^{1-2}(C^1 \times a)(DR) \times$ blw. ♂ $a (DR)$	... 7 blw.
(43) " " \times " "	... 4 blw. 2 w.
(44) blw. ♀ $C^{1-3}(C^1 \times \epsilon) DR \times$ brw. ♂ $\gamma (B \times a)(DR)$	... 7 blw. 1 w.
(45) blw. ♀ $D^{2-3}(D^2 \times a) \times$ blw. ♂ $a (DR)$	... 5 blw.
(46) blw. ♀ $D^{3-3}(D^3 \times a) \times$ brw. ♂ $C^{2-2}(C^2 \times a)(DD)$	1 bl. 1 br. 1 blw. (1 died).
(47) bl. ♀ $D^{1-1}(D^1 \times a)(DR) \times$ w. ♂ ϵ	1 bl. 2 blw. 2 w.
(48) blw. ♀ $C^{1-2-1}(C^{1-2} \times a) \times$ blw. ♂ $a (DR)$ ...	... 5 blw.
(49) blw. ♀ $C^{1-2-2}(C^{1-2} \times a) \times$ blw. ♂ $a (DR)$ ...	... 7 blw.
(50) blw. ♀ $C^{1-2-2-1}(C^{1-2-2} \times a) \times$ blw. ♂ $a (DR)$..	... 4 blw.

The mice originally introduced were 5 albino females, 2 albino males, 1 black-and-white male, and 1 black-and-white female, all of unknown extraction.

Several albinos were produced in the experiments. Mated with albinos they gave albinos only (41 in all). The original blw. ♂ a was heterozygous, containing albino, but the blw. ♀ C probably did not, though the figures are insufficient for proof. Both of the original blw. on mating with albino gave rise to some *brown* or brown*-and-white offspring, and were probably giving off gametes of this nature. All such specimens were alike in tint except one which was distinctly lighter.

The families of the albino D (expts. 10-14) are especially interesting; for, as Mr. Parsons pointed out to me, all the 13 coloured offspring by two different *broken*-coloured males, one brw., the other blw., were *self*-coloured, brown, or black. This result resembles one obtained by Castle (5. p. 542), but the suggestion that such a pied individual is a mosaic which throws self-colour gametes is not readily applicable to this case. For here the peculiarity evidently lies in the gametes of the individual albino, since with other albinos the same males gave pied offspring. As Castle commonly obtained such self-coloured mice from albinos crossed with pied, it is likely that the peculiarity may belong to certain strains of albinos. The detailed account of his experiments, which is promised, may perhaps give an indication on this point.

Parsons' cases give besides some indications as to the ratios of the gametes. It will be seen that the relation of brown to black is not merely that of dominant and recessive, for either may give either. Nor can it be supposed that the brown is a mere heterozygous form. Each colour, whether self or pied, may be dominant over albino, and the figures show pretty clearly that in

* Microscopical examination of a specimen kindly sent by Mr. Parsons proved this colour to be "chocolate."

the blw. ♂ α the albino gametes equalled the browns and the blacks collectively, for with various albinos he gave 27 coloured (*q.v.*), 31 albinos, a near approach to equality. As regards the brw. ♂ γ , the evidence is that with 3 albinos he gave 11 coloured, 19 albinos. On the other hand, 4 heterozygous coloured females \times w. ♂ ϵ gave 16 coloured, 7 albinos. As the result of the reciprocity of these numbers, the total (adding expt. 23) of coloured to albinos, produced by all matings in the form DR \times R, is exactly 59 to 59. It is, however, difficult to believe that the departure from equality just named is simply fortuitous, for it is in each case steadily maintained through a series of families. If the figures are grouped according to mothers (instead of fathers, as here) these peculiarities are partly lost, but further experiment may possibly indicate that different kinds of heterozygotes are here to be distinguished.

Of matings in the form DR \times DR there are ten cases, expts. 26-7, 32-4, 37-8, 42-4 giving a total of 49 coloured, 14 albinos, the simple Mendelian expectation being 47.25 to 15.75.

In these experiments there is also good evidence of the appearance of dominants containing no albino, for example brw. ♂ ($C^{2.2}$), and probably blw. C^1 .

Information given me by Mr. J. Wilson Steer and Mr. Atlee, and the experiments lately begun by Miss Durham and Mr. Staples-Browne, enable me to add a few indications as to the probable specific behaviour of some of the colour-types in crossing, though these have at present only the value of hints for further experiment.

The agouti (*Mus musculus* colour) is of course dominant to albino, but so far has not been resolved in F_2 , having apparently the same behaviour as the wild colour in Cuénot's experiments, but sometimes piebalds of agouti and white appear.

Yellow and black crossed have given sables or "dingy fawns."*

Chocolate \times albino may give, according to Mr. Steer, the wild *musculus* colour, doubtless by reappearance of the black pigment in association with brown of the chocolates. Probably the strains used had other differences also (*cf.* p. 97). Miss Durham has found chocolate a simple dominant over albino.

Sable \times black-and-white, according to the same authority, has given sables, though in this case the result will probably be found to differ according as the black-and-white is homo- or heterozygous.

Sables bred together have given sable, black, and dingy fawn in the same litter.

Blue \times albino has given a full black, sometimes with white patches on tail.

Two yellows (from an inbred strain 4 years old) gave 1 yellow and 2 chocolates (*Steer*). This last occurrence is unexpected and needs careful verification.

* More recently Miss Durham has thus bred some full *blacks*. Reliable and extensive information as to the result of mating yellows with blacks is greatly needed.

Variegated black-and-white \times chocolate-and-white gave on one occasion (*Steer*) 5 black-eyed whites and 1 chocolate-and-white.

As mentioned above, blue may be recessive to black and breed true from its first appearance, and will doubtless prove to be a homozygous colour.

We may now pass to a consideration of the crosses made with "Japanese" waltzing mice. The exact physiological nature of the waltzing habit seems to be still uncertain. Reference to the work especially of Cyon, Rawitz, and Zoth shows that, though malformation of the labyrinth is not infrequently associated with this condition, at least the degree of the structural malformation varies considerably.

The origin of the variation is still more obscure. Mouse-fanciers have assured me that something like it may appear in strains inbred from the normal type, though I cannot find an indubitable case. Such an occurrence may also be nothing but the appearance of a rare recessive form. Certainly it is not a *necessary* consequence of in-breeding, witness von Guaita's long series of inbred albinos. From analogy with other cases, we should be prepared to find that the existence of such a structural feature in one of the gametes had an effect on the colour of the heterozygote; but the evidence, as we shall see, is on the whole unfavourable to this view.

As to crossing of waltzers and albinos, the earliest evidence is that of Haacke, whose records are qualitative only. Crossing waltzers, blue-grey with white marks, and albinos, he obtained mice generally self-grey (? agouti), more rarely self-black. Their offspring occasionally had a small white mark on the ventral surface.

The next large body of evidence is that of von Guaita (19), who used black-and-white waltzers with dark eyes (von Guaita *in litt.*) and an inbred strain of ordinary albinos. From this cross, F_1 was always (from 4 pairs) a self-coloured house-mouse, and was also like that wild type in size (being larger than the waltzer and smaller than the albino) and in wild disposition. F_2 , raised from F_1 bred *inter se*, consisted of albinos and 4 coloured types—black, grey, black-and-white, grey-and-white. The totals were 30 coloured, 14 albinos. On the expectation of 3:1 there should have been 33 and 11, so that the excess of albinos is distinct, though the numbers are small; but when all *certain* cases of $DR \times DR$ (taking albino as R) are included, the numbers are 117 coloured and 43 albinos, coming very near indeed to the expectation 120 to 40. There can therefore be no doubt that the heterozygotes produced on an average equal numbers of albino gametes, and of gametes bearing the various colour-types.

There are only two matings certainly in the form $DR \times R$. These gave 23+1 coloured, 20+1 albinos, closely approaching the expected equality.

In (20) Table I., from 1st and 5th pairs, we have families of 17 coloured and 13 coloured respectively, showing pretty clearly that

some of the coloured individuals contained no albino. As far as the few observations went, the extracted albinos gave only albinos. So far therefore the Mendelian hypothesis harmonises well with the phenomena.

When, however, we begin to consider the relations of the several colour-types to each other, we meet some important problems. The original waltzers are described as black-and-white. Of what pigments the black was made up we do not know. Probably it contained both the black and the brown elements. However this may have been, the reversionary heterozygote clearly did, though whether it also contained the *yellow* pigment is not so clear.

On examining the details as to the offspring of the several pairs, it appears that though the self-greys may, as the first cross proves, contain all the other 3 coloured types and the albino, the grey-and-white contain the albino only. Similarly the black-and-white can only contain the albino, so far as the evidence goes. But black seems to be dominant over black-and-white.

The facts are not sufficient to make these deductions quite certain; and, in particular, since the evidence in rats shows that grey-and-white may dominate over black-and-white, it may be merely from accident in the choice of individuals that no black-and-white was produced by any of the grey-and-white mice.

The families from the 4th pair on Table I., and from the 3rd pair on Table II., are especially interesting as giving indications as to the gametic ratios in a complex case, though the evidence is insufficient to determine these ratios. In the first case black-and-white \times black gave 10 black, 15 black-and-white, 7 albino. Both parents were heterozygotes containing albino, being each raised from self-greys \times white. From the facts it is clear that one parent at least was giving off gametes black, black-and-white, and white; and from the indication that black is dominant to black-and-white, it is probable that this parent was the black. The simplest supposition is, then, that the black-and-white gave off blw. and w., and that the black gave off bl. and blw. in equal numbers, and whites equal to their sum. This distribution would give the ratio

$$1 \text{ bl.} : 2 \text{ blw.} : 1 \text{ w.,}$$

and where experiment gave

$$10 \text{ bl.} : 15 \text{ blw.} : 7 \text{ w.}$$

we should expect

$$8 \text{ bl.} : 16 \text{ blw.} : 8 \text{ w.,}$$

which fits well. But in the 3rd pair on Table II. we have a blk. \times albino giving

$$7 \text{ bl.} : 16 \text{ blw.} : 20 \text{ w.,}$$

where, on the hypothesis suggested, we should expect *equality* between bl. and blw., and the discrepancy is considerable and emphatic.

Pending further experiment, the relations of bl. to blw. and to white cannot be stated with any confidence. Another point

calling for elucidation is the distinction between the black-and-white of the original waltzers and the black-and-white of subsequent generations. F_1 from albino and the waltzers was the atavistic grey, but there is no indication that the subsequent heterozygotes between blw. and albino were grey; or more strictly there is a great deal of evidence that they were usually blw. The suggestion also that the atavistic colour was due to the union of the waltzing and non-waltzing character seems to be plainly excluded, because even normal albinos in later generations proved to be heterozygotes of waltzing and non-waltzing gametes. At present, therefore, we cannot declare what was *the* difference between the original pure gametes which caused the reversion when they were united.

Lastly, there is a difficulty, perhaps the most serious of all, in the result of the union of albino \times self-grey (19. p. 328, 2nd pair, both parents being in F_2) which gave 13 grey, 3 grey-and-white. I see at present no suggestion as to the gametic production of the grey parent in this case which can be made with any probability, consistently with the other facts. Possibly the diversity of gametes lay with the albino.

I now pass to an examination of the evidence of Darbishire, who crossed ordinary albino mice with waltzers. The waltzers used were "pale fawn"-and-white with *pink* eyes, thus outwardly corresponding somewhat with one of the breeds of rabbits called "Himalayan." The nature of the pigmentation described as "fawn" is not specified; but from the results, and especially from the distinction drawn by the author between "fawn," "fawn-yellow," and "yellow," there can be little doubt that the fawn was composed of both yellow pigment and a dark pigment, probably black. Twenty-nine pairs were used in the production of F_1 . The offspring of 23 of these pairs, 120 individuals, had grey colour. All except one had more or less white or whitish, differing in extent. Some had more white than the waltzers, while in others the whitish colour only appeared on the belly. The pure albinos gave on the whole more fully coloured, the extracted albinos less fully coloured heterozygotes. The tint of the grey is further classified into "pale wild colour" and "dark wild colour," both being stated to be such as occur in *musculus*. Full details as to distribution are given (*q. v.*).

Of the remaining six pairs, four gave one or more mice with the colour-patches *black* (with grey brethren in three families) as follows:—

Pair.	Patches.	
	Grey.	Black.
XXVII. ....	...	1
LXXVII.	1	3
LXXVIII.	4	3
LXXXV.	6	2
	<hr/> 11	<hr/> 9

Lastly two pairs gave both greys and yellows, thus:—

Pair.	Patches.	
	Grey.	Yellow.
XII.	2	3
LXXXIV.	5	4
	<hr/> 7	<hr/> 7

In the original account and in the discussion of the facts by Professor Weldon in 'Nature,' the offspring of the 29 families are referred to as having consisted of a mixture of greys, yellows, and blacks; and the fact that only certain families gave blacks and certain families yellows, and that no family gave both blacks and yellows, is not emphasised. We can conceive that both yellows and blacks *might* be associated with greys when "fawns" are crossed with albinos, but till the phenomenon occurs it need not be considered in this connection*.

To proceed with the fundamentally important question of the purity of the coloured race, we are informed that the original waltzers were bred together for some months and gave only offspring like themselves. The number of individuals thus tested and the number of offspring raised from them are not given, but we may conclude that they were considerable. When, however, we regard this evidence of purity in the light of the facts provided by the six families which gave either yellows or blacks, we perceive that if "fawn" is dominant to yellow and to black, the occurrence of yellows and blacks in the crosses with albino is readily explained. We have in fact only to suppose that in family 27 the coloured mother, and in families 77, 78, 85 the coloured fathers, contained *black*; and that in families 12 and 84 the coloured fathers contained *yellow*; and the results are fairly clear. The chance of seeing the impurity by merely crossing fawns together would not be very great. Most of them evidently were pure, and since black \times yellow certainly *may* give a dingy fawn heterozygote, the impurity would probably not be demonstrated unless fawns containing black bred together, or fawns containing yellow bred together. By breeding the mother of family 27 with the father of 77, 78, or 85, some test of this suggestion might have been made. Of course we have as yet no direct experimental proof that fawn is dominant to black and to yellow; but since sables can throw blacks, and since in rats grey-and-white is dominant to black-and-white, it seems very possible that these "fawns" may also have been thus dominant.

* When a compound character is crossed with a recessive, it sometimes happens that *components* of the compound appear already resolved in members of F₁. For example, I have seen the "walnut" comb of the pure Malay fowl (which can be produced by synthesis of rose-comb and pea-comb in a more or less stable union) crossed with single comb give some rose, some pea, some walnut, as well as some single. Such a phenomenon will probably be demonstrated to be a *partial* monolepsis ("false hybridism"), and zygotes exhibiting the several components will probably not reproduce the excluded elements in their posterity.

The most striking fact about the F_1 heterozygotes (not mentioned in Darbishire's first paper) is that they all had *dark* eyes, though both parents had pink eyes. The albino showed itself a recessive as usual. Moreover, just as in von Guaita's case, the colour of the waltzers did not behave as a simple dominant, but formed a specific and reversionary heterozygote. It is especially interesting that this heterozygote should have been so nearly the same*, though Darbishire's original coloured form was "fawn"-and-white, while von Guaita's was black-and-white. This certainly suggests that the *completeness* of the reversion may have been due to the meeting of some other dissimilarities than those indicated simply by colour and albinism (*cf.* Steer's case of chocolates, p. 85). Other facts point in the same direction.

Moreover, if the "fawn-yellow" of Darbishire's class *b* is the same colour† as the pale fawn of the original waltzers, it is curious to find that in F_2 there were black-eyed (therefore presumably heterozygous) "fawn-yellows," when the colour *grey* would have been the natural expectation. This phenomenon may be compared with that seen in von Guaita's work, where original black-and-white \times albino gave greys; but in F_2 black-and-white may be a simple dominant over albino. (Compare also Parsons' evidence as to chocolate (= brown) with Steer's experience.)

The result of mating the wild-coloured F_1 together, as far as the detailed tabulation extended, was :

Albino	9	.....	all pink-eyed.
Yellow	4	.....	3 pink-eyed.
Fawn-yellow	6	.....	3 pink-eyed.
Pale grey	9		
Dark grey	1		
Black	5		
"Lilac" ‡	3	.....	1 pink-eyed
	<hr/>		
	37		

In all, therefore, 16 were pink-eyed and 21 dark-eyed, when equality is expected.

A postscript gives the number raised in F_2 (presumably from *wild* coloured F_1) as increased to 66, and though the individuals are not classified according to colours, the information is given that there were—

	Albinos pk-eyed.	Coloured pk-eyed.	Coloured (?all) dk-eyed.
	13	17	36
the expecta- } tion being }	16.5	16.5	33

* Darbishire's being, however, mostly pied, while von Guaita's were selfs.

† Until qualitative details of these colorations are published, their exact nature can only be surmised.

‡ [From a specimen exhibited by Mr. Darbishire, I think this colour is probably one of the dilutions of *brown* pigment. It appeared to be a paler shade of the "silver" of fanciers.]

Before attempting further to analyse these facts, the results of wild-coloured $F_1 \times$ albino must be given. In the body of the paper 88 young so produced are recorded, viz., 39 albino, 31 wild-coloured (18 darker, 13 lighter), 15 black, 3 yellow. The total increased subsequently to 205, of which 111 were albinos and 94 had some colour in their coats, the specific colours not being as yet given. All the coloured individuals from this mating were dark-eyed, as would be expected. In accordance with the other results we should expect—

105.5 albinos and 105.5 coloured with dark eyes,
 where experi- } 111 " 94 " "
 ment gave }

It is therefore clear that if we regard the gametes of F_1 as consisting of two kinds, colour-bearing and albino, in equal numbers on an average, this simple form of the Mendelian hypothesis fits the facts very closely, and the distribution of albinism and eye-colour is approximately what that hypothesis leads us to anticipate. When, however, we try to assign the ratios of the several colour-gametes *to each other*, and to determine the specific results of their unions, we encounter certain difficulties, though in all probability further experiment will enable us to make this analysis complete.

So far we have no knowledge of the specific composition of the several types seen in F_2 , and until they are bred separately *inter se* we can only predict the offspring with reserve. Any such prediction can only be made on the hypothesis that the regularity of the behaviour has been maintained, and that no original variation or mutation arises (as may happen for instance in peas and perhaps sweet-peas). We must also expect some irregularities from the fact already mentioned, that the several families in F_1 were not all comparable, and in subsequent generations it will be necessary to distinguish members of black-giving, or of yellow-giving families from the rest. Subject to these provisos, we expect the pink-eyed coloured types to give only pink-eyed when bred *inter se* and no albinos*, but that the dark-eyed will give both pink-eyed and dark-eyed; and that some of the offspring of dark-eyed mated *inter se* (or with albinos) will be albinos. The pink-eyed coloured forms mated with pure albinos will presumably give all dark-eyed offspring again†.

Similarly taking the types of F_2 singly, it is likely that dark-eyed yellows will give only yellows, perhaps creams, and albinos,

* Unless the phenomenon seen in the albino guinea-pig occurs.

† In Mr. Darbishire's third report (28) just published it is recorded that a pink-eyed yellow-and-white in F_2 bred with albinos gave 8 albinos, 11 grey-and-white, 1 yellow-and-white. The occurrence of albinos from this mating is of course a proof that the constitution of the pink-eyed yellow was in this case not that suggested in the present text. Experiments with other coloured members of F_2 are not yet given. The relation of the yellows to the rest must be regarded for the present as quite unknown. It may be remarked that yellow-and-white varieties both of rabbits, fowls, and pigeons are often peculiar in their inheritance, and rarely breed true for many generations.—July, 1903.]

while the dark-eyed blacks should give only blacks, perhaps blues, and albinos. The dark-eyed greys will probably give both blacks and yellows, though in view of von Guaita's evidence that grey may exist as a new homozygote, this is perhaps doubtful. As far as the published evidence goes, the most probable constitution of the several forms in F_2 is as follows:—

<i>Albinos</i>	albino \times albino.
Pink-eyed yellows	yellow \times yellow.
Dark-eyed	yellow \times albinos.
Pink-eyed fawn-yellows ...	fawn-yellow \times fawn-yellow.
Dark-eyed blacks	black \times albino (?)
Dark-eyed greys	fawn \times albinos (and perhaps some other combinations).
Pink-eyed lilacs.....	lilac \times lilac.

The absence of blacks with pink eyes is noticeable, and raises the question whether there is not a permanent synthesis in these blacks.

Finally, we have two important problems, the nature of the dark-eyed fawn-yellows and of the dark-eyed "lilacs." As they are dark-eyed they presumably both contain albino. But as regards the first, it is difficult to see what the other gamete can be in that case. For from F_1 we learn that fawn \times albino give *grey*, not fawn-yellow. On the other hand, as there are black and yellow gametes, we ought to find their heterozygote, which will presumably be *fawn*. But if this combination follows the rules of the others, the heterozygote should be pink-eyed, not dark-eyed. The number of dark-eyed fawn-yellows, three, is too few to make it likely that these are the black \times yellows, which we expect to appear as a fairly frequent combination; and the general indications are quite unfavourable to the view that any considerable number of heterozygotes can be dark-eyed without the presence of the albino, though it is not impossible that such real synthesis may take place.

Next the "lilacs" raise certain questions. We must suppose that the dark-eyed "lilacs" contain albino; but in the offspring of $F_1 \times$ albino there are no "lilacs." As F_1 is giving off gametes capable of forming "lilacs," we see that the lilac \times pure albino gives some other colour. Next, which of the groups can be supposed to represent the lilac-bearing gametes in their other combinations? This also is a question we cannot answer.

A similar difficulty is created by the scarcity of yellows in the offspring of $F_1 \times$ albino. There were only 3 in 88. We might have expected the numbers of yellows and blacks to be equal, but there were 15 blacks. Moreover, all the yellows were in *one* family. So far this is quite inexplicable. It probably indicates that some of the albinos possessed powers of resolution different from those of others, or conversely that some of the original "fawns" were more easily resolvable than others. [*cf.* Cuénot's new results (27), where blacks were resolved out, but apparently *no* yellows.]

A line of inquiry is suggested by the miscellaneous constitution of F_1 . We have seen that all members of F_1 are not alike, and it is not impossible that the greys from families which give no blacks or yellows may be different in constitution from greys in families which gave one or the other. If the individuality of the several parents of F_2 were given, this possibility could be examined. The fact that an original waltzer was giving off yellow or black gametes might be an indication that resolution of characters had already begun; and perhaps therefore the F_1 from different families, though alike grey, may be in some measure heterogeneous. In these cases it is most important that each individual parent and its offspring should be separately traceable.

It is not impossible that some light on these questions could be obtained by noting the sexes in which the several forms appear.

In view of the facts I do not understand the meaning of Darbshire's statement that "the inheritance of eye-colour is not in accordance with Mendel's results."* So far as the experiments are yet recorded, the behaviour of the eye-colour is typically Mendelian, and follows Mendelian expectation in its simplest form. The occurrence of albinos is similarly Mendelian, one albino in four being plainly indicated as the average from $F_1 \times F_1$ †.

* For further criticism of this statement see Castle and Allen (7).

† As regards the waltzing character von Guaita's experiments agree with Darbshire's in showing that it was always recessive to the normal. No individual in F_1 , or in families produced by crossing F_1 with the pure normal, waltzed. In Darbshire's experiments $F_1 \times F_1$ gave 8 waltzers in 37 offspring, indicating 1 in 4 as the probable average. $DR \times R$ is not recorded. From von Guaita's matings in the form $DR \times DR$ the totals of families were 117 normal and 21 waltzers made up as follows:—

<i>Normal.</i>	<i>Waltzers.</i>
36	8
14	2
25	7
41	2
1	2
<hr/>	<hr/>
117	21

There is therefore a large excess of normals over the expected 3 to 1. This is possibly due to the delicacy of the waltzers, which are certainly much more difficult to rear than normals are. The small numbers in von Guaita's litters make it very likely that many were lost before such a character as this could be determined. On the other hand, we have to bear in mind that as the presence of waltzers is here the only proof that the matings were in the form $DR \times DR$, it is possible that the total of normals should really include some families which gave normals only.

$DR \times R$ gave 18 normal and 10 waltzers distributed in families thus:—

<i>Normal.</i>	<i>Waltzers.</i>
3	4
3	2
10	3
2	1
<hr/>	<hr/>
18	10

Here the same paucity of recessives is noticeable.

Von Guaita did not succeed in raising any offspring from extracted waltzers bred *inter se*.

All that can be positively asserted is that the qualitative result is in full agreement with the Mendelian expectation based on the absence of waltzers in F_1 , and that it is not impossible that there may be the expected equality in number between D and R gametes produced by F_1 .

As we have also seen, the colours taken collectively follow simple expectation; $F_1 \times F_1$ giving approximately 3 coloured to 1 albino, and $F_1 \times$ albino giving approximately equal numbers of each.

As to the frequencies and valencies of the particular colours nothing can be said with much confidence as yet, beyond the statement that F_1 gives off albino gametes about equal in number to the various coloured gametes collectively. In a discussion of this subject, Professor Weldon (25) has suggested that an average of *one albino in nine* might have been expected. I can see no reason why this proportion should be impossible in nature, from $F_1 \times F_1$. Its occurrence would, however, be remarkable and raise some important problems in gameto-genesis. So far, however, it has not been recorded. Professor Weldon is in error in stating (25. p. 34) that I have already dealt (4. p. 52) with such a case of 1 albino in 9. The case in question was that of *Antirrhinum*, where de Vries obtained from $F_1 \times F_1$ four forms in the proportion 9:3:3:1, the *one* being the white, which therefore occurred in the proportion of 1 in 16. This is the proportion Mendel himself conjectured might be found in a case of resolution, but I do not gather that he had actually observed such a case.

No case of resolution has yet been sufficiently studied for us to speak with any confidence as to the ratios of the gametes or the nature of the process of resolution. Tschermak has had cases of 1 recessive in 4, after resolution. In poultry I have had cases somewhat similar, to be described hereafter.

In apparently all recorded cases of resolution some gametes of F_1 carry the compound character unresolved. It is not at all easy to suggest a scheme which shall fit both the observed facts of resolution and those of cell-division. For example, suppose the gametes of F_1 to be 50 per cent. albino, 50 per cent. variously coloured, if segregation were complete. Let us consider the coloured gametes separately, and for simplicity assume there are only three kinds of them, viz. the unresolved grey, black, and yellow, the two latter being hypallelomorphs of grey. It is then clear that in whatever numbers the three types are each represented, so long as their sum equals the total of albino gametes, there must be more black character in any black gamete, and more yellow in the yellow gamete, than in any grey gamete; *or* there must somewhere be a cell-division in which a part of the yellow and a part of the black have been lost. If, for instance, the hybrid bore gametes in the proportions

2 grey (=black+yellow), 1 black, 1 yellow, 4 albino,

we recognise that unless the blacks and yellows carry double portions of their respective colours, part of the colour originally introduced into F_1 has been lost. Such doubling is not altogether inconceivable, though until histological methods are made applicable to these questions of gameto-genesis the possibility can hardly be tested. We note as a fact favourable to such a view, that the visible amount of pigment in a black or a yellow zygote is far

greater than the amount of the same pigment in the original compound colour. But this consideration cannot be allowed much weight, seeing that there may be an excess of pigment in *heterozygotes* produced even from two gametes apparently bearing no pigment elements at all (*cf.* p. 76). In the chemistry of pigmentation there may perhaps be interactions and cancellings so complex as to make this particular problem as yet quite insoluble.

Fuller analysis is especially needed also to determine the place of the pied and diluted colour-bearing gametes in the series, but it is fairly certain that they must be regarded as due to disintegration and imperfection of resolution of the colour from the albino character.

Future experiment must decide the conditions determining resolution. Cuénot, as I understand his paper, got none in the main experiment with wild mice; but he states that he obtained yellows, blacks, and peds "*accessoirement*" (perhaps by introducing some coloured fancy strain?).

From this survey of evidence mostly already published, it is clear that Mendelian analysis provides a means of elucidating a large part of the phenomena. The majority of the observations are in accord with the Mendelian hypothesis in a simple form. The true solution of several subordinate problems still remains obscure. The value of the Mendelian analysis will be the more appreciated when it is remembered that previously the whole body of facts must have been regarded as a hopeless entanglement of contradictions, as reference to any non-Mendelian discussion even of these very phenomena will show.

As I have elsewhere pointed out, the central phenomenon in Mendelian heredity is segregation. The characters in simplest cases are treated as units in gameto-genesis. In more complex cases there is resolution, sometimes also disintegration and imperfect segregation, leading to the formation of fresh units. The gametes bearing these units are produced in numerical proportions which on an average are also definite, but as yet these proportions have only been determined in the simple cases. There is no doubt that further experiment will determine them in complex cases also.

It is the object of Mendelian analysis to determine

- (1) the constitution of the several types of gamete produced by each type of zygote;
- (2) the numerical proportions in which each type of gamete is produced;
- (3) the specific result of the union of any two of the types of gamete in fertilisation.

Though for convenience we may still speak of inheritance as being "Mendelian" or "non-Mendelian," we are rapidly passing out of the initial phase of the inquiry in which such expressions are demanded. In our further investigations we are concerned not so much with the question of the applicability of the simplest

Mendelian hypothesis to special cases, as with the formulation of the specific laws followed by the several characters of various animals and plants in gameto-genesis and in union by fertilisation. As in chemistry, these laws must be worked out separately case by case, and each as it is determined has the value rather of fact than of hypothesis.

In dealing with this class of fact, special precautions are necessary in order to establish the identity and purity of any variety chosen for experiment. From the description of the varieties of mice given at p. 73 it will be seen that some colours may be easily confounded in description, though the pigments on which they depend have a different chemical behaviour. This is especially the case with regard to "fawn," "fawn-yellow," and "yellow." In such cases it is absolutely necessary that the presence or absence of *dark* pigment should be noted, and that some attempt should be made to distinguish the two dark pigments from each other.

In all attempts to trace laws of colour-heredity, colours of the various parts will usually have to be reckoned with. In horses, for example, the general body-colour, without that of the mane, tail, and fetlocks is likely to be an insufficient guide to the heredity. In man the heredity of eye-colour cannot be sufficiently investigated if it be separated from the colour of the hair, and so forth. For the present, therefore, Professor Pearson's conclusion that the Mendelian system does not apply to coat-colour of horses or to eye-colour in man should not be received without reserve. By neglect of the precautions named above many results may be described as conflicting with each other, which further analysis would show to be harmonious.

[Note added July, 1903.]

When this communication was read I had not seen the important paper of Cuénot (27) dated March 1903. He states that grey mice of his F_3 when crossed with albino gave several *blacks*. These, when bred with certain albinos produced black heterozygotes, which bred *inter se* gave the Mendelian 3 black to 1 albino. Some of these latter blacks were then homozygous, and from them a pure strain of blacks was raised. This strain crossed with wild *musculus* behaved as a simple recessive, giving grey F_1 , with Mendelian ratios 3 grey to 1 black, or 1 grey to 1 black in F_2 , according as F_1 was mated with F_1 , or with black.

The fact that the original black did not appear in F_2 or in F_3 calls for elucidation. It suggests a possible difference between the albinos used either in producing F_1 or later, some individuals having the power of resolving the grey, while others had not that power.

Cuénot next records the new and important fact that the colour of the F_1 produced from his black strain \times albino differed according to the class of albino used. (1) Albinos extracted from

the cross with wild grey gave *grey* F_1 . (2) Albinos extracted from the cross with black gave *black* F_1 . (3) Albinos extracted from a cross with yellows (of complex origin) gave a mixture in F_1 , either of *yellows and greys*, or of *yellows and blacks*. There is therefore a proof that individual albinos, though outwardly alike, may belong to several distinct classes, exhibiting different properties in their heterozygous unions (*cf.* Parsons' case, p. 84). The resemblance of the heterozygote to the coloured type from which the albino was extracted is a new fact, the significance of which we cannot yet fully appreciate*. Cuénot tentatively makes the attractive suggestion that the particular colour of the heterozygote may depend on the association in the same zygote of various colour-constituents; and that though the albino is white in itself, it may carry on such constituents from a previous coloured parent. Then, according as one or other of these complementary constituents is brought in by the albino, the heterozygote will show the corresponding colour. The chief obstacle to this view is the fact that when a heterozygote shows reversion (as opposed to simple dominance) the reversion frequently includes *various* qualities, such as size, temperament, habit of growth, &c., as well as colour.

A cognate problem was alluded to (p. 88) in the discussion of von Guaita's facts. His original black-and-white \times albino gave a reversionary heterozygote; yet in F_2 both the black-and-white and the grey-and-white DRs present those colours as simple dominants over albino, as their offspring proved. Since in this case no new strain was introduced, the reference to pedigree is not sufficient to elucidate the whole difficulty.

The relation of the several classes of albinos to each other seems to be the next point for investigation, and a useful experiment might be made by breeding albinos extracted from one colour, with albinos extracted from another colour, the offspring to be then tested with a single pure coloured race. It is not impossible that the various types of albino will then themselves exhibit phenomena of segregation.

The new report of Mr. Darbishire (28) and Professor Weldon's comment (29) have appeared too late for adequate discussion here. It may, however, be remarked that both authors scarcely appreciate the Mendelian view when they state that according to it all albinos (or other recessives) may be treated as "in every respect similar." No one, I imagine, would suppose that the similarity need extend to characters other than the albinism. We are familiar with cases in which recessives, though alike in the recessive character, are dissimilar in other respects; and (as stated *supra* p. 76) may, when crossed together, even produce heterozygotes exhibiting a character known to be dominant over the particular recessive concerned. We should no more suppose all albino mice to be identical because they were albino, than all white sweet-peas

* Possibly it is to this phenomenon that Crampe refers in the statement discussed on p. 79 of this paper. I cannot, however, find a case of Crampe's exhibiting Cuénot's phenomenon.

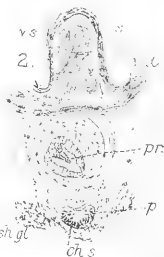
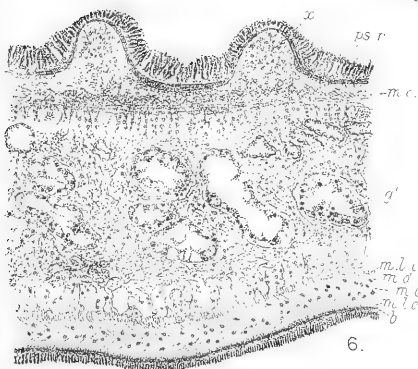
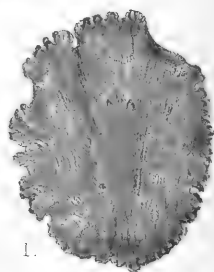
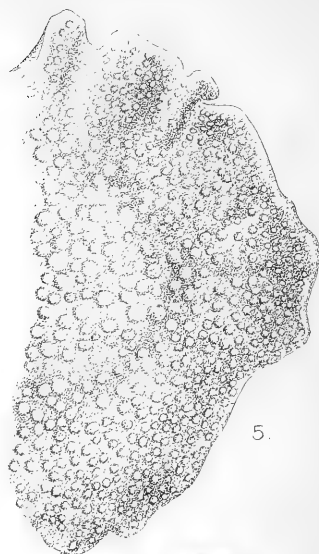
because they were white, or all glabrous stocks because they were glabrous.

Professor Weldon's appeal for the precise gametic formula of F_1 must at present go unanswered. Pending analysis of the various coloured types in F_2 , no one could give the statistical composition of the gametes of F_1 so far as coat-colour is concerned; and though the general composition of F_2 agrees closely with simple Mendelian expectation, the particular composition of the various types is a question that further experiment must decide. To take only one possibility, imperfect segregation is often seen in such cases of complex resolution. No criterion save the actual production of F_3 from F_2 can show whether any of the types of F_2 illustrate this phenomenon. When such evidence is forthcoming there is every likelihood that both the qualitative and quantitative composition of the gametes of F_1 will be determinable with approximate accuracy.]

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Figs. 3-6. A.D. Darbishire. del. ad. nat.

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PLANARIANS FROM ZANZIBAR.

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[Received May 25, 1903.]

(Plate IX.† & Text-figures 3-7.)

Mr. Crossland's collection contains, so far as the *Acotylea* are concerned, specimens of four new genera and eight new species out of a total of nine species in all. This high percentage of novelties is not surprising when one remembers that but little is known of

* Communicated by the SECRETARY.

† For explanation of the Plate, see p. 113.

the Polyclad fauna of the Indian Ocean, and especially of the African coasts.

As a matter of fact, I believe that no shore-haunting species have hitherto been recorded from the East Coast of Africa, save from the Red Sea and from the neighbourhood of the Cape of Good Hope.

Of the four new genera described in the present communication, *Phylloplana* is closely related to *Leptoplana*, whilst the other three are of unusual interest.

In order to keep the paper within reasonable limits I have done little more than give an account sufficient, I hope, in each case, to render the future identification of the species a matter of certainty. I have not attempted to enter into any detailed account of the anatomy of the various species, or to deal with many of the interesting questions which have been suggested to me by their structure. I have given a list of species of one or two of the genera, with their distribution and some of their more obvious characters, as I believe such lists may have some use.

My thanks are due to Mr. Crossland, who has permitted me to examine and describe this collection, and has furnished me with useful notes and coloured sketches of some of the species.

I am also indebted to Mr. A. D. Darbishire for drawings reproduced on Plate IX.

Family PLANOCERIDÆ.

PLANOCERA CROSSLANDI, sp. nov.

"White, leaf-like form. Dredged off the mainland coast in 10 fathoms." Slightly damaged.

Length	22 mm.
Breadth.....	16 "
"Mouth"* from anterior end...	12.5 "
♂ aperture from "mouth." ...	4 "
♀ " " male	1.5 "
Tentacles from anterior end ...	6 "

Only a single specimen collected. This species is most closely allied to *Pl. armata* mihi [5].

The eye-spots have an arrangement very similar to that found in the latter species. There is a dense cluster at the base of each tentacle; the paired group of brain-eyes lying in front of the brain is more extensive than that behind it. The epidermis unfortunately has entirely disappeared from the surface of the specimen. The muscles of the body-wall are very similar to those found in *Pl. armata*. The brain is well defined and of moderate size. The gut has the character typical of the genus, viz. some seven pairs of large branches from the main gut, each of which gives off numerous smaller ramifications which do not form any anastomoses. The gut is without the peculiar diverticula found in *Pl. armata*.

* The term "mouth" is used to mean the opening of the pharyngeal pouch to the exterior.

Genital Organs.

The *male apparatus* consists of a short, muscular, somewhat barrel-shaped penis, which tapers a little towards its free posterior end, where it carries three large chitinous hook-like structures, identical in character with those found in *Pl. armata*. In front of these its entire lumen is lined with the small, very numerous chitinous spines so characteristic of this and allied genera. The penis-muscles are longitudinal and diagonal. The prostate gland is large, and, with the penis, is enclosed in an outer muscular sheath, the walls of which are made up of an inner circular and an outer longitudinal layer of muscle-fibres. At the distal end of the penis the prostatic muscles come into close contact with the muscles of that organ, but at the upper end of the penis a wide space intervenes between it and the sheath. Here the muscles of the penis are collected into bundles of retractor fibres, and traverse the surrounding sheath-cavity to join the muscles of the sheath.

The prostate is closely enfolded by the inner muscle-layer of the sheath; it gives off a short duct which enters the base of the penis after receiving the ductus ejaculatorius from the vesicula seminalis. As in *Pl. pellucida* and *Pl. armata*, this duct runs for a short distance right inside the prostatic duct.

The vesicula seminalis lies outside the sheath.

The vasa deferentia are much dilated.

The antrum masculinum, into which the free end of the penis projects, is lined with a ciliated non-secretory epithelium.

Cf. von Graff's figures of the genital apparatus of *Pl. pellucida* and *Pl. simrothi* [3]; also my figure of *Pl. armata* [5].

Female apparatus.—The bursa copulatrix is large, and has thick walls composed of an outer layer of circular and an inner layer of diagonal radial fibres. Its walls are much folded. Beyond the bursa, the vagina, which is lined with ciliated epithelium, runs forwards and upwards through the large shell-glands, and then turns sharply back, receiving as it does so the common duct from the uteri. Beyond this it is continued back as the thread-like accessory vesicle, which ends blindly. The walls of the bursa show no trace of secretory activity.

The following is a list of species which can be referred at present with tolerable certainty to the genus *Planocera*:—

A. Species in which the penis is armed with large chitinous hooks as well as with spines.

a. Six hooks present.

Pl. armata Laidlaw [5]. Maldives.

b. Three hooks present.

Pl. crosslandi, sp. nov. Zanzibar.

B. Species in which the penis is armed with spines only.

a. Pelagic forms.

† Nervous system much decentralised.

Pl. sinrothi v. Graff [3].

†† Nervous system normal.

Pl. pellucida (Martens) [3].? *Pl. pelagica* (Moseley) [1].

β. Non-pelagic.

Pl. graffii Lang [1].

Mediterranean.

Pl. folium CErsted [1].

Mediterranean, North Sea.

Pl. reticulata Diesing [1],

Sandwich Is.

nec Stimpson.

Planocera nebulosa Verrill [2] is probably not a member of the genus *Planocera* s. str.

PARAPLANOCERA AURORA, sp. nov. (Plate IX. fig. 1.)

Body almost circular, margin crenellate. Shore form.

Length	15 mm.
Breadth.....	12.5 "
" Mouth " from anterior end	7.5 "
Tentacles " "	5.0 "
♂ aperture from " mouth "	2.5 "
♀ " " male .....	.5 "
Length of receptaculum seminis.....	3.0 "
Tentacles apart.....	1.0 "

The coloration of this beautiful species is shown in Pl. IX. fig. 1. In general it is of a rich rose-pink, becoming more intense towards the margin, and mottled with lines and spots of yellowish white. The tentacles are pink, and the mid-dorsal region white.

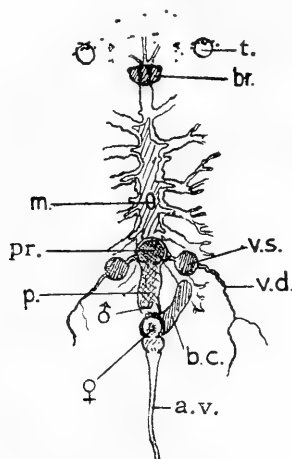
The gut-branches are six in number. The arrangement of eye-spots and appearance of the genital apparatus are shown in the accompanying figure (text-figure 3, p. 103).

The genital organs have an arrangement in general precisely similar to that found in the other species of the genus [6]. The antrum masculinum is small, lined with ciliated epithelium. The penis is a coiled muscular tube (*p.*), its walls consisting of circular and radial muscle-fibres. Its lumen is lined with chitinous spines of two different kinds, those near the distal end of the penis being large and irregular, whilst further forward (*i. e.* away from the antrum) the spines become small and thorn-shaped. These two kinds of spines merge rather gradually into each other.

Some way in front of the antrum a thin outer layer of circular fibres detaches itself from the wall of the penis, to form an outer sheath which remains attached to the ventral side of the penis for some distance, so that it is only at its proximal, anterior, end that the penis is completely free from the sheath. The space

between them is occupied by a loose spongy reticulum of protoplasm with few nuclei. At its proximal end the penis receives the very short duct which opens into it from the prostate (*pr.*), which with its duct is ensheathed in a continuation of the muscle-wall of the penis, which at this level again fuses with the muscles of the outer sheath.

Text-fig. 3.

Sketch of anatomy of *Paraplanocera aurora*, sp. nov.

a.v., accessory vesicle; *br.*, brain; *b.c.*, bursa copulatrix; *m.*, mouth; *p.*, penis; *pr.*, prostate; *v.d.*, vas deferens; *v.s.*, vesicula seminalis; *t.*, tentacle.

The prostate is large. There is a pair of thin-walled vesiculæ seminales (*v.s.*) outside the sheath. From each of these a short duct runs, piercing the sheath, and uniting with its fellow to enter the commencement of the prostatic duct.

The terminal parts of the female apparatus are exactly similar to those of *P. langi*, structurally and histologically. However, in the present species I cannot find any indications of the shell-glands.

DISPAROPLANA DUBIA, gen. et sp. nov. (Plate IX. fig. 2.)

A single specimen.

Length	12.5 mm.
Breadth	3.0 "
" Mouth " from anterior end	4.0 "
♂ aperture from " mouth "	1.5 "
♀ " " male .....	.4 "

The external characters of this species are shown in text-fig. 4 (p. 104).

There are no tentacles The eye-spots are arranged in two

rows extending forward from over the brain. They are mostly of small size, but immediately over the brain there are on either side some half-a-dozen eyes of a much greater size than the rest.

Text-fig. 4.



Disparoplana dubia, sp. nov. $\times 4$ circ.

Unfortunately the solitary specimen is not in a very satisfactory state of preservation. The epidermis has almost completely disappeared, and the body is much distended with ripe eggs, so that the characters of the gut are difficult to determine. The pharynx is folded and of the usual Acotylean type. The brain is protected by a sheath of unusual toughness.

Genital Organs.

Male apparatus.—The terminal parts consist of a cylindrical penis lined with short chitinous spines, of a small prostate gland, and of a muscular vesicula seminalis (Pl. IX, fig. 2). The resemblance to the corresponding organs in *Planocera* or *Paraplanocera* is very close. The male aperture is very small and opens into a narrow tube which runs forwards and a little upwards. The cells lining it give off a granular secretion. After a course of about 1 mm. this passage widens out to become the lumen of the penis. This organ is proportionately longer than in *Planocera* and a little coiled; but shorter than in *Paraplanocera*. Its walls are not very stout, and the muscle-fibres which form them are continuous with those that surround the prostate. The spines lining the lumen bear a close resemblance to those of *Planocera*; but the diameter of the penis is relatively less. The prostate is small, but similar to that of *Planocera*. Its duct is joined by the ductus ejaculatorius running to the penis from the relatively large vesicula seminalis which lies in front of the prostate and receives

the two vasa deferentia at its hinder end. Its walls are thin and consist of circular muscle-fibres.

The resemblance existing between these organs of *Disparoplana* and those of *Planocera* and *Paraplanocera* is so great, that we are compelled to assume a close relationship between these genera. In the shape of the penis *Disparoplana* approaches rather the latter genus, whilst in possessing a single vesicula seminalis it approximates rather to the former.

Female apparatus.—The antrum femininum is large and rather elongated. The vagina, after running forward to receive the separate openings of the uteri, is continued back as the accessory vesicle which ends blindly after making a second turn forwards, ventral to the first part of its course. The shell-glands open into the accessory vesicle.

The inclusion of this species in the Planoceridæ will necessitate an alteration of the definition of that family. I do not attempt to offer a new definition in the present paper, since it is necessary to have information concerning the anatomy of a large number of species the internal structure of which but little is known, before any useful modification of Lang's definition can be suggested.

However, it is permissible to point out here that the discovery of such a form as *Disparoplana* indicates, I think forcibly, not only that in the future our definition of the Planoceridæ will have to be altered, but also that the Leptoplanidæ may be a polyphyletic family.

The genus *Disparoplana* may be defined as follows:—An elongated form, not provided with tentacles; the eyes arranged in two lines over the brain. Mouth a little in front of the middle of the body. Penis cylindrical, armed with chitinous spines resembling those of *Planocera*; a well-developed prostate and single large vesicula seminalis present. Female ducts simple, a small accessory vesicle present.

STYLOCHUS ZANZIBARICUS, sp. nov.

Labelled "s.s. Juba."

A small, rather elongate form.

Length	10 mm.
Breadth	4 "
Tentacles from anterior end	2.5 "
" Mouth " " "	7 "
Genital openings from hinder end ...	.5 "

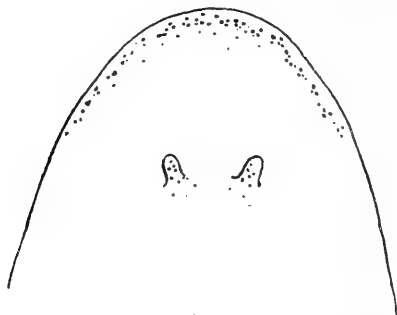
No note as to colour, but to judge from the single spirit-specimen, this is mottled reddish-brown and yellow on the dorsal surface; the ventral surface is uniform greyish yellow.

The eye-spots are found on and about the base of the tentacles and on the anterior margin, where they are of moderate size (see text-fig. 5, p. 106).

I have not found any definite group of brain-eyes.

The anatomy of the genital organs is practically identical with that of *S. neapolitanus* [1]. As in that species, the mature ovaries have passed to a ventral position.

Text-fig. 5.



Anterior end of *Stylochus zanzibarius*, sp. nov., showing the arrangement of the eye-spots.

STYLOCHUS SUESENSIS Ehrenb. ?

Stylochus suesensis Lang.

A single large specimen from Ras Oswemba, 10 fathoms.

Length	40 mm.
Breadth.....	25 „

The specimen is much damaged and the dorsal surface badly broken.

The marginal eye-spots extend completely round the body. This character is not stated to occur in Ehrenberg's type, but may well have been overlooked. In other respects, size and colour, so far as the latter can be determined, viz. dull yellow mottled with small brown spots on the dorsal side, it agrees. The ovaries are immature and lie *among* the gut diverticula. Doubtless, when ripe, they would shift ventralwards. The penis is squared at its free end. The prostate is very large and has thick muscular walls.

The genus *Stylochus* includes at present a few rather closely related species, most of which have a very similar style of coloration, viz. a ground-colour ranging from dirty white to dull yellow or greyish brown; irregularly mottled with darker spots or streaks of brown. The tentacles lie far forward and carry eye-spots. Marginal eye-spots may extend completely round the body.

A satisfactory grouping of the species is not at present possible, since one of the most remarkable features, known to occur in several species, viz. the ventral position of the ovaries, has

been studied only in a few cases. Consequently it cannot, unfortunately, be employed as one of the principal characters in sub-dividing the genus.

I give below a tentative table of the species of the genus hitherto described, with their distribution:—

A. Species with eyes on the anterior part of the margin only.

a. Ovaries dorsal.

S. pilidium (Götte) [1]. [Mediterranean. Valparaiso (v. Plehn) [4].

β. Ovaries ventral.

Marginal eyes extremely small.

S. neapolitanus (Delle Chiaje) [1]. Mediterranean.

Marginal eyes moderate, brain-eyes absent?

S. zanzibaricus, sp. nov. Zanzibar.

γ. Position of ovaries doubtful.

S. frontalis Verrill [2]. New England.

S. limosus Diesing [1]. Japan.

S. conglomeratus Diesing [1]. Japan.

B. Species with eyes completely surrounding the margin.

a. Ovaries dorsal.

Small brightly coloured species.

S. plessisii Lang [1]. Mediterranean.

b. Ovaries ventral.

S. suesensis Ehrenb. ? [1]. Zanzibar.

c. Position of ovaries doubtful.

S. suesensis Ehrenb. [1]. Red Sea.

S. argus Czerniowsky [1]. Black Sea.

S. ?zebra Verrill [2]. New England.

Since the publication of Lang's Monograph, the following species have been removed from the genus:—

1. *Stylochus littoralis* (Verrill) = *Planocera elliptica* Girard.

This species is now referred by Verrill to a new genus, *Eustylochus*, characterised by the presence of a median female anterior accessory vesicle, apparently similar to that found in *Paraplanocera*.

2. *Stylochus* ? *surgassicola* (Mertens) is referred by von Graff to the genus *Stylochoplana* [3].

Verrill's species *Stylochus crassus* [2] is, I think, evidently not a member of this genus.

Family LEPTOPLANIDÆ.

PHYLLOPLANA LACTEA, gen. et sp. nov. (Plate IX. fig. 3.)

Shore form. "White, with minute grey dots scattered sparsely over dorsal surface." Collected 19.2.01; several specimens.

The dimensions of an adult specimen are as follows:—

Length	30 mm.
Breadth.....	17 "
"Mouth," from anterior end ...	14 "
♂ aperture from "mouth" ...	4 "
♀ " " male	1 "

This species externally bears a close resemblance to a typical *Leptoplana*, being perhaps a trifle broader and more leaf-like. Further, its internal anatomy shows it to be distinctly related to the members of that genus, but the presence of two vesiculæ seminales with thick muscular walls is sufficient to distinguish it from that somewhat crowded genus. The arrangement of the eye-spots is shown in fig. 3, Pl. IX. The pharynx is very large, and extends for a distance of over 8 mm. The gut-branches are numerous and without anastomosis.

Genital Apparatus.

Male organs.—The two vasa deferentia each open into the hinder end of the elongated and somewhat convoluted vesiculæ seminales (Pl. IX. fig. 3, *v.s.*). These have thick muscular walls consisting of circular fibres, amongst which are found a small number of oval nuclei. The lumen is narrow, and lined with a flattened epithelium. After running forwards for a total distance of about 75 mm., the two vesiculæ unite, and their lumen is continued backwards into a median ductus ejaculatorius, which has a length of about 5 mm. For the first part of its course it has thick walls, and its diameter is about equal to that of either of the vesiculæ, whilst the epithelium lining its lumen is apparently of a prostatic character. For the last third of its course or thereabouts it becomes much narrower, and has much thinner walls and the epithelium loses its secretory character. Finally, this narrower part of the median ductus, which lies through nearly its whole length at a level dorsal to the vesiculæ, opens on to the base of a small penis, which is armed with a downwardly-curved, backwardly directed stylet. The penis lies at the upper end of a fairly long antrum masculinum.

Female apparatus.—The female aperture opens into a wide convoluted vagina, which at first has a course in general in a forward direction, and is provided with rather thick walls, but after a time its walls become thinner and the lumen wider. It then turns backwards, lying dorsal to the first part of its course, and becomes rather narrow, whilst the cells lining it, up to this point ciliated, lose their cilia, and have rather the appearance of secretory cells. When this backwardly-directed part reaches the level of the female aperture, it receives the two uterine ducts through a common opening on its ventral side, and is continued beyond this to end in a small, slightly muscular accessory vesicle. The shell-glands lie close about the aperture.

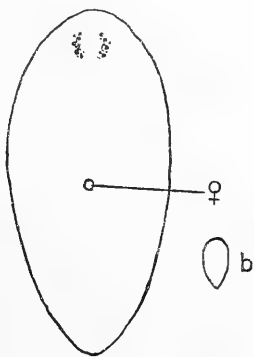
The genus may be defined very briefly as follows:—Leptoplanoid with flattened leaf-like body. A pair of long muscular vesiculæ seminales, which lie parallel to the median ductus ejaculatorius and penis and receive the vasa deferentia of either side respectively at their hinder ends.

HAPLOPLANA ELIOTI, gen. et sp. nov. (Plate IX. fig. 4.)

Two specimens dated 25.3.01. One of them is immature; the other, from which I prepared sections, is in a late stage of sexual activity, and the centre of the body is crowded with eggs. The body is oblong, about 6 mm. in length, 3 in breadth, with rounded ends. In places it is as much as 1 mm. in thickness.

The eye-spots are arranged in two irregular lines lying over the brain on either side of the middle line. They are not numerous (text-fig. 6).

Text-fig. 6.



Haploplana elioti, sp. nov., magnified and (b) natural size.

On the dorsal side the epithelium contains a number of pseudorhabdites. On the ventral surface close to the margin there are numerous small rhabdites on either side, but these do not occur elsewhere. The basement-membrane is thin, and the muscles of the body-wall are very feebly developed. On the dorsal side these consist of a narrow longitudinal layer followed by a few circular fibres. On the ventral side there is an additional inner longitudinal layer. The dorso-ventral musculature is well-developed. The ovaries are dorsal, the testes ventral.

The pharynx is of a very simple type; it consists of a fold projecting from the middle of the wall of the oval pharyngeal pouch, the longer axis of the pouch coinciding with the main axis of the body. The opening into the gut lies rather in front of the opening to the exterior, which is about at the middle of the pouch (see Pl. IX. fig. 4, *ph.t.*).

The gut-branches are numerous and appear to undergo anas-

tomoses, but it is difficult to determine this owing to the great accumulation of eggs in the lateral parts of the body.

The "mouth" is about 1.5 mm. behind the anterior margin.

The opening of the antrum masculinum is about 1 mm. behind that of the "mouth." It is very minute. The small vasa deferentia are full of spermatozoa; at the level of the antrum masculinum they become much contorted, and finally both open into a very small median vesicle, which latter appears to open directly by a minute pore into the antrum. Thus there would appear to be no intromittent organ, though it is quite possible that the vesicle may be to some extent everted. The vesicle is provided with a very thin wall of circular muscle-fibres.

The antrum femininum opens some .25 mm. behind the male aperture; it is small and surrounded by a number of shell-glands. Dorsally it passes upwards and then backwards, receiving as it turns back the common opening of the two uteri. Beyond these it is prolonged into the very small accessory vesicle.

The uteri extend along either side of the body not far from the middle line; they vary much in diameter in different localities, and in places contain spermatozoa. At intervals, where they become dilated, the eggs can be seen making their way into them by what appear to be simply gaps in the uterine walls.

The whole lateral regions are crowded with large eggs, which lie embedded in a matrix that consists apparently of a yolk-like material (Pl. IX. fig. 4).

The female aperture is of such small size that it seems impossible that the eggs can escape through it. Possibly the body of the parent ruptures after a time and allows the eggs to pass out. This view is suggested by the fact that in some of the sections eggs can be seen lying in the gut itself.

The genus may be defined as follows:—

Body small, oval, and rather stout. No tentacles or sucker. Body-wall muscles feeble. The pharynx of a simple type, opening at the end of the first fourth of the body. Male genital apparatus of small size, copulatory organ much reduced. Female apparatus simple, with a small accessory vesicle. Eyes in two rows over the brain.

The position of this curious form amongst the Leptoplanidæ depends on negative rather than on positive characters. Its exact affinities are doubtful, and it is probably a degenerate organism.

Family CESTOPLANIDÆ.

CESTOPLANA FILIFORMIS, sp. nov.

"15.2.01. Ribbon-shaped, about 1 in. \times $\frac{1}{8}$ in. Creamy white with bright yellow border, and a median stripe of the same colour" (cf. *C. rubrocincta* for colour).

The "mouth" lies within 1.5 mm. of the hinder extremity.

Evidently closely allied to the Mediterranean *C. rubrocincta*,

but, I think, sufficiently distinguished by its much smaller size and yellow instead of red stripes. I have accordingly ventured to describe it as a new species, partly on account of the above-mentioned differences and partly on account of its different habitat. The genital organs, which are those of a typical *Cestoplanea*, are not fully mature, but are at the same time sufficiently advanced to lead one to suppose that the specimen will not increase very largely in size.

Unfortunately the head of the only specimen has been damaged, so that it is not possible to determine the arrangement of the eye-spots.

OMMATOPLANA TUBERCULATA, gen. et sp. nov. (Plate IX. figs. 5-7.)

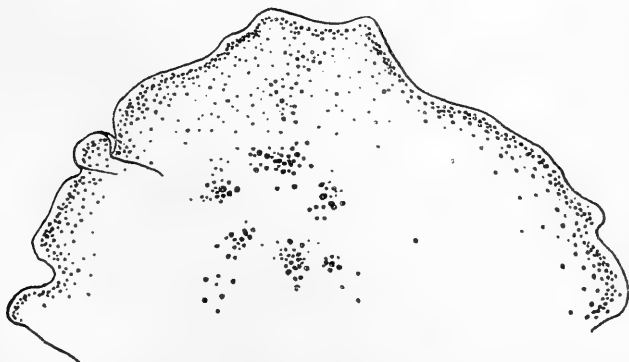
One specimen, immature. "Prison Island, 4.6.01. White, about 1 in. long, stiff and almost harsh to the touch when alive."

Length	26	mm.
Breadth	14	"
"Mouth" from anterior end...	13.5	"
♂ aperture from "mouth" ...	.75	"
♀ aperture ?	?	

The stiff texture of the specimen noted by Mr. Crossland is very obvious in the spirit specimen, and is due to the presence of large numbers of muscular wart-like projections on the dorsal surface.

The eye-spots are numerous and lie scattered over the anterior part of the dorsal surface. Their arrangement is shown in text-figure 7.

Text-fig. 7.



Anterior end of *Ommatoplanea tuberculata*, sp. nov., to show the arrangement of the eye-spots.

The epithelium on both dorsal and ventral surfaces contains very numerous pseudorhabdites which stain deeply. Below the

epithelium lies a thick basal membrane which shows no trace of nuclei.

On the ventral side the muscles of the body-wall consist first of a very narrow outer layer of longitudinal fibres lying against the basal membrane. These are succeeded by an outer diagonal layer, which in turn is followed by a few circular fibres, and these by an inner diagonal layer, the fibres in this latter running at right angles to those of the outer diagonal layer. Lastly comes the thick inner longitudinal layer.

On the dorsal surface there are first a fine outer longitudinal layer, next a diagonal layer, and lastly a thick circular layer. Hence the dorsal muscles are somewhat similar to those of *Cestoplana*, the ventral are more highly developed (see Lang [1], t. 16. fig. 1).

The dorsal tubercles are more muscular and broader in proportion to their height than those of *Cycloporus*. They are covered with an epithelium, which about their base is similar to that of the rest of the surface of the body, but which towards their apices becomes flattened and loses its pseudorhabdites. Under the basement-membrane, which becomes somewhat attenuated on the tubercles, is a special layer of circular muscle-fibres. In the centre of each tubercle is a small quantity of tissue richly supplied with nuclei, and connected with the parenchyma of the body by a strand of tissue which pierces the muscles of the body-wall. This tissue is perhaps nervous in character (Pl. IX. fig. 6, *x, y*).

The pharynx is large and much folded. The "mouth" lies behind its posterior end, and communicates with the elongated pharyngeal pouch by a narrow channel. The gut-branches are numerous and lie at different levels (Pl. IX. fig. 6, *g'*).

Genital Organs. (Plate IX. fig. 7.)

Owing to an unfortunate accident some of the sections in the region of the body where these organs occur have been lost. Consequently the account given below is necessarily incomplete.

There appears to be a single genital atrium. The penis is provided with a true penis-sheath (cf. *Cestoplana*), and there is also a prostate gland. The vagina runs backwards and upwards for some little distance, then bends forwards and downwards, receiving on its dorsal side the common opening of the uteri. Beyond this it runs forwards and downwards towards the atrium (possibly opening into it?).

My chief reasons for placing this oval form in the neighbourhood of *Cestoplana* are to be found in the shape of the penis, the presence of a prostate gland, the backwardly-directed mouth-opening, and the disposition of the eye-spots. The thickness of the basement-membrane and the arrangement of the gut-branches and muscles of the body-wall are, I believe, indications which point in the same direction.

The genus *Ommatoplana* may be defined as follows:—

Body oval, covered on the dorsal side with numerous wart-like tubercles. Eye-spots scattered over the anterior third of the body dorsally. "Mouth" behind the pharynx. A single genital atrium. Penis provided with a true penis-sheath, without a stylet; prostate gland present, with thick muscular walls. Vagina provided with an accessory vesicle.

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EXPLANATION OF PLATE IX.

- Fig. 1. *Paraplanocera aurora*, sp. nov. (p. 102). $\times 1\frac{1}{2}$.
 Fig. 2. Section through the region of the male apparatus of *Disparoplana dubia*, sp. nov. (p. 103). The section is oblique, and hence it is possible to see the vesicula seminalis in the same section with the anterior end of the penis, which actually lies some distance behind it. The plane of the section is very nearly longitudinal.
 Fig. 3. General anatomy of *Phylloplana lactea*, sp. nov. (p. 107). $\times 1\frac{1}{2}$.
 Fig. 4. Transverse section across the body of *Haploplana elioti*, sp. nov. (p. 109), in the neighbourhood of the pharynx.
 Fig. 5. Anterior end of *Ommatoplana tuberculata*, sp. nov. (p. 111). $\times 5$.
 Fig. 6. Part of a transverse section across the body of *Ommatoplana tuberculata* passing through two of the tubercles.
 Fig. 7. Part of a transverse section of ditto, showing the prostate, penis, and penis-sheath.

Explanation of Lettering.

<i>a.m.</i> , antrum masculinum.	<i>ph.t.</i> , pharyngeal pouch.
<i>b.</i> , basement membrane.	<i>pr.</i> , prostate.
<i>ch.s.</i> , chitinous spines.	<i>ps.r.</i> , pseudorhabdites.
<i>d.e.</i> , ductus ejaculatorius.	<i>s.</i> , spermatozoa.
<i>g.</i> , gut.	<i>sh.gl.</i> , shell-glands.
<i>g.</i> , gut-branches.	<i>te.</i> , testis.
<i>m.c.</i> , circular muscles.	<i>ut.</i> , uterus.
<i>m.d.</i> , diagonal muscles.	<i>v.s.</i> , vesicula seminalis.
<i>m.l.i.</i> , inner longitudinal muscles.	<i>v.d.</i> , vas deferens.
<i>m.l.o.</i> , outer longitudinal muscles.	<i>x.</i> , tissue of tubercle-process of <i>Ommatoplana</i> , perhaps nervous in character.
<i>n.</i> , nervous tissue.	<i>y.</i> , gap in muscles of the dorsal body-wall of <i>Ommatoplana tuberculata</i> .
<i>o.</i> , egg.	
<i>ov.</i> , ovary.	
<i>p.</i> , penis.	
<i>p.s.</i> , penis-sheath.	
<i>ph.</i> , pharynx.	

June 16, 1903.

F. DU CANE GODMAN, Esq., D.C.L., F.R.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie in May 1903:—

The registered additions to the Society's Menagerie during the month of May were 122 in number. Of these 14 were acquired by presentation, 7 by purchase, 17 were born in the Gardens, and 84 were received on deposit. The total number of departures during the same period, by death and removals, was 143.

Mr. F. Finn, F.Z.S., exhibited a living hen-feathered Bantam cock and the feet of a fowl showing a three-jointed hallux, and made the following remarks:—

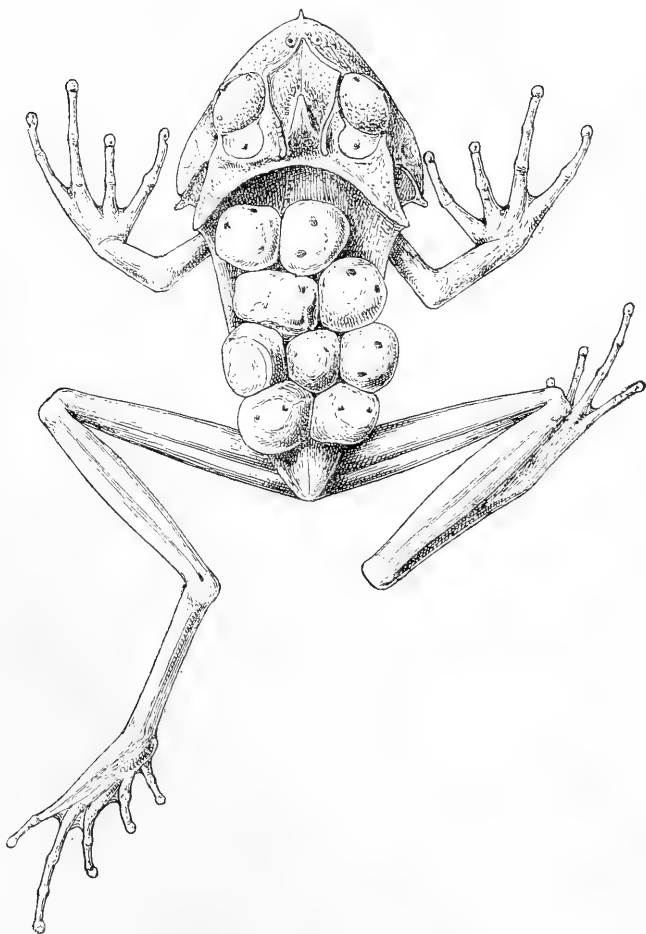
"Although there exist two breeds of fowls in which hen-feathering in the male is a constant character—the 'henry' Game and the Sebright Bantam—yet the occurrence of hen-feathering in the male as a casual variation appears to be so rare that I thought the present specimen worthy of exhibition to the Society. It is, as will be seen, a fully adult Bantam cock of no particular breed, and certainly shows no traces of Sebright blood, being single-combed and possessing black body-plumage and a white-bordered neck-hackle, with no trace of the characteristic black-laced plumage of Sir John Sebright's birds. It is interesting to recall that that gentleman made his celebrated breed hen-feathered by crossing into his strain a hen-tailed Bantam he came across casually, just as this one occurred to me.

"Mr. W. Bateson ('Experimental Studies in the Physiology of Heredity': Royal Society, Reports to the Evolution Committee, I.) speaks of the occurrence of a chick with a long hallux bigeminus as an abnormality which was probably unrecorded. About a month before, however, in a letter published in 'Nature,' January 30th, 1902, I had mentioned the occurrence of an abnormally long hallux in a common Egyptian fowl, which I regarded as the homologue of the 'fifth' toe of birds possessing a double hallux. I did not keep this specimen, but I now exhibit the feet of another Egyptian fowl showing the same peculiarity, which I obtained last year. The long halluces have each three phalanges, but the foot, although looking powerful, had no particular power of grasping, as was the case with the first specimen I met with. I have seen another case of long single halluces in a fowl which I believed to be Egyptian, and one also in a 'Silky' fowl, this breed having usually five toes. As Egyptian fowls display a continuous variation from one normal hallux to the 'five-toed' forms, more research amongst them would be interesting."

Mr. G. A. Boulenger, F.R.S., exhibited a specimen of *Ceratohyla bubalus* Espada, carrying eggs on its back (text-fig. 8), and made the following remarks:—

“A very interesting addition has been made by Mr. Ockenden, a zoological collector in Peru, to our knowledge of the nursing-

Text-fig. 8.



Ceratohyla bubalus, ♀, carrying eggs on back.

habits of Batrachians. The frog now exhibited is a female of the rare *Ceratohyla bubalus*, an inhabitant of the Andes of Ecuador, Bolivia, and Peru. It measures 63 millimetres from snout to

vent, and carries on its back nine large spherical eggs, 10 millimetres in diameter, each containing a little frog distinctly visible through the transparent membrane which at this stage constitutes the egg-capsule. The little one, with the abdomen, tumid with yolk, turned towards the back of the mother, and the limbs folded against the belly, is connected with the membrane by two string-like cords on each side, proceeding from the throat, as figured in *Nototrema cornutum* Blgr. (P. Z. S. 1898, pl. xviii.), and which serve to convey the blood, for the purpose of respiration, to the vascular, allantois-like membrane. The resemblance which the young bears to that of *Nototrema cornutum* is very striking, except in the breathing-organs, which in the latter, as well as in *N. oviferum* and *N. testudineum*, form funnel- or bell-shaped appendages. Whilst in *Nototrema* the eggs are protected in the dorsal pouch with which the mother is provided, the eggs in this *Ceratohyla* simply stick to the back, leaving shallow hexagonal impressions on the much-thinned dorsal skin, through which the neural processes of the vertebræ project to such an extent as to leave marks on the vitelline sacs with which they are in contact.

"A near ally of the Hemiphractidæ, to which family *Ceratohyla* belongs, *Amphignathodon guentheri* Blgr., is provided with a dorsal pouch as in *Nototrema*. We therefore find among the Tailless Batrachians with teeth in both jaws the same adaptations for the protection of the offspring as occur among the Hylidæ, where *Hyla goeldii* Blgr. stands, in this respect, in the same relation to *Nototrema* as *Ceratohyla bubalus* to *Amphignathodon*.

"The specimen exhibited was obtained at Santo Domingo, Carabaya District, S.E. Peru, 6000 ft. Mr. Ockenden is unable to give any particulars as to the conditions in which it was found, he not having been the actual discoverer of the remarkable specimen."

Mr. F. E. Beddard, F.R.S., exhibited on behalf of the "Flower Memorial Committee" a bust of the late President of the Society, Sir William Henry Flower, K.C.B., D.C.L., F.R.S., which had been executed by Mr. Thomas Brock, R.A., and which would ultimately be placed in the British Museum of Natural History.

Mr. F. E. Beddard also exhibited and made remarks upon sections of the ovary of *Thylacinus* which showed the immigration of follicular cells into the ova.

Mr. R. E. Holding exhibited some skulls of the St. Kilda four-horned Sheep, and made the following remarks:—

"The small black Spanish or St. Kilda four-horned Sheep is interesting not only on account of the curious legend as to its first appearance on the island of St. Kilda, but from its having

Text-fig. 9.



Variations in the horns of St. Kilda Sheep.

- A. Ram Lamb, aged 15 months, showing retention of median or upper horns only. The sire and dam of this had each four horns.
- B. A well-grown St. Kilda head.
- C. Ram, showing retention of median horns and suppression of right lateral horn.
- D. Head of Ewe, showing two small horns on right side; on the left side is a knob apparently containing three or four points of bone covered by a single horn-sheath.
- E. Indian Ram (Brit. Mus.) having five horns. As many as seven or eight horns have been observed.

so persistently retained its colour (dark brown and black) and characteristic four horns which exist in both sexes. The irregular development and somewhat erratic growth of these horns have been noted and commented upon by both veterinary surgeons and comparative anatomists; and some diversity of opinion exists as to the homology of the two pairs of horns when compared with the single pairs of horns as carried by some Domestic and Wild Sheep. The purpose of this communication is, from a biological point of view, to trace the cause of the duplicate pair of horns and to determine their homology. Text-figure 9, B, represents a typical well-grown head.

"An examination of a number of heads in the British Museum and the Museum of the Royal College of Surgeons and elsewhere shows an extraordinary variation in the form and direction, or 'pitch' as it were, of the median or upper pair of horns. These may grow quite upright, as shown on the left side of E, or may be curved forward to a greater or less degree, but are *always* present.

"The lateral or lower pair of horns, though more constant as regards form and more nearly approaching the typical horns of the Domesticated Sheep, are more subject to arrest in development from a variety of causes and are often absent. The apparent cause of the reduplication in the horns of this breed, in a considerable number of instances, is the splitting or segmentation into two or more nodules of the centre of ossification of the frontal bone, as indicated by three examples exhibited and by the skull (text-fig. 9, E). It is upon this point or 'boss' that the horns of all Ruminants ultimately grow, its prolongation forming the 'pedicle' of the Cervine horns and the 'horn-bearer' or core of the Hollow-horned Ruminants.

"The lateral horns, on the other hand, though bearing a closer resemblance in form and position to the typical horns of the Domestic Sheep, are variable and erratic in their development. Frequently only one is present (as in text-fig. 9, C), or they may be altogether absent, leaving only the median pair, which then assume a typical form (text-fig. 9, A).

"In-breeding, as recorded by the history of three small herds of these sheep, causes a reduction or arrest in development and often absence of the lateral horns (as in text-figs. 9, C and D), the median or upper pair of horns remaining constant.

"Castration has a precisely similar effect. The totality of evidence gathered from the life-history of the breed would seem to indicate that it is the median pair of horns, notwithstanding their variation and abnormal appearance, which are homologous to those of the Domesticated or Wild Sheep."

Examples of three or four horns in the Domestic and Wild Sheep or Goat as well as in Cattle and Deer are of sufficient interest to the anatomist to merit record. In Proc. Zool. Soc. 1879, p. 803, there is a good figure of a skull of the Chamois with four horns. In the Museum of the College of Surgeons there is a skull of a Goat with four horns. In the current volume of Proc.

Zool. Soc. *supra*, p. 2, there is a figure of a skull of a Muntjac showing small supernumerary horns on the pedicle, and, although the horns of the Roebuck vary more than do other Cervine horns, examples of four horns are rare.

Dr. A. S. Woodward, F.R.S., exhibited photographs by Dr. Otto Herz, illustrating the discovery and exhumation of a Mammoth in the Government of Jakutsk, Siberia. He also made remarks on the specimen, which has now been mounted in the Zoological Museum at St. Petersburg under the direction of Dr. Salensky.

Mr. Oldfield Thomas, F.R.S., exhibited some remarkable Gazelle skulls and horns from German East Africa, which had been contributed to the National Museum by Messrs. F. Russell Roberts and C. E. Blaine.

The specimens belonged to the *Gazella granti* type, but their horns were each completely twisted round inwards, as shown in the figures (text-figs. 10, 11), so that the tips pointed backwards

Text-fig. 10.



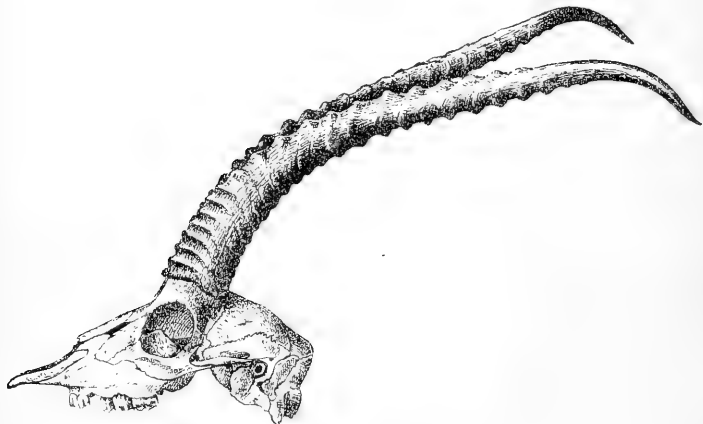
Skull and horns of *Gazella granti robertsi*. (Front view.)

and outwards and were very far apart. The twisting was spread over the whole length of the horn, and being in the direction characteristic of domestic as opposed to wild Bovidae, gave to the animals a remarkably goat-like appearance. In the female the horns were also twisted, although not so strongly as in the male.

Writing from Mwansa, German East Africa, Mr. Roberts

stated among other things that all of the Gazelles, in the district where these were shot, were of the same kind, so that they could not be said to be abnormalities; that it was quite possible for the animal to be unknown to science, as few sportsmen had ever shot before in that region; that the specimens sent, two males and a female, were much above the average in size, though still finer ones had been seen; and that the ordinary *Gazella granti* of the Athi plains and Kilimanjaro was unknown there. This Gazelle was known as the "Biza" by the natives, who were Wanyumwesi.

Text-fig. 11.



Skull and horns of *Gazella granti robertsi*. (Lateral view.)

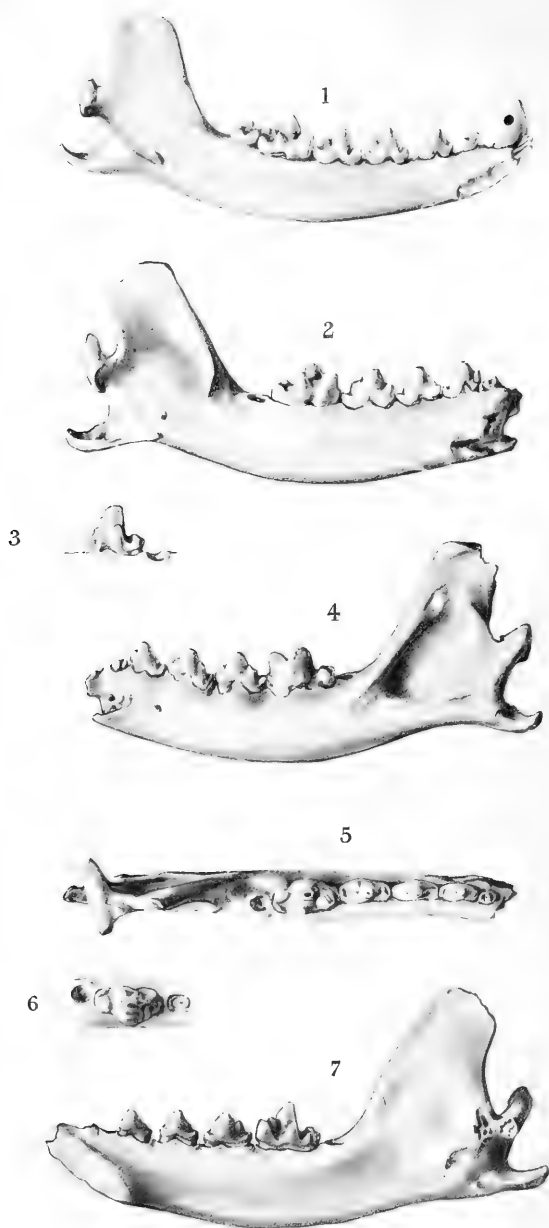
The colour of this Gazelle appeared to agree in all respects with that of the typical form of *G. granti*, having the undivided white rump-patch, the obsolete lateral bands, and the narrow but distinct pygal band of that form*. The fur was somewhat more wavy than in ordinary specimens.

Besides those seen by Messrs. Roberts and Blaine, two heads presenting similar characters had been obtained by Herr Oscar Neumann in the Loita Mountains, on the boundary of British and German East Africa, but had been not unnaturally regarded by him as abnormalities†.

In spite of the very unusual nature of the distinguishing characters of this Gazelle, and its identity with *Gazella granti* in other respects, Mr. Thomas thought that the number of examples that had now been recorded, and the fact that this type alone inhabited certain districts and had never been found elsewhere, necessitated

* Cf. P. Z. S. 1900, p. 806. By a *lapsus calami* the name of the new subspecies there described (*Gazella g. brightii*) was erroneously written *G. g. smithii* in the synopsis.

† Zool. Jahrb. Syst. xiii. p. 561 (1900).



G. M. Woodward, del.

LOWER JAWS AND TEETH OF (1), *GENETTA GENETTA*, (2-6) *GENETTA PLESICTOIDES*, sp. nov. (7) *PLESICTIS CROIZETI*.

its recognition as a subspecies; and he therefore proposed for it the name of *Gazella g. robertsi*, in honour of the donor of the specimens to the National Museum. The type would be the finer of the two males sent home by Messrs. Roberts and Blaine, B.M. No. 3.6.12.1.

In this specimen the horns measured $23\frac{1}{4}$ inches along the (morphological) anterior curve, their tips were $23\frac{1}{2}$ inches apart, and the basal length of the skull was $9\frac{3}{4}$ inches. Mr. Roberts quoted other examples having horns $24\frac{1}{2}$ inches long, with a spread of $27\frac{3}{4}$ and 28 inches.

The following papers were read:—

1. On an Extinct Species of Genet (*Genetta plesictoides*, sp. n.) from the Pleistocene of Cyprus. By DOROTHY M. A. BATE*.

[Received May 12, 1903.]

(Plate X.†)

In October, 1901, I began my search for Pleistocene bone-caves in the island of Cyprus, and for the next few months confined my attention to carrying on some work near the Monastery of Aghios Chrysostomos in the north, and to excavating in several caves in the south-east of the island.

In the following January I first discovered Dikomo Mandra, a cave containing an extensive deposit of Hippopotamus remains, and the largest found in the Kerynia range of limestone-hills, in the north of the island. However, it was not until April 1902, after receiving a grant from the Royal Society, that I was enabled to begin work here. This proved to be the only cave in which the remains of any carnivorous animal were found, other than those of the Fox still living in Cyprus. The remains obtained appear to be those of an extinct species and consist of a few limb-bones, a small piece of a right mandibular ramus with the posterior half of the carnassial, and a left mandibular ramus in which the incisors, the canine, and the last molar are missing. These portions of jaws, differing somewhat in size and wear, are evidently those of two individuals.

At the back of the cave, and some feet above the floor, was a mass of rock and earth containing a number of Hippopotamus bones. Work was begun here, an attempt being made to extricate a skull of this animal which could be seen embedded in the matrix. As soon as some of this rock had been broken away, several rents and fissures were found filled, partly with earth which must have been there since the time when the cave was inhabited by these

* Communicated by HENRY WOODWARD, LL.D., F.R.S., V.P.Z.S.

† For explanation of the Plate, see p. 124.

extinct mammals, and partly with earth and rubbish that had filtered down through the cracks in the rocks above. This accounted for the fact that the fossils in question, which are probably of the same age as *Hippopotamus minutus*, were found together with many teeth and bones of the Goat, several small rodents, and other recent species.

On comparing the left mandibular ramus (Pl. X. fig. 2), it appears to be that of a carnivore nearly allied to *Genetta genetta*, which is still found living on the opposite shores of Palestine. On the other hand, it presents many similarities to *Plesictis croizeti* of the Oligocene deposits of France, a mandible of which was originally figured by M. Pomel from a specimen found in the Department of Allier (Bull. Soc. Géol. France, t. iv., 1846-47, p. iv). A more perfect lower jawbone was procured by Dr. Forsyth Major from the same deposit, and both are now in the collection of the British Museum. The genus *Plesictis* is variously placed by different authors—by some among the *Viverridae* and by others among the *Mustelidae*. In a work published in 1853*, M. Pomel places *Plesictis* with the *Viverridae*, while Mr. Lydekker, in the 'Catalogue of Fossil Mammalia' (Brit. Mus. i. p. 183), includes the genus among the *Mustelidae*, at the same time saying that "In the above mentioned general characters the genus indicates viverrine tendencies, and the transition to the extinct *Stenoplesictis* is so gradual that the viverrine and musteline families are practically united by the two genera."

The Cyprus fossil agrees with, and at the same time differs from, both *G. genetta* and *P. croizeti*, and that so impartially, that it is a matter of extreme difficulty to decide with which group it ought most properly to be associated. The scanty material adds to this uncertainty, which would probably be removed were the skull and upper dentition of this species known. However, in consideration of its much more recent age compared with that of the Oligocene fossil, it is proposed, at all events for the present, to include it among the Genets under the name of

GENETTA PLESICTOIDES, sp. n. (Plate X. figs. 2-6.)

The mandibular ramus is intermediate in size between those of *G. genetta* (Pl. X. fig. 1) and *P. croizeti* (Pl. X. fig. 7), being more robust than that of the former and slightly less so than that of the latter. The anterior margin of the inner aspect of the coronoid process is somewhat deeply excavated, a feature which is found in neither of the last-mentioned species. The three posterior premolars and first molar are considerably worn; the small anterior premolar is rather damaged and its shape consequently uncertain; while the second molar is absent, though the clearly defined alveolus shows it to have been furnished with a single root.

The lower carnassial is distinguished from that of *P. croizeti*, *G. genetta*, and other *Viverridae* in the area between the three

* Cat. Vert. Foss. . . . de la Loire, etc. (Paris, 1853).

anterior cusps being less deeply excavated, and in the edge of the anterior lobe being less broadly expanded, though this last may be partly due to wear. This tooth also differs in the size of the inner cusp, which is lower than in the older form and higher than in *G. genetta*, in which it is much reduced. The talon is small and has a raised posterior edge.

The second, third, and fourth premolars are of considerable length antero-posteriorly, and do not narrow towards their apices to so great an extent as do those of *P. croizeti* and generally those of *Genetta*. The outer edge of the carnassial is strongly convex in shape, and as a result of this there is a deep angle between the anterior portion of the tooth and the small posterior talon. This is not so marked in *P. croizeti*, in which the position of the angle is filled by a ridge. Although the carnassial of *G. genetta* does not show this convexity, there is nevertheless a very slightly developed cusp between the front of the tooth and the talon.

Besides those characters in which *G. genetta* and *P. croizeti* agree together and differ from the Cyprus fossil, this last is further distinguished from the older form by having a less well-marked cingulum round the carnassial and the two posterior premolars, and in the crowns of these teeth being somewhat lower. Also the faintly marked notches on the anterior and posterior edges of the second and third premolars of *G. plesictoides* are absent in *P. croizeti*.

Below are some measurements, given in millimetres, taken from the left mandibular ramus of the Cyprus fossil and of the recent Genet, and from the two right mandibular rami of *P. croizeti* in the collection of the British Museum, both of which are from the Oligocene of France.

	<i>G. genetta.</i>	<i>G. plesictoides.</i>	<i>P. croizeti</i> (type).	<i>P. croizeti.</i>
Antero-posterior length of lower carnassial	7.5	8	9	8
Greatest width of lower carnassial	4	4.5	5	4.5
Ant.-post. length of pm. 4.....	6	7	7	6.5
" " pm. 3.....	6	6.5	6	5.5
" " pm. 2.....	5	5.5	...	4.5
From ant. margin of pm. 2 to post. margin of carnassial ...	25	27	27 approx.	26
From lower margin of ramus to top of coronoid process ...	24	24.5	...	28
Thickness of ramus below carnassial	4	5	5.5	5
Approximate height of carnassial	5	6	6.5	6.5

The limb-bones procured belong, presumably, to *G. plesictoides*, but probably all are not those of the same individual. I have compared them with the corresponding bones in a skeleton of *G. senegalensis* in the collection of the British Museum. They

include the proximal halves of two humeri, which are of about the same size as those of the African species, while a calcaneum is, on the other hand, distinctly smaller, being 19 mm. in length as compared with 21 mm. in the recent species. This is also the case with the radius, of which two specimens were found, it being more slender and 59 mm. in total length as opposed to 61.5 mm. Besides these, three pieces of ulnæ and several portions of ribs were obtained.

I have been unable to find record of any fossil *Genetta*, and among the rest of the *Viverridae* the only species of Pleistocene age appear to be *V. karnuliensis* from India (Lydekk. Mem. Geol. Surv. Ind. 1886), and a *Viverra* identified by a single canine from the cave of Lunel Viel, France.

Besides these, some portions of skulls found in the Quaternary deposits of Algeria are referred somewhat doubtfully to *Herpestes* by M. Pomel (Carte Géol. de l'Algérie, Les Carnassiers, 1897).

EXPLANATION OF PLATE X.

Fig. 1. Inner view of left mandibular ramus of *Genetta genetta* from Mt. Carmel, p. 122.

2. Inner view of left mandibular ramus of *G. plesictoides*, p. 122.

3. Inner view of a right carnassial of *G. plesictoides*, p. 123.

4. Outer view of the specimen shown in fig. 2, p. 123.

5. Crown view of the specimen shown in figs. 2 & 4, p. 123.

6. Crown view of tooth shown in fig. 3.

7. Inner view of right mandibular ramus of *Plesictis croizeti* Filhol, p. 122.

All the figures are of natural size.

2. Description of a new Fish of the Gobiid Genus *Rhiacichthys* from British New Guinea. By G. A. BOULENGER, F.R.S., V.P.Z.S.

[Received May 13, 1903.]

(Plate XI.*)

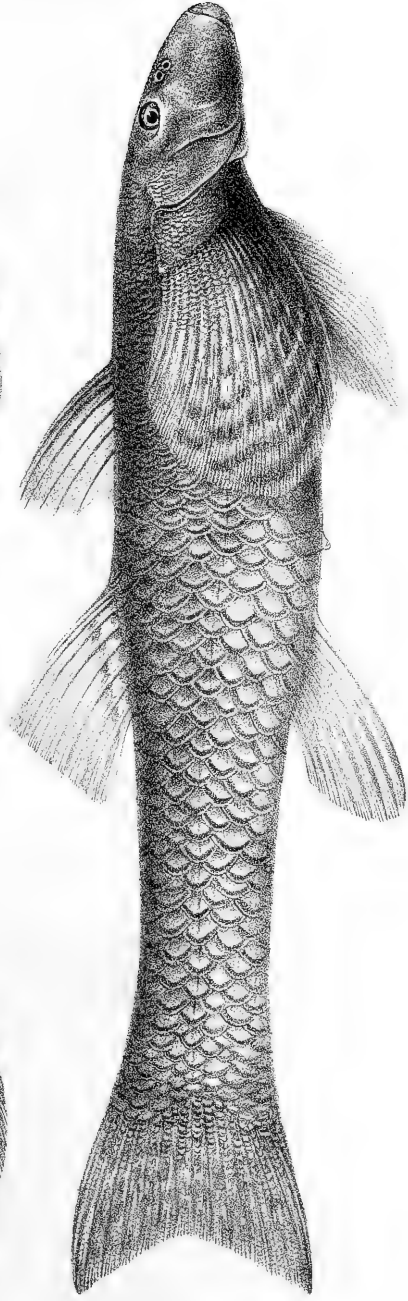
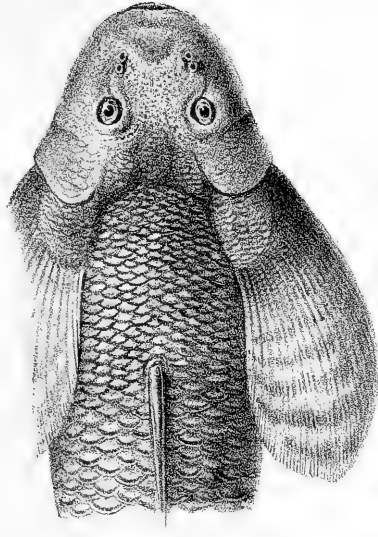
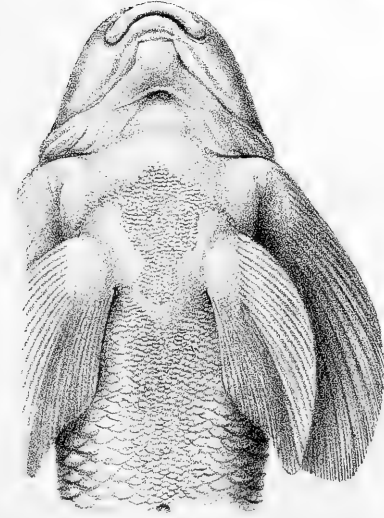
RHIACICHTHYS NOVÆ-GUINÆÆ. (Plate XI.)

Depth of body nearly equal to length of head, 5 to 6 times in total length. Diameter of eye 6 or 7 times in length of head, interorbital width 3 times; snout but very slightly longer than postocular part of head. Dorsals VII, I 8-9; longest spine $\frac{3}{4}$, longest soft ray $\frac{4}{5}$ length of head. Anal I 8-9, longest ray as long as head. Pectoral about $1\frac{1}{2}$ length of head, ventral as long as head or a little longer. Caudal feebly emarginate. Caudal peduncle $2\frac{1}{2}$ as long as deep. Scales strongly ciliated, 37 to 39 in a longitudinal series on each side, 14 or 16 round caudal peduncle. Dark olive above, whitish beneath.

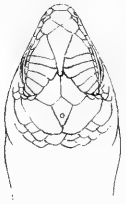
Total length 225 millim.

Three specimens were obtained by Mr. A. E. Pratt at Dinawa, Owen Stanley Range, at an altitude of 4000 feet.

* For explanation of the Plate, see p. 125.







2a.



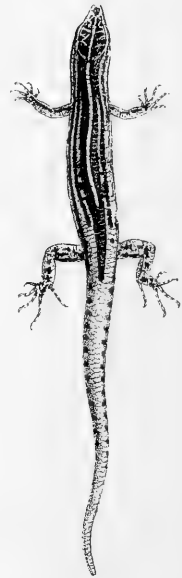
3a.



2.



1.



3.

J.Green del.et lith.

Mintern Bros. imp.

1. LYGOSOMA MILNENSE. 2. L. GRANULATUM.
3. L. PULCHRUM.



2a.



3a.



2.



1a.



3.



1.



2b.



3b.

The discovery in New Guinea of a fish of the genus *Rhiacichthys* Blgr. (*Platyptera* C. & V.), a type of Gobiidæ so admirably adapted to life in mountain torrents, is a very interesting addition to our knowledge. The type of the genus, *R. aspro*, C. & V., which differs from *R. novæ-guineæ* in the larger eye situated much nearer to the gill-opening than to the end of the snout, inhabits Bantam, Celebes, and Luzon*, whilst a doubtful species, *R. sinensis* Blkr., is founded on a Chinese drawing described as "*dubie exactitudinis*."

EXPLANATION OF PLATE XI.

Rhiacichthys novæ-guineæ, with upper and lower views of head and anterior part of body, reduced $\frac{2}{3}$ nat. size.

3. Descriptions of new Reptiles from British New Guinea.

By G. A. BOULENGER, F.R.S., V.P.Z.S.

[Received May 13, 1903.]

(Plates XII. & XIII.†)

LYGOSOMA MILNENSE. (Plate XII. fig. 1.)

Section *Hinulia*. Head large, especially in the male, body short; the distance between the end of the snout and the fore limb is contained once to once and one third in the distance between axilla and groin. Snout short, obtuse. Lower eyelid scaly. Nostril pierced in a single nasal; no supranasal; a single anterior loreal; rostral forming a very long, curved suture with the frontonasal, which is nearly twice as broad as long; præfrontals forming a median suture; frontal much narrowed posteriorly, longer than frontoparietals and interparietals together, in contact with the three first supraoculars; five supraoculars, first longest; 10 or 11 supraciliaries, first largest; frontoparietals and interparietal distinct, nearly equal in length; parietals forming a suture behind the interparietal; nuchals absent or reduced to one pair; third, fourth, and fifth labials below the eye. Ear-opening oval, nearly as large as the eye-opening; no auricular lobules. Scales smooth, dorsals largest, 30 or 32 round the middle of the body. Præanals slightly enlarged. The hind limb reaches the shoulder, or between the shoulder and the ear. Digits rather elongate, slightly compressed; subdigital lamellæ smooth, 35 to 37 under the fourth toe. Tail once and a half to once and two-thirds the length of head and body. Coloration very variable. Upper parts uniform brown, or with a light, dark-edged dorso-lateral streak joining its fellow on the base of

* I have not been able to find on any map the locality "Wanderer Bay" given by Günther, Cat. Fish. iii. p. 138.

† For explanation of the Plates, see p. 129.

the tail, or with dark brown spots forming bars across the body or restricted to the sides; three or four large black spots, with white dots between them, may be present on each side of the neck; a black canthal and temporal streak sometimes present; lips uniform whitish, or blotched with brown or black; lower parts whitish, throat sometimes blotched with dark brown.

	♂.	♀.
Total length	173	165 millim.
Head	20	17 "
Width of head	14	9 "
Body	48	44 "
Fore limb	27	23 "
Hind limb	40	35 "
Tail	105	104 "

Several specimens from Milne Bay, British New Guinea, collected by Mr. A. S. Meek.

The nearest allies of *L. milnense* are *L. concinnatum* Blgr., from the Solomon Islands, and *L. simum* Sauv., from New Guinea.

LYGOSOMA GRANULATUM. (Plate XII. fig. 2.)

Connecting the Sections *Hinulia* and *Otosaurus*. Habit lacertiform; the distance between the end of the snout and the fore limb is contained once and one third in the distance between axilla and groin. Snout very short, obtuse. Lower eyelid scaly. Nostril pierced in a single nasal; a very small supranasal, between the frontonasal, the nasal, and the first loreal, which is single; rostral forming a straight suture with the frontonasal, which is much broader than long and touches the anterior angle of the frontal; latter much narrowed posteriorly, a little longer than frontoparietals and interparietal together, in contact with the three first supraoculars; seven supraoculars, first more than twice as long as second, seventh very small; eleven supraciliaries, first largest; frontoparietals and interparietal distinct, the former a little longer than the latter; parietals forming a suture behind the interparietal; no nuchals, each parietal in contact with four scales; fourth, fifth, and sixth upper labials below the eye. Ear-opening large, oval, as large as the eye-opening; tympanum scarcely sunk; no auricular lobules. 36 scales round the middle of the body, laterals smallest, dorsals slightly larger than ventrals, dorsals and laterals rough with minute granular asperities. A pair of enlarged præanals. The hind limb reaches the axilla. Digits elongate, compressed, obtusely keeled below; 20 lamellæ under the fourth toe. Tail about once and a half the length of head and body. Pale reddish brown above, variegated with dark brown; sides with large dark brown spots, some forming vertical bars; a white dot above the tympanum, another above the shoulder; sides below the large spots reticulated with dark brown;

lips spotted with dark brown; lower parts whitish, throat almost entirely dark brown.

Total length	117 millim.	Fore limb	14 millim.
Head	11 "	Hind limb	23 "
Width of head ...	7 "	Tail	72 "
Body	34 "		

A single specimen from the Albert Edward Range, 6000 feet, collected by Mr. H. S. Rohn.

Nearest ally: *L. annectens* Blgr., from New Guinea.

LYGOSOMA PULCHRUM. (Plate XII. fig. 3.)

Section *Lirolepisma*. Habit lacertiform, slender; the distance between the end of the snout and the fore limb is contained once and one fourth in the distance between axilla and groin. Snout moderate, pointed. Lower eyelid with an undivided transparent disk. Nostril pierced in the middle of a rather large nasal; no supranasal; anterior loreal as deep as the nasal; frontonasal broader than long, forming a short straight suture with the rostral; præfrontals meeting with their inner angles, or narrowly separated; frontal small, acutely pointed behind, in contact with the first and second supraoculars; frontoparietal single, as long as the frontal; interparietal distinct, about half as long as the frontoparietal; four supraoculars; eight supraciliaries; parietals in contact behind the interparietal; three to five pairs of nuchals; four upper labials anterior to the subocular. Ear-opening roundish, smaller than the eye-opening; no auricular lobules. 24 scales round the middle of the body, perfectly smooth; dorsals, especially the two vertebral series, largest, laterals smallest. Two strongly enlarged præanals. The hind limb reaches the elbow of the adpressed fore limb. Digits slender, a little flattened at the base, fourth toe much longer than third; subdigital lamellæ smooth, 22 under the fourth toe. Black above, with five white longitudinal lines, commencing on the snout, the vertebral narrowly interrupted behind the head and ending a little before reaching the sacral region; an interrupted additional line on each side of the body between the vertebral line and the upper lateral; limbs reddish, spotted with black, with regular black bars across the digits; tail coral-red, with a regular series of black spots or vertical bars on each side; lower surface of head and body greenish white.

Head	9 millim.	Fore limb	11 millim.
Width of head ...	5 "	Hind limb	16 "
Body	27 "		

Two specimens, both with the tail injured, from the Albert Edward Range, 6000 feet, collected by Mr. H. S. Rohn.

Nearest ally: *L. pulchellum* Gray, from the Philippines.

LYGOSOMA PRATTI. (Plate XIII. fig. 1.)

Section *Lygosoma*. Body elongate, limbs short; the distance between the end of the snout and the fore limb is contained once and three fourths in the distance between axilla and groin. Head small, much depressed; snout moderate, obtusely pointed. Lower eyelid scaly. Nostril pierced in a single nasal; no supranasal; rostral narrowed and produced posteriorly between the nasals, forming a narrow suture with the frontonasal, which is a little broader than long and narrowly in contact with the frontal; latter as large as frontoparietals and interparietal together, much broader than the supraocular region, in contact with the first supraciliary, the first supraocular, and a very small part of the second; four supraoculars; seven supraciliaries; frontoparietals and interparietal distinct, subequal; parietals forming a suture behind the interparietal; no nuchals; fourth and fifth labials below the eye. Ear-opening oval, nearly as large as the eye-opening; no auricular lobules. 36 smooth scales round the middle of the body; dorsals, especially the two vertebral series, largest. A pair of slightly enlarged præanals. Limbs widely separated when pressed against the body. Digits short, compressed, keeled below; subdigital lamellæ mostly divided, 13 or 14 under the fourth toe. Tail very thick. Pale brown above, mottled or vermiculate with dark brown; head and nape blackish; two oblique white streaks from below the eye to the throat; belly white.

Total length	162 millim.	Fore limb	14 millim.
Head	15 "	Hind limb	21 "
Width of head ...	10 "	Tail (reproduced) .	75 "
Body	72 "		

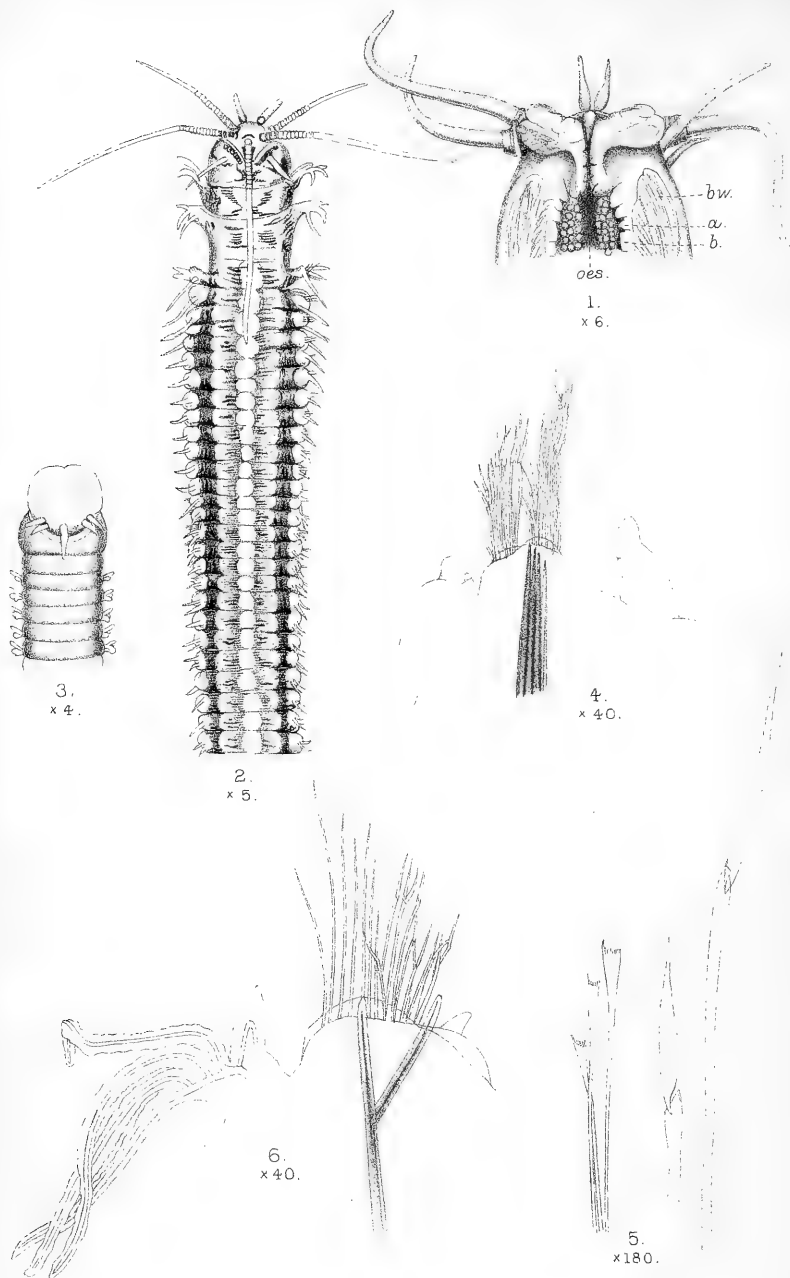
This new species, of which a single specimen was obtained at Dinawa, Owen Stanley Range, 4000 feet, by Mr. A. E. Pratt, is most nearly related to the Papuan *L. muelleri* Schleg., and clearly belongs to the same section of the genus *Lygosoma*. But it is also closely allied to *L. loricæ* Blgr., from New Guinea, which has been referred to the section *Hinulia* and evidently constitutes a connecting-link between the two sections.

Having, through the kindness of Mr. Thomas Steel, of Sydney, had the loan of the type of *Homolepida englishi* De Vis, I am able to confirm its identity with *L. muelleri*, as already pointed out by me in the 'Zoological Record' for 1890.

TOXICOCALAMUS STANLEYANUS. (Plate XIII. fig. 3.)

Rostral much broader than deep, just visible from above; internasals nearly as long as the præfrontals, which are in contact with the second upper labial and with the eye; frontal small, slightly broader than the supraocular, once and three fourths as long as broad, as long as its distance from the end of the snout, a little shorter than the parietals; one postocular; temporals 1 + 2;





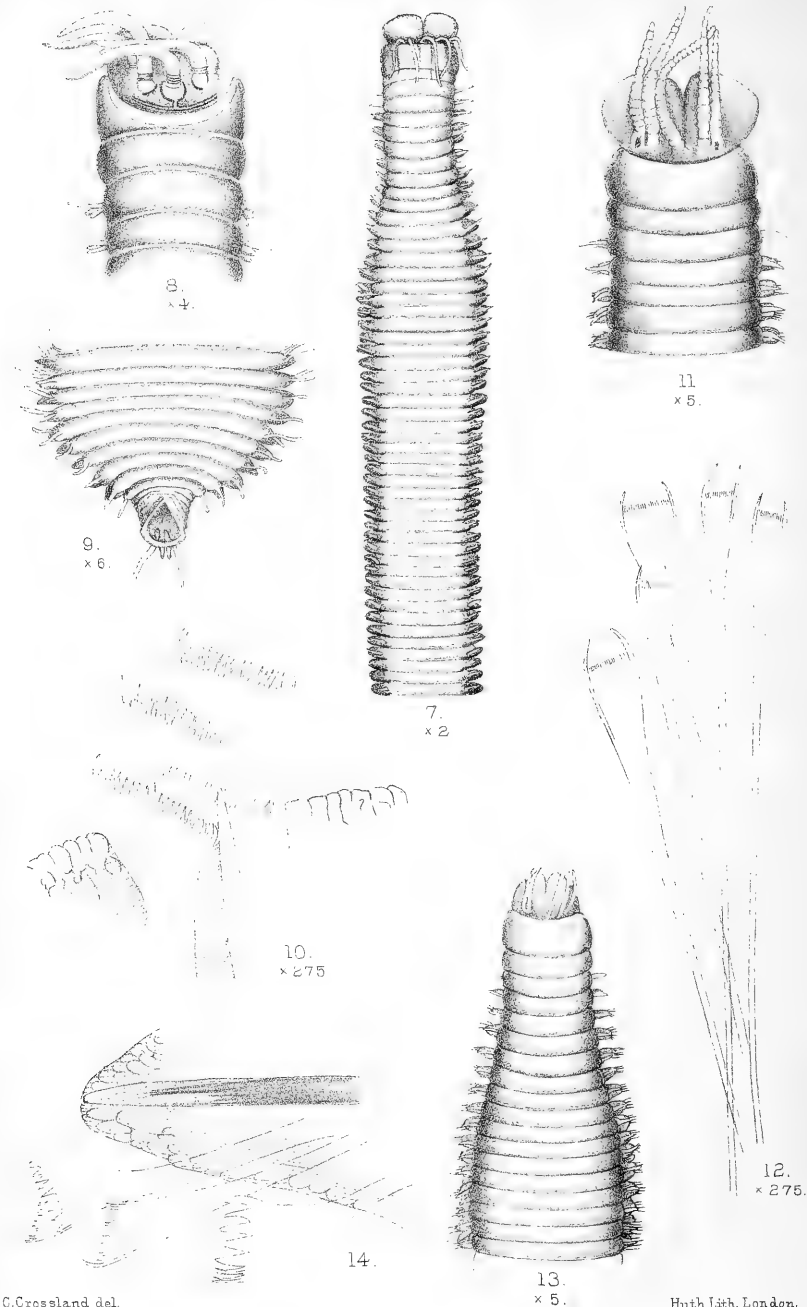
C. Crossland del.

Huth, Lith. London.

Fig. 1. DIOPATRA NEAPOLITANA.

2. ONUPHIS HOLOBRANCHIATA.

3-6. MARPHYSA MACINTOSHI. n.sp.



G. Crossland del.

Huth, Lith. London.

Fig^s 7-10. *MARPHYSA MOSSAMBICA*.

11, 12. *M. SIMPLEX*. n.sp.

13, 14. *M. FURCELLATA*. n.sp.

five upper labials, second and third entering the eye; three lower labials in contact with the anterior chin-shields, which are larger than the posterior. Scales in 15 rows. Ventrals 261; anal entire; subcaudals 25 pairs; tail ending in a compressed, obtusely pointed scute, which is obtusely keeled above. Blackish brown above; traces of a yellowish nuchal collar; upper lip white; two outer rows of scales white, each scale with a blackish central spot; ventrals and subcaudals white, with a black spot on each side, some of the ventrals with an interrupted blackish border.

Total length 610 millim.; tail 40.

A single female specimen from Dinawa, Owen Stanley Range, 4000 feet, collected by Mr. A. E. Pratt.

The genus *Toxicocalamus* was established by me in 1896 (Ann. & Mag. N. H. [6] xviii. p. 152), for a Snake from Woodlark Island, British New Guinea, *T. longissimus*, here figured (Pl. XIII. fig. 2), which differs from the one now described in the numbers of scales and shields (Sc. 17; V. 299-305; A. 2; C. 30-31), in the smaller eye, in the shorter internasals and frontal, in the proportions of the upper labials, of which the third and fourth enter the eye, and in the coloration.

EXPLANATION OF THE PLATES.

PLATE XII.

- Fig. 1. *Lygosoma milnense*, p. 125, male, natural size.
 2. *Lygosoma granulatum*, p. 126, natural size.
 2 a. " " Upper view of head, $\times 2$.
 3. *Lygosoma pulchrum*, p. 127, natural size.
 3 a. " " Upper view of head, $\times 2\frac{1}{2}$.

PLATE XIII.

- Fig. 1. *Lygosoma pratti*, p. 128.
 Figs. 2, 2 a, 2 b. *Toxicocalamus longissimus*, p. 128. Upper, side, and lower views of head and anterior part of body.
 3, 3 a, 3 b. *Toxicocalamus stanleyanus*, p. 129. Upper, side, and lower views of head and anterior part of body.
 All natural size.

4. On the Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland in the Years 1901 and 1902.—Polychæta. Part II. By CYRIL CROSSLAND, B.A., B.Sc.*

[Received May 25, 1903.]

(Plates XIV. & XV.†, and Text-figures 12-15.)

PART II.—THE EUNICIDÆ.

Before beginning my examination of the typical Nereidiform (*i. e.* Errant) Polychætes, I investigated to some extent the variability of those characters usually employed for specific

* Communicated by Prof. W. C. McINTOSH, F.R.S., C.M.Z.S.

† For explanation of the Plates, see p. 144.

distinctions, the proportions of which are described numerically and with great minuteness by some of the best workers. However one may admire the care which has been employed, and however desirable the use of such numerical statements may be, my results showed clearly that they are, from the nature of the case, unpractical. As their employment can only render descriptions more cumbrous, and the limits of the species so defined more hazy even than in nature, I forego all minuteness in statements of proportion and numbers. Accurate figures, drawn to scale, will provide as full and unmistakable accounts of species as is possible by the medium of ink and paper; the extent of variation rarely being so great as to render a drawing thus prepared from one specimen not recognisable at once as a likeness of any other member of the same species.

The deductions from my tables of measurements of specimens of *Marphysa mossambica* are shortly as follows :—

- (1) The body shape is generally constant, but the numerical position of the widest segment may be very different in certain individuals.
- (2) The proportions of pro- and peristomium *in se* and *inter se* are roughly constant.
- (3) The length of the unpaired tentacle is variable within limits, but the number of the segment to which it reaches when laid along the back is not worth giving in a description of the species.
- (4) The gills, as often noted, begin on different segments in different specimens, increase in size and complexity quite irregularly, and vary in the maximum number of the filaments they bear.

In another examination, all the smaller gills were left out of account, the distance from the anterior end to the point where gills of approximately the full size begin to occur being measured. This varies from 5 to 6 cms.; the number of segments it contains varies from 64 to 80.

- (5) The number of teeth borne by the dental plates frequently varies by one on either side of the mean, *i. e.* for the larger plates from 4 to 6.

In *Marphysa belli*, a species which is characterised by the large size and the concentration of the gills to a few segments, these still vary in the same ways. Two specimens, collected and preserved together*, differed as follows :—

Though both are 3·5 mm. in breadth the segments in no. 1 are much the shorter. In no. 1 the gills do *not* meet over the back, though no. 2 agrees with the specific definition in this respect. No. 1 bears 17 pairs of gills on feet 13 to 30 †, and no. 2 21 pairs

* I owe my opportunity of examining this species to the kindness of Prof. McIntosh. The specimens were dredged by the 'Porcupine' in 1870 from 81 fathoms, off Cape Finisterre.

† In all cases the first *setigerous* segment is counted as the first, a method of reckoning which is free from any possible ambiguity.

on feet 14 to 35. The prostomium is of nearly the same size in both specimens, yet the unpaired tentacle, when laid along the back, extends beyond the anterior border of the fourth segment, or only up to that of the second segment. The colour of the two specimens differs markedly, being much duller in no. 2.

Similar results were obtained in the case of *Diopatra neapolitana*, in which species such variations are much more conspicuous in accordance with the great development of the organs concerned. The resulting differences of facies have caused some synonymy, and have made some authors content to give quite insufficient descriptions.

The ONUPHIDINÆ.

The genera *Rhamphobrachium* (Ehlers), *Onuphis* (Aud. et Ed.), *Hyalinœcia* (Malm), and *Diopatra* (Aud. et Ed.) form a very well-marked group characterised by modifications for a permanently tubicolous mode of life.

The last three genera are differently defined, however, by the principal authorities. All authors but Ehlers agree in separating the genus *Diopatra* because of its very characteristically formed and distributed gills. In other cases Ehlers would be theoretically right in objecting that the gills of Annelids are too variable to be made a basis for generic distinctions, and in urging that the gill-less species are derivable from either *Onuphis* or *Diopatra*, if the distinction between these genera is maintained. Practically, however, we find no form with gills intermediate in structure between those of *Diopatra* and any other Eunicid whatever; and this distinction is emphasised by the fact that no other member of this group has its largest gills confined to the anterior part of the body. There is no real necessity, therefore, for the confusion introduced by assigning the two gill-less species, *fragosa** and *glutinatrix**, and the forms with pectinate gills *posteriorly*, *pourtalesii**, *magna*†, and *dorsalis*‡, to the genus *Diopatra* instead of to the genera *Paronuphis* and *Onuphis*, as would have been done by any other writer.

The confusion in the definitions of the genera *Hyalinœcia* and *Onuphis* has its origin simply in the name of the former. The addition of a coating of mud or larger pieces of foreign material to the foundation of the tube secreted by the body of the worm cannot be regarded as a sufficient cause for generic distinction, however striking the difference in *appearance* of the tube. The name *Hyalinœcia* may be retained when not literally applicable, the transparency of their abode being characteristic of the great majority of the species.

The character of the gills forms the basis of a distinction between nearly all the species of the two genera, but, as elsewhere, all stages are found between the typical comb-like gill of

* Ehlers, "Annelids of the U.S. Survey ship 'Blake,'" Cambridge, Mass., 1887.

† Andrews, Pr. U.S. Nat. Mus. xiv. p. 277.

‡ Ehlers, 'Hamburger Magal. Sammelreise,' p. 71 (1897).

Onuphis and the cirriform gills of *Hyalinacacia*, or even the complete absence of gills (*Paronuphis*), so that in some cases the only distinction available is that provided by the presence or absence of tentacular cirri.

Genus DIOPATRA.

DIOPATRA NEAPOLITANA Clap. (Plate XIV. fig. 1.)

Since Grube's enumeration in 1877* of eighteen species but few fresh descriptions have been published (Langerhans, *D. madeirensis*†; Ehlers, *D. chilensis*‡, redescribed). This fact, and the very local distribution of the species given, probably indicate the existence of a very considerable amount of synonymy, though Kinberg's seven species, assuming the correctness of his figures, are distinct. It is thus the more remarkable that the species should have so wide a distribution as from the Mediterranean to the East coasts of Africa and North America§.

The species is so abundant at low spring-tides on any sandy or muddy shore in East Africa, that it is strange that it has not been before recorded from this locality. The material of the tubes varies with the habitat—on a sandy beach being built of shell-fragments or small stones, the edges always projecting horizontally, on muddy shores the grass-like leaves of *Zostera* or any suitable vegetable fragments being employed. Only the projecting and the upper two or three inches of the buried portions are thus strengthened, the remainder being soft and collapsable.

Dark green and umber-brown coloured varieties of the animal occur, both colours being destroyed by a brief immersion in alcohol. The only specimen I obtained from below the level of lowest tides (from 10 fathoms in Wasin Harbour, the mainland coast) shows a third distinct variety||.

The living worm was red- (not umber-) brown anteriorly, the colour remaining distinct after immersion in strong spirit for more than a year. The gills were red, the colour of the blood not being hidden by green and brown pigments as in the preceding varieties. Structurally, I find this specimen to agree with the shore forms. The presence of similar pigmentation in preserved specimens obtained from Naples suggests that this colour variety occurs there also, and is probably the variety of colour which is described by Claparède as "*ferrugineuse*." It is possible, of course, that green, umber, and red-brown pigments may occur occasionally in the same individual, though I have not seen cases of this in East Africa.

The lack of perfect completeness in Claparède's account, and the obviously diagrammatic nature of at least two of his figures, made it impossible to decide whether I was examining a nearly related species or a variety only. A comparison of specimens obtained from Naples with my own from Zanzibar has enabled me to

* 'Mitth. über die Familie der Euniceen,' Naturw. Schles. Ges. 1877.

† Z. Wiss. Zool. xxxiii. pp. 513-593.

‡ 'Polych. des Magal. u. Chil. Strandes,' 1901.

§ Andrews, *loc. cit.*

|| Very numerous tubes were dredged from 3 fathoms in one spot in Chuaka Bay.

supplement the earlier description and in a few details to correct it. As, however, a complete description, by Professor McIntosh, of specimens obtained by the 'Porcupine'* has recently appeared, there is no need for me to do more than summarise the most definite points.

If the proportionate sizes of gills and tentacles were ever approximately constant, surely they would be so in this species, in which their large size is so characteristic. I find, however, that the first gill, which is usually on the fourth foot, is often on the fifth. (Claparède and Grube give the fifth as the first gill-bearing foot.) The ringing of the gill-bases, upon which stress is laid in Grube's tabulation of the species, may be quite obvious or only to be made out by very careful examination. The anterior feet are ringed very faintly. The last gill-bearing segment may be any one between the fiftieth and sixtieth, and in one case it was the fiftieth on the right side, the fifty-fifth on the left. The gills, when laid forward, may extend either to the middle of the first setigerous segment or beyond the front of the prostomium. The buccal and first three setigerous segments are of about the same length, but those succeeding rapidly shorten, so that numbers four to eight or twelve are the shortest in the body.

The palps are very large, together forming an area greater than that of the prostomium itself. Between them is a deep and narrow groove bounded anteriorly by a tubercle, which leads back a little dorsally to the œsophagus, separation of which from the jaw-apparatus is effected by a pair of lips bearing large tubercles (Pl. XIV. fig. 1).

I do not find in either set of specimens any setæ corresponding to Claparède's fig. 4 D, pl. vi. of the 'Annélides du G. de Naples.' The compound setæ ("soies incomplètement composées") of the first three feet have invariably two hooks, which are quite distinct. In the Naples specimens the comb-setæ have few teeth, and these are remarkably broad and flat; the capillary setæ, like the aciculæ, are gently bent near their ends, a fact which led Claparède to describe them as being bordered or ending in a lance-head. This is not the case, though their sides are toothed, the teeth usually being fine but sometimes large and coarse.

The Zanzibar specimens agree with those mentioned above except that the teeth of the combs are very fine and numerous, and that the distal filaments of the gills are almost as long as the proximal. In the Naples specimens the shape of the gill agrees with Claparède's figure in the shortness of the distal filaments. These differences, though constant, do not warrant the creation of a specially named variety.

At Prof. McIntosh's suggestion I append an account of further observations on the variation of the special anterior feet, to which importance has been attached by systematists. Prof. McIntosh †

* "Notes from the Gatty Marine Laboratory," Ann. & Mag. Nat. Hist. (ser. 7) vol. xii. p. 128 (1903).

† My thanks are due to Prof. McIntosh for showing me his preparations and for an opportunity of discussing them with him.

finds in his specimen of this species from Naples that the setæ described by Claparède as "*incomplètement composées*" end in a simple hook covered by a guard*, whereas in the 'Porcupine' specimen a second hook is present a short distance behind the terminal one. Also in the former the gill is borne on the fourth foot, in the latter on the fifth, and in both cases, simultaneously with its appearance, the ventral cirrus is thickened and shortened, presenting an intermediate stage between the normal pointed organ of the first feet and the secretory pad which represents it throughout the remainder of the body. This consensus in the variation of three characters seems a sufficient ground for the separation of the specimens as two distinct varieties.

The question, however, now arises as to whether these characters always vary together and in the same direction, or whether their variations may not occur independently and sporadically.

As regards the difference between the setæ, Claparède mentions the occasional appearance of a second hook. Both in Prof. McIntosh's specimens and in my own we find that the young setæ which do not yet project from the foot are always provided with the second tooth, which in my Naples specimens may be present or absent in those setæ which are exposed. This indicates that, in spite of the absence of a scar in some cases and the unbroken condition of the guard in nearly all, the lack of the proximal tooth is always accidental, and is owing to its brittleness and to the flexibility of the delicate guard. In the Zanzibar specimens a distinct scar is always to be seen in those rare cases where the somewhat stouter hook has been lost.

In three specimens from Naples the first gill was borne on the fourth, in three others on the fifth foot, the total number of gills varying between 37 and 50. Out of nine examples from Zanzibar only two bear their first gill on the fifth foot, and the total number is between 46 and 59. The first gill is usually about half the length of the largest, but in two cases those borne by the fourth feet were only a quarter of that length. In the three Naples specimens, the fourth feet of which are devoid of gills, the same appendages bear hooked setæ and ventral cirri of the normal form; but in the three other examples, the fourth feet of which possess gills, they bear simple setæ and possess ventral cirri which are knob-like in form. Of nine Zanzibar specimens, in five cases the change in the ventral cirrus takes place on the first, being deferred to the second branchiferous foot only in the remaining two, and in one of these cases the foot on which this change occurs is the sixth. Though I have not found a case of the extension of the hooked setæ to the first gill-bearing foot in any of the Naples specimens, I find such setæ to be present on these feet in all those from Zanzibar, even in the two cases where this is the fifth foot.

* As in the lower right-hand seta of those figured by Claparède. His other figures, as noted above, are optical delusions. See Prof. McIntosh's note on the 'Porcupine' specimen in the 'Annals and Magazine of Nat. History,' *loc. cit.*

Thus, though in the majority of cases the disappearance of hooked setæ and the change in the character of the ventral cirrus are coincident with the appearance of the first gill, exceptions are proportionately numerous, so that variations of these characters cannot well be made the ground for systematic distinctions.

Genus ONUPHIS.

ONUPHIS HOLOBRANCHIATA Marenzeller. (Plate XIV. fig. 2.)

Five specimens were collected, and in all the hind end was missing. The largest fragment is very nearly of the same size as that described by Marenzeller from Japan, viz. 4 cm. \times 0.3 cm., and consists of nearly the same number of segments, 85. This, with three others about half the size, was dredged from 10 fathoms in Wasin Harbour; the fifth, still smaller, being from the shore in the same locality. This last specimen is abnormal in having no gills on the first two pairs of feet.

The coloration of the living animal is characteristic, the pattern on its dorsal surface serving to distinguish it at a glance from any of the numerous small species of Eunicidæ living in the same locality. The ground-colours are of a light flesh-tint ventrally and light yellow-brown dorsally, but the central part of the prostomium and a small round area in the middle of each segment are white. The upper surface, however, as far as the thirty-fifth segment, is largely covered by markings of a dark, rather purple-brown (Marenzeller's "Dunkelbraun-violett" suggests an almost blue colour, which is not that present in my specimens). These are most numerous and closely placed at the bases of the feet, with the exception of the first three. On either side of the white central marks are slender transverse lines, three pairs, one of long, two of short marks to each segment. To the naked eye the back appears marked by two pairs of longitudinal bands, the outermost darker and of definite zigzag shape, the inner which bound the median moniliform white stripe, lighter and less definite in outline. The former is omitted from the first four segments, and the latter also is irregular there. There are dark marks on the prostomium just behind the bases of the tentacles, the ringed portions of which are themselves lightly marked. The fig. 2, Pl. XIV., shows this pigmentation, the peculiar proportionate lengths of the tentacles, &c.

In feet, setæ, gills, and other characters my specimens agree minutely with Marenzeller's. The former, like their gills, are white and somewhat dorsally directed. The mandibular plates differ slightly in shape from Marenzeller's figure, having, in the cutting-edge, one deep, instead of two shallow notches.

EUNICINÆ.

Genus MARPHYSA.

The following table, which includes all the species of which

- M. acicularium* Webster. "Annelids of Bermuda," Bull. U.S. Nat. Museum, 25, 1884, p. 319.
- M. fallax* Marion et Bobretsky. Ann. Sci. Nat. (6), 1875.
- M. saxicola* Langerhans. "Einige canarischen Anneliden," Nova Acta Acad. Cæs. Carol.-Leop., 1881.
- M. striata* Kinberg. 'Eugenies Resa,' &c. (These figures without text are of far more value than many verbose descriptions without figures.)
- M. corallina* Ehlers. 'Die Anneliden des Magellanischen und Chilenischen Strandes.' Berlin, 1901, p. 131. (Kinberg gives figs. of head.)
- M. regalis* Verrill. "Additions to Fauna of Bermuda," Trans. Connecticut Acad. v. pt. 2, 1900.
- M. januarii* Grube. Sitz. der naturf. Gesell. Freunde zu Berlin, 1881, p. 111.
- M. parishi* Baird. Journ. Linn. Soc., Zool. x. 1870. (See note also by Ehlers in U.S. Fishery Survey by s.s. 'Blake.')

MARPHYSA MACINTOSHI, sp. nov. (Plate XIV. figs. 3-6.)

Three specimens were obtained by digging in sand between tide-marks, on both east and west coasts of Zanzibar. The hind end is missing from all three, though the largest fragment has a length of 20 cms. Their breadth is very uniform (4 mm.), only the first half-dozen segments being rounder and narrower. There is no regular pigmentation.

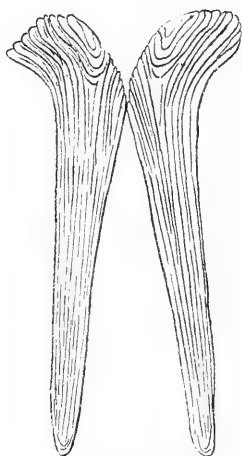
The prostomium is large and undivided, resembling in shape the outline of a horse's hoof. It is flat above, but deeply grooved below (Pl. XIV. fig. 3). The tentacles are slender, smooth, and pointed, without differentiated basal portions. The median tentacle does not quite reach the anterior border of the prostomium, and the other two pairs, which are inserted close together at some distance on either side of it, are considerably shorter. Between the bases of the two latter can be made out with care a pair of small ill-defined eye-spots.

The mandibles are curved outwards at their tips, their anterior ends marked by the lines shown in text-fig. 12, p. 138. The maxillary forceps are slender and strongly curved at their points. Great dental plates with 4 teeth on the left, 5 on the right, uppermost on both sides, are well developed. Curved laterals narrow, with 5 and 6 teeth on the left, 7 on the right.

Feet normally developed, with rounded lip of seta-sac and long bunches of setæ. The cirri are well developed for a member of this genus, their tips extending as far as the level of the seta-sac lip. The ventral cirrus has a thick base which almost hides the rest of the foot in a ventral view, to which is joined a smaller cylindrical tip, the whole roughly resembling a nereid palp (see fig. 4, Pl. XIV.). There are three black aciculæ anteriorly, at a short distance behind the beginning of the gill-region only two, with an acicular 'hook' seta. This is bent and projects, and is simply bluntly pointed (Pl. XIV. fig. 6). Over the greater part

of the body the feet are provided with this and one aciculum only. The ordinary setæ project considerably, especially in the anterior feet. Here they are arranged in two distinct bundles of simple capillaries dorsally and compound ventrally, with a set of shorter and stouter compound setæ between the two. Posteriorly this arrangement is less definite, the bundles running into one another. The long capillaries are as usual slightly bent, smooth, and end in a very delicate point. Long and slender comb-setæ occur among the more ventral capillaries (Pl. XIV. fig. 5) of the posterior segments, the teeth of which, except the two outermost, are hardly to be made out even by the $\frac{1}{4}$ -in. objective. The articulated pieces of the compound setæ are of the knife-shape. Their proportions are shown in Pl. XIV. fig. 5.

Text-fig. 12.



Marphysa macintoshi. Mandibular jaw-plates, $\times 45$.

The gills begin from seg. 32 to 54, attaining their full size more gradually in the former case. Their greatest number of branches may be four, five or, six, of moderate length, *i. e.* they can be nearly made to meet over the back. Their arrangement is bushy rather than comb-like (Pl. XIV. fig. 6). As the gills are present up to the ends of all three fragments, it is most probable that they extend to near the anus.

All the other species of *Marphysa* in which an undivided prostomium is met with are characterised by the possession of few, and those very large gills. The present species therefore occupies a conspicuous position in the genus, as indicated in the above table. The shortness, slenderness, and insertion of the tentacles, the rudimentary condition of the eyes, and the articulation of the ventral cirri are also prominent specific characters.

MARPHYSA MOSSAMBICA Peters. (Plate XV. figs. 7-10.)

Marphysa novae-hollandiae Grube, Annulata Semperiana, p. 165.

M. mossambica Gravier, Nouv. Arch. Mus. de Paris, 1900; also Kinberg & Peters.

The most complete description of this species is that recently given by Gravier, following on, and adding figures to, that of Grube.

The species occurs abundantly in Chuaka Bay, Zanzibar, living in deep burrows where the sand is of some consistence, *i. e.* well above low-water mark. In obtaining specimens for bait, the natives dig pits two or three feet deep, scooping away the sand from the circumference until a sufficient number of the worms has been met with. My own specimens were obtained in this way, through the natives, except two younger ones, which were found under the bark of a tree which lay half buried in the sand.

The worm is of fair size, a foot or two long, by nearly half an inch wide when alive. Its colour is a dark blood-red, with a green iridescence anteriorly, the red being obscured, however, only by the black gut posteriorly. No pigmentation occurs except certain small marks on the prostomium described below.

The shape of the anterior end of the body (Pl. XV. fig. 7) is very characteristic of this as of several other species. The head and first few body-segments are proportionately long and round in section, forming a cylinder, but at about the fifth they become much broader and especially shorter and flatter. The broadest segment is usually about the twelfth, after which a slight decrease in breadth occurs, the rest of the worm having parallel sides and being composed of very short and flat segments. From about half an inch before the anus the segments rapidly narrow, so that the hind end is triangular (see Pl. XV. figs. 7 & 9). The upwardly directed thick-lipped anus and its cirri are as figured by Gravier, but his figures of both head and anus suggest that the worm increases and decreases in breadth but slightly, and quite gradually.

I find no reduced eyes on the prostomium. The pigment-marks at the bases of the tentacles and under the anterior border of the peristomial segment are shown in fig. 8, Pl. XV., which shows also the rings round the lower ends of the tentacles mentioned by Gravier. The tentacles are always distinctly more slender, and appear to arise nearer together than those shown by Gravier's figure.

The dental apparatus is soft and brown in the two young specimens, very hard and black in the adults, a very little white matter occurring on the lower or mandibular plates. The uppermost tooth of the right great dental plate is always smaller and duller than the corresponding one on the left, and those of the right curved lateral plate are all longer than those of the left.

Except near the extremities of the body, the feet present the peculiarity of being provided with no more than the stumps of their setæ. This, which would appear a mere regrettable accident

if only one specimen occurred in the collection, becomes an interesting character when it is found that it occurs in all cases, even in young specimens. Besides the characteristic long capillaries, short, remarkably broad comb-setæ occur in some feet at either end of the body (Pl. XV. fig. 10).

There are four aciculæ in the anterior feet, two or three in those of the middle region, and one posteriorly, which may or may not be accompanied by another which is almost colourless.

MARPHYSA SIMPLEX, sp. nov. (Plate XV. figs. 11, 12.)

Two specimens from between tide-marks, near Zanzibar Town: the larger incomplete, measuring 10 cms. by 0.45 cm., composed of 155 segments; the smaller complete, 15 cms. long by 0.3 cm. broad.

The circular section of the body is very nearly uniform throughout, and the length of the segments is greater than in the case of the preceding species, and those immediately following the head are neither longer nor narrower than the rest. The body narrows quite gradually to the anus, the opening of which is large, upwardly directed, and provided with a pair of moderately long cirri ventrally.

The prostomium is bilobed, the median notch being continued dorsally as a narrow groove to its base. The tentacles are nearly twice as long as the prostomium and are delicately ringed. Their insertion, basal parts, and the position of the eye-spots are shown in fig. 11, Pl. XV. No considerable portion of the prostomium is hidden by the next segment. The peristomium has a total length about equal to that of the head, the segments immediately succeeding being about half as long and of the same size, or nearly so, as those composing the rest of the body.

The larger pieces of the dental apparatus all show a white edging, especially prominent on the upper ends of the mandibles, which bear large plates of this calcareous matter. The great dental plates bear three teeth each in the larger specimen, four in the smaller. The teeth of the laterals are blunt, and number four and three on the left, six on the right. The whole apparatus presents no peculiarity save the structure of the mandibles, for which see text-fig. 14, p. 142.

The feet are small, and contain numerous long setæ, projecting from a seta-sac, the posterior lip of which is very broad and straight-edged (text-fig. 13, p. 141). All the setæ are smooth, without toothing or borders, the capillaries being bent gently and pointed in the usual way, the articulated pieces of the compound setæ being sword-like and slenderly pointed. The comb-setæ are long and slender, very finely toothed, the outer teeth on either side being considerably the longer. Pl. XV. fig. 12 represents a group of these setæ, showing their variation in the same foot, the distance they project from the seta-sac, &c. They are much larger than the somewhat similar ones of *M. macintoshi*.

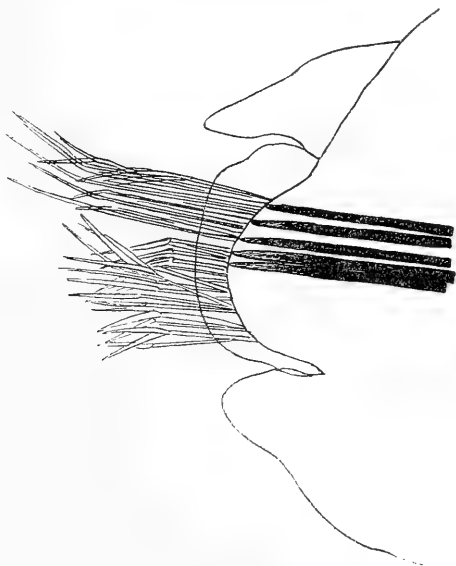
There are four or five aciculæ in the anterior feet; three, with

a lighter-coloured, bent, simply bluntly pointed acicular seta, in the posterior.

The setæ are thus exactly like those of *M. macintoshi* except in the greater size of the combs and the larger number of the aciculæ.

The dorsal and ventral cirri are very short, and the latter are also thick.

Text-fig. 13.



Marphysa simplex, sp. nov. 15th foot, $\times 45$.

The gill-region extends over practically the whole body, the first thirty segments alone being without them. The gills increase rapidly in size, the largest having four or five filaments arranged comb fashion and long enough to be made nearly to meet over the back. In the smaller complete specimen gills of four filaments are found only near the beginning of the gill-region; the remaining segments bearing gills of equal length but of three filaments or, more posteriorly, only two.

MARPHYSA FURCELLATA, sp. nov. (Plate XV. figs. 13, 14.)

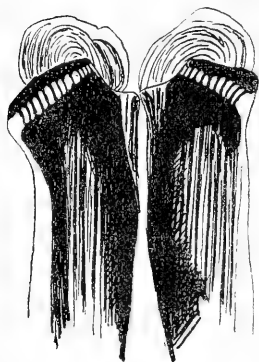
The head and first 120 segments of one specimen were collected between tide-marks near the town of Zanzibar, and the whole of a second was dredged from 15 fathoms in Zanzibar Channel, the bottom being mud. The former measures 4 cms. in length and 4 mm. in breadth, the latter 12 cms. by 4 mm. in the anterior third, after which the breadth decreases to 3 mm. Only the first few segments are round, the rest of the body being very flat

dorsally and only slightly convex ventrally. Posteriorly it narrows gradually to the anus, which has thick lips, is dorsally directed, and bears ventrally four cirri, two long and two very short. There is no pigmentation.

The prostomium, the insertion of the tentacles, and the position of the eyes resemble their arrangement in *M. simplex*, but the tentacles are much shorter (being but little longer than the prostomium) and the eyes much smaller (Pl. XV. fig. 13).

The dental apparatus is quite of the ordinary type (see text-fig. 15). The numbers of teeth are given by the formula $5-5:5+4-7$. All are long and sharp, a character not shared by the *laterals* of any of the preceding species. The slender maxillæ are straight proximally, bent towards each other distally.

Text-fig. 14.



Text-fig. 15.



Text-fig. 14.—*Marphysa simplex*, sp. nov. Ends of lower or mandibular jaw-plates from the ventral side, $\times 22$.

Text-fig. 15.—*Marphysa furcellata*, sp. nov. Dorsal or inner aspect of ventral jaw-plates, $\times 22$.

The feet are normally developed, and carry bundles of setæ of moderate length. Dorsal and ventral cirri as in the preceding species and most others of the genus. Lip of seta-sac rounded in anterior feet, pointed in posterior. The setæ are as in *M. simplex* except the combs, which are of two kinds, both projecting very slightly. The one kind has few strong curved teeth (whence the name of the species), the other having the usual numerous minute teeth, and intermediates between these extremes are frequent (fig. 14, Pl. XV.). There are three or four aciculæ anteriorly and one behind. The acicular seta has a simple point, is very slightly bent, and projects.

The gill-region comprises the greater part of the body, continuing from the twentieth segment to near the anus. In both specimens

there comes first a region of about forty segments bearing small gills of three or four filaments; these gills at about the sixtieth segment rapidly enlarge and consist of four or five filaments, though they never become long enough to meet over the back.

So far as Grube's and Baird's descriptions go, the last two species correspond with *M. januarii* and *M. parishi*. Indeed the comb-setae of the latter form a distinct point of similarity between it and *M. furcellata*. But the descriptions published of these two forms are so exceedingly meagre that certainty is impossible, so that in preference to the risk of giving two worms a distribution from East Tropical America to East Africa, I have described my forms *de novo*.

Genus LYSIDICE.

LYSIDICE COLLARIS Ehr., Grube.

This species, though never abundant, occurred at most of my collecting-places, viz., two specimens from Wasin Harbour (one from between tide-marks, the other from a depth of 10 fathoms), two smaller ones from 3 fathoms in Chuaka Bay, and three, smaller still, from the shore near Zanzibar Town.

Discrepancies of some importance occur between the descriptions of the species already published by Grube (Red Sea and Philippine collections), Marenzeller (Japan), and Gravier (Red Sea). My own collection shows that variations of features, usually considered diagnostic, occur in specimens from the same locality.

The name '*collaris*' obviously refers to the white ring found near the anterior end of the living animal. As the colour disappears from specimens which have been a few years in spirit (it is already becoming faint in my own after the lapse of one year), it has not yet been described. The ground-colour is a bright yellow-brown, best developed anteriorly and gradually dying out at about the tenth setigerous segment. Posteriorly the body is nearly colourless, unless sexual products, which are pink, give it that colour. In one of my specimens (and presumably in that collected by Ehrenberg) this pigmentation is interrupted by numerous small white dots, and is omitted altogether from segments three and four, forming the above-mentioned white collar. In the remaining specimens, one of which is of equal size to this, the coloration is perfectly uniform.

The form of the body is in life, as after preservation, flat below and strongly arched above throughout its length.

The insertion of the tentacles is not noticed by former authors except Gravier, and in this respect, as in others, none of my specimens agree with his description. The tentacles, though a little narrowed at their bases, have no distinct basal joint, and though they in some cases arise from nearly the same level, yet the origin of the middle one is *always in front* of the origin of the other two, thus reversing the usual arrangement. The prostomium itself is rather longer than in Gravier's figure.

All authors agree as to the characteristic form of the eyes. As noticed by Grube and seen in the present collection, they vary in breadth from narrow crescents to kidney- or bean-shape, yet never becoming merely oval.

The lower or mandibular jaw-plates are most characteristic in constitution and form, being usually calcareous with special plates of brown or black horny material. Marenzeller's figure is the only adequate representation of a very beautiful structure. The number of teeth on the left great dental plate varies from three to five, though usually it bears, as does always the right, four teeth. The curved laterals are exceptionally variable, as shown by the formulæ $3+5-5$; $5+1-5$; $3+1-5$; $3+3-3$; $4+5-3$.

All authors agree in making the dorsal and ventral cirri much longer than those figured by Gravier. In all the specimens I have examined, their tips extend as far as do the lips of the seta-sac, or in anterior feet a little further.

The articulated pieces of the compound setæ are not always the shape of an equilateral triangle, being usually somewhat longer. Their shafts are bent and broadened distally, and the striation and the toothing at the point opposite the articulation (mentioned by Gravier, but best seen in Marenzeller's figure), like the bordering of the capillary setæ, are not always distinct.

The acicular setæ always bear two distinct hooks, when not damaged by wear, as sometimes happens, but only in a few cases does their covering or winging remain.

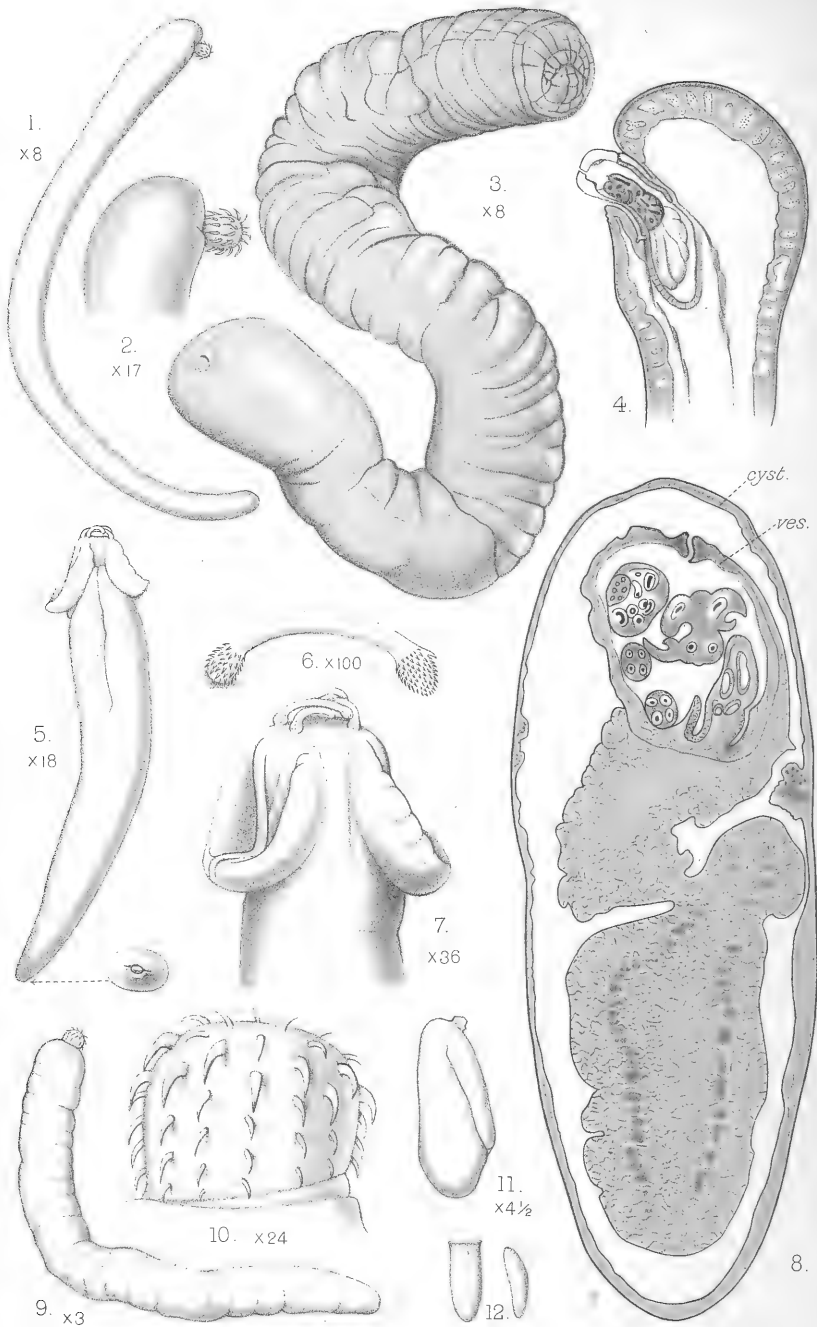
EXPLANATION OF THE PLATES.

PLATE XIV.

- Fig. 1. *Diopatra neapolitana* (p. 132). Ventral view of the head after removal of the jaw-apparatus.
æ., œsophagus; *b.w.*, body-wall; *a.*, lip of jaw-sac; *b.*, lip of œsophagus with its tubercles.
 2. *Onuphis holobranchiata* (p. 135). Head and anterior end, showing the characteristic pigmentation.
 3. *Marphysa macintoshi*, sp. nov. (p. 137). Head and anterior end.
 4. 25th foot of the same.
 5. Compound setæ from 25th foot. Comb-setæ from the 100th foot. The whole free length of these is represented.
 6. 160th foot of the same.

PLATE XV.

- Fig. 7. Anterior end of *Marphysa mossambica* (p. 139), showing the proportions of the body in spirit-specimens.
 8. Ditto. The front edge of the peristomium is cut away to show the pigment-marks on the tentacles and prostomium.
 9. Hind end, anus and its cirri.
 10. Group of comb-setæ from one of the posterior feet, showing the extent of their projection from the seta-sac.
 11. *Marphysa simplex*, sp. nov. (p. 140). The ringing of the tentacles is rather too strongly emphasised in this figure.
 12. Group of comb-setæ from the 60th foot.
 13. *Marphysa furcellata*, sp. nov. (p. 141). Head and anterior end.
 14. Tip of seta-sac of 120th foot, shewing the short strong combs characteristic of the species.



E. Wilson, Cambridge.

5. On the Ento-Parasites collected by the "Skeat Expedition" to Lower Siam and the Malay Peninsula in the Years 1899-1900. By ARTHUR E. SHIPLEY, M.A., F.Z.S., Fellow and Tutor of Christ's College, Cambridge, and University Lecturer in the Advanced Morphology of the Invertebrata.

[Received May 28, 1903.]

(Plate XVI.*)

C'est parmi les parasites et non chez l'homme qu'il faut chercher le dernier mot de la création.

ÉLIE METCHNIKOFF,
'Études sur la Nature Humaine.'

The collection made by the members of the Skeat Expedition of Entozoa was rich and varied, and inasmuch as it was gathered in a land hitherto unsearched for this purpose, it is not surprising that it contained a large proportion of new forms. Amongst the more interesting of the results brought to light by the investigation of the material are:—(i.) A new species of *Tetrarhynchus* found in a Holothurian. This is, I believe, the first record of a *Tetrarhynchus* being found in any Echinoderm, and indeed the presence of Tetrarhynchidæ in invertebrates at all is only recorded for one or two Molluscs and doubtfully for a species of *Aphrodite*. (ii.) An undeterminable species of *Tetrarhynchus* from a sea-snake. Here, again, we have an entirely new host, no *Tetrarhynchus* having been hitherto found in any vertebrate outside the class Pisces with the exception of the Chelonian *Testudo mydas*. (iii.) A considerable collection of new forms of Acanthocephala. The Nematodes, which have been described elsewhere by Dr. von Linstow, include some fourteen new species.

As will be seen, the collection covers a wide field and includes representatives of the Sporozoa and all the chief groups of metazoan Entozoa, except the Trematoda. The Cestoda, Acanthocephala, Nematomorpha, Nematoda, and Linguatulida severally contribute one or more species to the total.

With regard to the localities, the parasites were collected mainly in three or four places: Biserat, in Jalor, a province of Lower Siam, in Kwala Aring in the same province, and at Tremangan.

CESTODA.

Fam. BOTHRIOCEPHALIDÆ.

BOTHRIOCEPHALID LARVÆ.

The snakes of Lower Siam seem frequently to harbour the large larval form of certain of the Bothriocéphalidæ, of which it is

* For explanation of the Plate, see p. 156.

impossible to identify the species or even the genus. I have recently dealt somewhat fully with a similar larval form from under the skin of a Serval from the Soudan*. These Siamese specimens differ from the African one in the thickness of the anterior end, which was cushiony, and perhaps almost as thick as one quarter of the transverse diameter; and in the regularity and extension forward of the annuli, which extend right up to and even into the orifice of the single apical sucker. Specimens of these larvæ were taken in three different snakes, almost certainly specimens of *Dipsadomorphus dendrophilus* Boie, at Biserat, and beneath the skin of a snake from Patalung.

Fam. TETRARHYNCHIDÆ.

TETRARHYNCHUS HOLOTHURÆ, n. sp. (Plate XVI. figs. 5, 6, & 7.)

A small collection belonging to the genus *Tetrarhynchus* was contained in a bottle labelled "Parasites from the commonest Holothurian found in the sea off the Patani river." The specimens measure some 7 mm. in length, by a maximum body breadth of 1 mm. The suckers, however, add to this last measurement in the region of the head. The body tapers smoothly to the posterior end, where there is a slight indentation at the extreme point, into which sections show that the two longitudinal water-vascular canals open, one on each side.

The bothria are somewhat ear-shaped (Pl. XVI. figs. 5 & 7) and each is divided into two longitudinal halves by a median ridge, so that in transverse section there is the appearance of four suckers. The hooked arms which project from the head end in a conical tip, covered with very numerous spines all pointing forward (Pl. XVI. fig. 6). In the specimen figured, one of these spines is much larger than the others, but this is probably a slight abnormality. Following on this spiny end is a smooth portion, and then a second spiny region where the very numerous spines, all pointing backward, form a very firm organ of attachment.

The tapering conical body shows no trace of strobilisation and is externally smooth, the only differentiation visible being the line of the sac into which the toothed processes are withdrawn, which in some cases is seen through the surrounding tissue.

Sections reveal no trace of reproductive organs. The cuticle surrounds a mass of parenchyma which is looser and more vacuolated just under the cuticle, and this looseness is even more pronounced around the stout muscular sacs from which the four toothed introverts spring. The muscles of these sacs are unusually stout and circularly or perhaps spirally arranged. Two—there are said to be four in most adults—laterally placed water-vascular vessels run down the animal, and open into the terminal depres-

* Arch. Parasit. vi. 1902, p. 604.

sion. The number of calcareous bodies is small, and other deeply staining structures, *e.g.* the nuclei and muscle-fibres, are but sparsely scattered through the tissues. There is a four-cornered nerve-mass well lying about the level of the juncture of the anterior one-third with the posterior two-thirds of the bothria, and this gives off four strands which pass peripherally and probably supply the bothria and introverts. I did not see any longitudinal nerves, though probably they exist.

In his exhaustive monograph* "*Recherches sur les Tetrarhynques*," Vaulleopard records his opinion that the numerous species of Tetrarhynchous Cestodes belong to but one genus, *Tetrarhynchus*. Railliet has pointed out that the generic name *Rhyncobothrius* Rudolphi, 1819, has precedence of *Tetrarhynchus* 1809, the latter name having been given to a larval form. In the present case, although it may be inconsistent with the laws of nomenclature, I have followed Vaulleopard, partly because everyone knows what *Tetrarhynchus* is, and partly because, in my opinion, needless confusion is introduced into the study of tapeworms by using a double nomenclature for larvæ and adults. In civilized society it is not considered necessary for a human being to change his name when he leaves the home of his childhood and sets up in a new house, and there seems as little reason for a young Cestode to change its name when it changes its host.

Vaulleopard arranges the various species into two sections, one of which, on the type of *T. lingualis* Cuv., has in its larval form no vesicle projecting over and protecting the head. To this section the cestode in question belongs. The larvæ which were collected by the Skeat Expedition were some of them wholly and some of them partly enclosed in cysts, but none of them showed any trace of the projecting vesicle.

Tetrarhynchus holothurice, n. sp. (Plate XVI. figs. 5, 6, & 7.)

The larval form (but not the encysted form) is 6 mm. long by 1 mm. broad. Tapering posteriorly where there is a depression receiving the excretory pore. The two large bothria are subdivided by a ridge. The four introverts are provided with a cap of hooks pointing forward at the tip and a circular band of hooks pointing backward, between these two toothed regions is a considerable portion devoid of hooks.

Habitat. A common Holothurian, probably a *Molpadia*, taken off the mouth of the Patani River.

TETRARHYNCHUS sp. (Plate XVI. figs. 8 & 11.)

Some eight or nine small cysts about the size of very poor wheat-seeds were taken from the body of a sea-snake, *Enhydryna valakadien* Boie. Unfortunately the position of the cysts in the body is

* Mém. Soc. Normandie, xix. 1897-1899, p. 185.

unrecorded, but I should judge that they lay just under the peritoneal lining of the body-cavity. In one or two cases the worm itself was emerging, or had emerged, from the cyst, but I attribute that to the handling the cyst received as the worms were removed from the body of the host. The cestodes usually were bent but once within the cyst, as is shown in the figure (Pl. XVI. fig. 11).

Sections through these cysts (Pl. XVI. fig. 8) show that the form in question belongs to Vaullegeard's second group founded on the type of *Tetrarhynchus erinaceus* van Ben., in which the larvæ have a vesicle surrounding and protecting the head. This vesicle is clearly shown in the figure; within it the head of the larva and the neck, as far back as the muscular sacs into which the introverts are retracted, are coiled. These coils, being hidden by the vesicle, cannot be seen through the walls of the cyst; they are, however, sufficiently numerous to permit four or five sections of the head at different levels to be displayed in one section. The head passes into the body, which has two longitudinal excretory canals and shows no sign of reproductive organs; in fact, the only differentiation from the loose parenchymatous tissue is a layer of muscle-cells situated about halfway between the periphery and the centre.

The vesicle is folded over the head like an amnion; it is, however, not closed, but remains open by a pore guarded by thickened lips. I am inclined to think that these lips contain muscle-fibres, and that the aperture can be tightly closed if occasion arises. According to Vaullegeard the vesicle detaches itself when the larva becomes sexually mature.

The genus *Tetrarhynchus* is often regarded as exclusively a fish parasite: it has, however, been described in certain Molluscs, e. g. *Sepia officinalis* and the Pearl-Oyster, and perhaps in *Aphrodite aculeata*, though nobody seems to have found it in that animal since the distinguished courtier, philosopher, parasitologist, and poet, Francis Redi of Arezzo, recorded it in 1664. I have found no record of the genus occurring in Echinoderms, so that the discovery by the Skeat Expedition of the larval forms in a Holothurian is a matter of considerable interest. This form, though not mature, is not enveloped in a vesicle, and presents certain features which allow me to suggest a specific diagnosis.

The second form brought back from the coast of Lower Siam is equally new as regards its host. There has hitherto been recorded, so far as I can find, but one vertebrate host of the genus *Tetrarhynchus* outside of the class Pisces. This is *Testudo mydas*, in which, in 1840, Meyer described vesiculate larvæ. We can now add a second Reptilian host in the case of *Enhydryna valakadien* Boie, a sea-snake, belonging to the family Colubridæ, which is not unfrequently taken along the coast of India and Burmah, and which ranges from the Persian Gulf to the Malay Archipelago and Papuasia. These very poisonous ophidians are fish-eaters.

ACANTHOCEPHALA.

Fam. ECHINORHYNCHIDÆ.

ECHINORHYNCHUS PATANI, n. sp. (Plate XVI. figs. 9 & 10.)

The encapsuled larvæ of Echinorhynchidæ are by no means uncommon in snakes, and von Linstow* suggests that their corresponding adult forms are to be looked for in the bodies of raptorial birds. In the paper referred to, he enumerates species of these parasites taken from snakes the names of which he gives. Unfortunately many of the names are *nomina nuda*, and the hosts cannot now be identified, and the same is the case with the new species here described, as the name of the snake was not preserved.

The cysts are at most 10 mm. long by 5 mm. broad. The worm is bent twice, and the three limbs may lie in one plane or in two. One of the specimens had escaped from its cyst, and had already inserted its spiny head into some piece of tissue from which it was well nigh impossible to free it. Another had freed its head and straightened out its body, which, however, was still surrounded by a thin film-like sheath of tissue. The length of these specimens was 25 mm., the breadth of the trunk was 2 mm., of the head 1 mm. The hooks were arranged in 12-14 longitudinal rows, the hooks of one row being at the level of the space between two neighbouring hooks of the row right and left (Pl. XVI. fig. 10). In this way the hooks in the horizontal rings also alternated with one another. There were six of such rings, and the second and third row consist of markedly large hooks, twice as large at least as any of the others. Altogether there were six rings visible; there may have been one or more hidden by invagination, but I do not think so.

It is most unfortunate that the name of the snake which harboured this parasite is unknown, but the parasite seems to be a hitherto undescribed species. The names of those already known to be encapsuled in snakes are recorded by von Linstow as follows:—

- (i.) *Ech. oligacanthoides* Rud., with 4-5 rows of hooks.
- (ii.) *Ech. cinctus* Rud., with 140 rows of hooks of similar size.
- (iii.) *Ech. obligacanthus* Rud., with 13 rows of hooks.
- (iv.) *Ech. megacephalus* Westrumb, with very numerous rows of hooks and the proboscis swollen in the middle.
- (v.) *Ech. dipsadis* von Lins., with some 12-14 rows of large hooks, followed by 20 rows of smaller hooks.
- (vi.) *Ech. heterorhynchus* Par. Proboscis anteriorly slender with 11 rows of hooks, posteriorly enlarged with 16 rows of hooks.

Wedl has mentioned other larval forms found in snakes, but they are not in any case specifically identified.

* Arch. Naturg. 54 Jahrgang, i. 1888.

Echinorhynchus patani, n. sp. (Plate XVI. figs. 9 & 10.)

Length 25 mm., breadth 2 mm., breadth of head 1 mm. Hooks in 6 rings, perhaps 7 or 8, and in 12-14 longitudinal rows. The hooks in one ring are opposite the interspaces in the next. The 2nd and 3rd rings composed of unusually large hooks. The worms were folded twice with cysts some 10 mm. long by 5 mm. broad.

Habitat. The body of an unknown snake, possibly *Dipsadomorphus dendrophilus* Boie, taken at Patani, Lower Siam.

ECHINORHYNCHUS BUFONIS, n. sp. (Plate XVI. figs. 1, 2, & 4.)

Several specimens of what I regard as the same species of *Echinorhynchus* were taken from the alimentary canal of two species of *Bufo* obtained at Patani, which have been kindly identified for me as *Bufo melanostictus* Schneider, and in all probability *Bufo penangensis* Wilson & Gray, by Dr. Gadow.

Bufo is known to harbour the comparatively widespread *Ech. hærUCA*, but I know of no other species of *Echinorhynchus* parasitic in this amphibian, and as the parasites from Patani differ in many respects from any descriptions which are available, I have established a new species.

The worms fall into two groups. The larger, probably the females, measure some 15 mm.; the smaller, probably males, some 5 mm., but there are many intermediate in length. The greatest breadth of the larger specimens is 1.5 mm. As a rule their outline and surface is smooth, but some were wrinkled either wholly or in part. The body is usually curved, and in the larger specimens markedly so. The most conspicuous feature in which this species differs from the majority of its congeners is that the proboscis or introvert is not median and terminal, but projects from the trunk a little way, sometimes more, sometimes less, from the anterior end; it usually slopes forward, but it may stand out at right angles to the axis of the body like the handle of a walking-stick (Pl. XVI. figs. 2 & 4). It is always protruded on the inner surface of the curve. This feature and its divergence from the more usual type are represented in the Gyphurea, where *Aspidosiphon* bears the same relation to most other Sipunculids that this species does to other *Echinorhynchi*.

The number of hooks is comparatively small, there being some 6-8 rings, alternately arranged with 14-16 longitudinal rows. The rings being alternating, the number of hooks in each ring is half the number of longitudinal rows.

Echinorhynchus bufonis, n. sp. (Plate XVI. figs. 1, 2, & 4.)

Curved, with proboscis opening on the concave surface just behind the anterior end of the body, which extends beyond the point of emergence of the proboscis. Length 15 mm. or less; a number, probably males, only 5 mm. long. Few hooks, 6-8; rings with 7-8 hooks alternating with those of the next row.

Habitat. The alimentary canal of *Bufo melanostictus* Schneider and of *Bufo* ? *penangensis* Wilson & Gray, taken at Patani.

ECHINORHYNCHUS XENOPELTIDIS, n. sp. (Plate XVI. fig. 3.)

Three curious specimens of Echinorhynchidæ were taken free in the body of *Xenopeltis unicolor*, the sole species and genus of the family Xenopeltidæ, which ranges over South-eastern Asia, from India to the Malay Archipelago. Unfortunately, the part of the host's body infested by the parasite is unnamed, but, presumably, it was the intestine.

The parasites are three in number, and measure respectively about 25 mm., 17 mm., and 15 mm. I say about, because they were all coiled in a curious, angular sort of way, so that it was not possible to straighten them. They are plump, fleshy-looking creatures with an average breadth of 2.5 mm., though in one specimen a breadth of fully 3 mm. was attained. They hardly taper at all at the ends, which are truncated.

Their most peculiar external features are two. The first is the colour. This, in specimens kept for some years in spirit, is a delicate, salmony pink, somewhat resembling a freshly peeled pink banana. I have never seen an Echinorhynchid with anything approaching this colour. The second feature is the wrinkling. This is very marked, and produces a very definite deepening of the colour. The areas into which the wrinkles divide up the skin become in the anterior end almost regularly quadrilateral, and a quite peculiar marking is the result. This is well seen in Pl. XVI. fig. 3.

The only specimen I sacrificed to the razor showed that these wrinkles are the expression of deep narrow grooves which penetrate the subcuticle almost as far as the basement membrane. Unfortunately the sections obtained did not clearly show the number of rings of hooks. They were not very numerous, perhaps some 8 to 12. In each of the three specimens the proboscis was retracted.

Echinorhynchus xenopeltidis, n. sp. (Plate XVI. fig. 3.)¹

Length varying from 15 to 25 mm. Average breadth 2.5 mm. Plump forms with anteriorly many wrinkles, which showed a tendency to break up the surface into squarish areas. Colour, a delicate salmon-pink. Hooks in ? 8-12 rows.

Habitat. *Xenopeltis unicolor* Reinw. Taken at Kwala Aring.

ECHINORHYNCHUS TIGRINÆ, n. sp.

Two complete specimens and a fragment were taken from the intestine of a *Rana tigrina* Daud. The former had a length of 10 mm., and an average breadth of 2 mm. They were of a slaty-grey colour, and marked by transverse grooves at irregular intervals.

The proboscis is very short and very small. It does not emerge

terminally, but rather from the side, where it is overtopped by the anterior end, and looks like a little head sunk in one of the enormous collars in vogue at the Regency period. The number of hooks is very small, only 4-5 rings, and but few hooks in a ring. At first I thought that the smallness of the number of the hooks indicated that we had to do with a young, or, at any rate, a not fully grown, individual, but the lumen of the trunk was crowded with ova in well-developed chitinous egg-shells. Each ovum is a long cell, rounded at the ends with a conspicuous nucleus in the centre. The egg-shell is rather more pointed at the ends, so that the egg with its shell forms a spindle-shaped object some .08 mm. in length and .02 mm. at the greatest diameter.

Echinorhynchus tigrinae, n. sp.

Length 10 mm., average breadth 2 mm. Greyish, transversely wrinkled. Proboscis short, small, arising from behind the anterior end. Four or five rings of very few hooks. Ova spindle-shaped, 0.8 mm. \times .02 mm.

Habitat. Intestine of *Rana tigrina* Daud. Taken at Biserat, Jalor.

Some small fragments of another *Echinorhynchus*, too small to admit of identification, were taken from the intestine of the toad *Callula pulchra* Gray.

NEMATOMORPHA.

Professor Camerano has kindly described the specimens of this very difficult group and has published accounts, with full details as to the structure of the cuticle on which the classification of these creatures so largely rests, of four species, two of which, *Chordodes siamensis* and *Gordius paronae*, are new. I extract the following from Camerano's descriptions :—

1. *CHORDODES MONTONI* Camer.

1895. L. Camerano, Bull. Soc. Zool. France, xx. p. 99.

1897. L. Camerano, Mem. Acc. Torino, ser. 2, xlvii. p. 387.

1899. L. Camerano, Atti Acc. Torino, xxxiv. figs. 3, 3 a.

1901. L. Camerano, Boll. Mus. Torino, xvi. no. 408.

A single specimen, a male, was taken by Mr. Laidlaw whilst making its exit from a large Mantis captured at the foot of Gunong Inas, Perak. The length could not be determined, as the worm was in pieces. The colour of the spirit-specimen is white at each end, black and velvety in the middle.

The cuticle showed the characteristic markings described by the author in the first-named specimen, which came from China, other specimens have been described from Perak.

2. *CHORDODES PUNCTICUTATUS* Camer.

1895. L. Camerano, Notes Leyden Mus. xvii.

1897. L. Camerano, Mem. Acc. Torino, ser. 2, xlvii. p. 384.

1899. L. Camerano, Atti Acc. Torino, xxxiv.

1901. L. Camerano, Boll. Mus. Torino, xvi. no. 408.

A single male specimen taken on an island off Kedah measured 23.2 mm. Its colour was a darkish brown lightening towards each tip. The cuticle resembled other examples described from Deli in Eastern Sumatra and from Perak.

3. *CHORDODES SIAMENSIS* Camer.

1903. L. Camerano, Boll. Mus. Torino, xviii. no. 437.

A single female specimen, brownish-black in colour, but lighter towards the ends, 20 cm. long. This specimen was taken at Biserat.

4. *GORDIUS PARONÆ* Camer.

1903. L. Camerano, Boll. Mus. Torino xviii. no. 437.

Three male specimens taken at Kota Bharu, varying in length from 17.5 cm. to 22.5 cm.

NEMATODA.

The Nematoda have been described by Dr. von Linstow in the 'Archiv für mikroskopische Anatomie und Entwicklungsgeschichte,' Band lxii. 1903, p. 108. I here give only a list of the species and of their respective hosts, and must refer the reader to the memoir mentioned for further details.

1. *ASCARIS INFUNDIBULICOLA* v. Lins.

From the alimentary canal of *Python reticulatus* Gray, killed in Tremangan.

2. *ASCARIS SOLITARIA* v. Lins.

A single undeveloped female was found in the stomach of *Dipsadomorphus dendrophilus* Boie, taken at Kwala Aring.

3. *ASCARIS DIPSADOMORPHI* v. Lins.

A number of larvæ found in the cysts scattered through the mesentery of *D. dendrophilus* Boie, Kwala Aring.

4. *HETERAKIS RIMULA* v. Lins.

Out of *Centropus sinensis* Steph.

5. *HETERAKIS CIRCULARIS* v. Lins.

From the same host as No. 4.

6. *CHEILOSPIRURA OPHTHALMICA* v. Lins.

From the eye of *Turnix taigor* Sykes.

7. *CHEILOSPIRURA SIAMENSIS* v. Lins.

From *Centropus sinensis* Steph., probably from the eye.

8. *OXYURUS SIAMENSIS* v. Lins.

From the stomach of *Liolepis bellii* Gray.

9. *OXYURUS CORONATA* v. Lins.

From the large intestine of *Galeopithecus volans* Linn., taken at Patalung.

10. *OXYSOMA TUBERCULATUM* v. Lins.

From the alimentary canal of *Megalophrys montana* Wagl.

11. *FILARIA LONGICIRRATA* v. Lins.

From the subcutaneous tissue of *Galeopithecus volans* Linn.

12. *FILARIA SCIURI* (?) v. Lins.

A single immature female found under the skin of *Sciurus caniceps* Gray. Von Linstow regards the naming of this specimen as provisional.

13. *FILARIA CORYNODES* v. Lins.

From under the skin of *Semnopithecus albocinereus*, Kwala Aring; see also von Linstow, MT. Mus. Berlin, i. 1899, p. 23.

14. *ANGIOSTOMUM BRACHYLAIMUS* v. Lins.

From *Bufo melanostictus*, probably from the lungs.

15. *LISSONEMA ROTUNDATA* v. Lins.

From *Centropus sinensis* Steph., probably from the alimentary canal.

LINGUATULIDÆ.

POROCEPHALUS MONILIFORMIS (Diesing).

Synonym. *Pentastoma moniliforme* Diesing Denk. Ak. Wien, xii. 1856.

Three specimens of this common parasite were taken from the lungs of a *Python reticulatus* Schneid., at Biserat; and six or seven specimens, varying a good deal in size, from another Python of the same species at Tremangan.

SPOROZOA.

Order SARCOSPORIDIA Balbiani.

Several specimens of this order were found amongst the muscles and the tissues at the base of the tongue of a *Bos bubalis* killed at Kwala Aring. Dr. von Linstow has described these specimens as a new species—*Balbiana* (*Sarcocystis*) *siamensis*—in the article mentioned under the Nematoda. I have figured these life-size, on Pl. XVI. fig. 12.

LISTS OF HOSTS CONTAINING THE PARASITES COLLECTED ON THE
SKEAT EXPEDITION.

ECHINODERMA.

A Holothurian, probably a *Molpadia*, infested by *Tetrarhynchus holothurice*, n. sp.

INSECTA.

A Mantis was infested by the Gordian Worm, *Chordodes montoni* Camer.

AMPHIBIA.

Bufo melanostictus Schneider and ? *Bufo penangensis* Wilson & Gray had *Echinorhynchus bufonis*, n. sp., in their intestines, and *Angiostomum brachylaimus* v. Lins. probably in its lungs.

Callula pulchra Gray, infested by indeterminate species of *Echinorhynchus*.

Megalophrys montana Wagl. had in its stomach examples of *Oxysoma tuberculatum* v. Lins.

Rana tigrina Daud., infested by *Echinorhynchus tigrinae*, n. sp.

OPHIDIA.

Dipsadomorphus dendrophilus Boie, infested by *Ascaris solitaria* v. Lins. in the stomach, a single specimen, and by *Ascaris dipsadomorphi* v. Lins. in numerous cysts on the mesentery; and almost certainly by certain Bothriocephalid larvæ and by *Echinorhynchus patani*, n. sp.

Enhydrina valakadien Boie, infested by a cystic form of *Tetrarhynchus* whose species is not determinable.

Python reticulatus Schneid. had its lungs infested by *Porocephalus moniliformis*, and another specimen contained many examples of *Ascaris infundibulicola* in its alimentary canal.

Xenopeltis unicolor Reinw., infested by *Echinorhynchus xenopeltidis*, n. sp.

LACERTILIA.

Liolepis bellii Gray, contained in its stomach examples of *Oxyurus siamensis* v. Lins.

AVES.

Centropus sinensis Steph. contained specimens of *Heterakis rimula* v. Lins., and of *H. circularis* v. Lins., and of *Cheilospirura siamensis* v. Lins., the last-named probably from the eye. A new genus and species, named by von Linstow *Lissonema rotundatum*, was found in this species, probably in the alimentary canal.

Turnix taigoor contained in its eye examples of *Cheilospirura ophthalmica* v. Lins.

MAMMALIA.

Bos bubalis was infested at the root of its tongue with specimens of a Sarcosporidian, regarded by von Linstow as new and named by him *Balbiana siamensis*.

Sciurus caniceps Gray, had under its skin an example of a *Filaria*, provisionally named by von Linstow *Filaria sciuri*.

Galeopithecus volans Linn. was infested in its large intestine with *Oxyurus coronata* v. Lins., and in its subcutaneous connective tissue with *Filaria longicirrata* v. Lins.

Semnopithecus albocinereus was subcutaneously infested by *Filaria corynodes* v. Lins.

EXPLANATION OF PLATE XVI.

Fig. 1. Side view of *Echinorhynchus bufonis*, $\times 8$, p. 150.

2. Anterior end of the same, $\times 16$, p. 150.

3. *Echinorhynchus xenopeltidis*, $\times 8$, p. 151.

4. Section through the anterior end of *E. bufonis* to show the angle at which the proboscis leaves the body, p. 150.

5. *Tetrarhynchus holothuriae*, $\times 18$, and the indented posterior end, p. 146.

6. A single hooked arm of the same, $\times 100$, showing the arrangement of the hooks, p. 146.

7. An enlarged view of the head of the same, $\times 100$, showing the arms and the bothria, p. 146.

8. A longitudinal section through the cyst and the contained larva of a *Tetrarhynchus* from the sea-snake *Enhydrina valakadien*, showing the cyst and the vesicle (ves.) surrounding the head, p. 147.

9. *Echinorhynchus patani*, $\times 3$, p. 149.

10. Head of the same, $\times 24$, p. 149.

11. View of one of the cysts, $\times 3$, containing the *Tetrarhynchus* found in the sea-snake *E. valakadien*, p. 147.

12. Two specimens, life-size, of the *Balbiana siamensis* found in *Bos bubalis*, p. 155.

6. On the Modifications of Structure in the Syrinx of the Accipitres, with Remarks upon other Points in the Anatomy of that Group. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received June 16, 1903.]

(Text-figures 16-20.)

Although a considerable number of species of Accipitres have provided material for the study of the avian syrinx*, I am not aware of the existence of any general survey of the structure of the windpipe in this group of birds which is so extensive as that which I am able to lay before the Society. My material has been gradually amassed by my predecessors in the office of Prosector to the Society and by myself, and represents a large series of Accipitrine genera †, viz. the following:—

Thrasaëtus, *Falco*, *Herpetotheres*, *Buteo*, *Milvus*, *Spizaëtus*, *Gypaëtus*, *Urubitinga*, *Haliaëtus*, *Pandion*, *Tinnunculus*, *Vultur*, *Milvago*, *Spilornis*, *Erythropus*, *Morphnus*, *Helotarsus*, *Leucopternis*, *Circus*, *Aquila*, *Circaëtus*, *Dryotriorchis*, *Gyps*, *Hieracidea*, *Archibuteo*, *Geranoaëtus*, *Nisaëtus*, *Asturina*, *Polyborus*, *Polyboroides*, and *Gypohierax*: in all 31 genera, of many of which I have examined several species.

I shall not, however, describe all of these types in detail, inasmuch as there are very close resemblances between many of them. My purpose is rather to establish the importance of the syrinx as confirmatory of other opinions upon the Classification of this Group.

Genus *FALCO*.

Of this genus I have examined syringes of the following seven species, viz.:—*F. sacer*, *F. aesalon*, *F. candicans* ‡, *F. feldeggii*, *F. peregrinus*, *F. biarmicus*, *F. lanarius*.

Wunderlich's description applies perfectly well to all of the species enumerated above. The species studied by him were *F. peregrinus* and *F. subbuteo*. The salient feature of the syrinx is the large extent of the membrana tympaniformis externa, due to the concave lower border of the first bronchial ring and the concave upper border of the second bronchial semiring. This characteristic feature of the syrinx of *Falco* is more marked in *F. sacer* than in any other species. The intrinsic muscles are attached to a specially thickened and apparently cartilaginous bar-like tract of the membrana tympaniformis externa, which varies somewhat in stoutness and exact position. The complete-

* See Wunderlich, "Beiträge zur vergleichenden Anatomie und Entwicklungsgeschichte des unteren Kehlkopfes der Vögel." Nova Acta Acad. C. Leop.-Carol. Deutsch. Ak. Naturf. Halle, xlviii. No. 1 (1884).

† I do not, of course, include the American Vultures, *Sarcorhamphus*, *Gypagus*, &c., among the Accipitres.

‡ Or *Hierofalco candicans*.

ness or incompleteness of the bronchidesmus is a feature which apparently differs from species to species. In *F. feldeggii* I find that the membrane is incomplete, that is to say it does not extend right up to the bifurcation of the bronchi. In *F. sacer* and *F. biarmicus*, on the other hand, the bronchidesmus is quite complete. Upon other species I am unable to report.

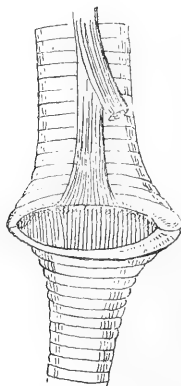
Genus HIERACIDEA.

This genus, represented for me by the species *H. berigora* alone, has a syrinx belonging quite to the same type as that of *Falco*. In fact a general description would apply equally well to both, an obvious justification of the close alliance usually asserted to exist between them*.

Genus MILVAGO.

This genus, as represented by *Milvago chimango* (text-fig. 16) and *M. chimachima*, is essentially Falconine in the characters of its syrinx, and does not appear to me to come nearer to *Polyborus* than to *Falco*.

Text-fig. 16.



Syrinx of *Milvago chimango*, lateral view. $\times 2$.

The first bronchial ring is very thick, especially posteriorly, where it curves down and bends forward; it is to this piece that the intrinsic muscles are mainly attached, though they are also inserted into the membrana tympaniformis externa. It is, I take it, the homologue of the thickening of the membrana tympaniformis which is so characteristic of *Falco*.

Genus HERPETOTHERES.

Herpetotheres cachinnans has a syrinx which is constructed upon the Falconine plan.

* I may remark, however, that the backwardly directed papillæ upon the tongue are shorter than in any *Falco*.

Genus POLYBORUS.

The syrinx of *P. brasiliensis* is constituted upon the plan of *Falco*, but there are a number of differences in detail.

There is the same extensive membrana tympaniformis externa into which is inserted the intrinsic muscles. But the last six tracheal rings are more thoroughly fused into a box, this fusion taking place in front. At the same time the last three or four of these rings increase rapidly in diameter so that the lower part of the trachea is very wide, much more so than in *Falco*. The intrinsic muscles, moreover, are distinctly smaller in proportion in *Polyborus*.

Genera TINNUNCULUS and ERYTHROPUS.

The syrinx of the Common Kestrel (*T. alaudarius*) appears to me to need no special description. It is quite like that of *Falco*, as is also that of *Erythrops vespertinus*, which genus perhaps hardly needs to be separated from *Falco*.

Genus NISAËTUS.

The syrinx of *Nisaëtus fasciatus* (text-fig. 17) will serve as a type of the Aquiline form of this organ as contrasted with the Falconine.

Text-fig. 17.



Syrinx of *Nisaëtus fasciatus* (from a drawing by the late Prof. Garrod): the left-hand bronchus seen from in front, the right from behind. $\times 2$.

The most salient difference is the absence of a specially enlarged area of membrane between two of the early bronchial semirings; that is to say, the membrana tympaniformis externa is not a conspicuous feature of the syrinx of this bird, as it is of that of *Falco*. The ring which gives rise to the pessulus in front is separated by four semirings from that which receives the insertion of the intrinsic muscles; but some of these rings, three at any rate, are

united to the pessulus. Posteriorly the pessulus is fused with the ring in front of that from which it originates anteriorly.

Genus SPIZAËTUS.

The syrinx of *S. ceylonensis* presents no differences from that of *S. orientalis*, and the genus itself should, I think, be placed near to *Nisaëtus* by virtue of its syringeal characters.

There is, however, a complete union between the rings which are connected with the pessulus, although the intrinsic muscles are inserted on to a semiring which appears to correspond exactly to that which bears the same muscles in *Nisaëtus*.

Genus POLYBOROIDES.

I found, much to my surprise, that the syrinx of *P. typicus* is not like that of *Polyborus*, that it does not conform to the Falconine, but to the Aquiline, or Buteonine, type.

The bronchial rings are close together, and there is no spacious membrana typaniformis externa as in *Polyborus* and *Falco*. I find also that the intrinsic muscles are attached to the second bronchial semiring. The name of this genus is clearly unfortunate, as is its association with *Milvago* and *Polyborus* in the 'List of Vertebrated Animals'*.

Genus VULTUR.

The two species, *V. auricularis* and *V. calvus*, which I have examined, show rather more differences than might perhaps have been expected. The differences concern the musculature of the organ†. In *V. auricularis* the muscles are inserted upon the second bronchial semiring; in *V. calvus* the bulk of the fibres are inserted upon the same ring, but a good many bundles of fibres stray down a few rings beyond.

Except for the fact that the connections of the pessulus are "normal," the syrinx agrees in structure with that of *Gyps*. It is moreover cartilaginous, the pessulus alone being bony.

Genus GYPS.

The syrinx of *Gyps rueppelli* shows one characteristic feature which I have not observed in any other Accipitrine bird. The pessulus, or threeway-piece, is not coossified posteriorly with any of the tracheal rings. It is only connected by membrane, and forms therefore a movable triangular plate, which (in the spirit-preserved specimen at any rate) is depressed below the level of the tracheal rings which abut upon it—thus giving a peculiar and unusual appearance. The pessulus itself is ossified, the rings of the trachea and bronchi are cartilaginous. The intrinsic muscles

* List of the Vertebrated Animals now or lately living in the Gardens of the Zoological Society of London, 9th ed. 1896, p. 403.

† The horny papillæ upon the tongue differ in the two species.

are attached to the middle of the second bronchial semiring. The first three bronchial rings are closely laid by each other and the tracheal rings; larger interspaces separate the ensuing bronchial semirings; but there is no wide membrana tympaniformis externa.

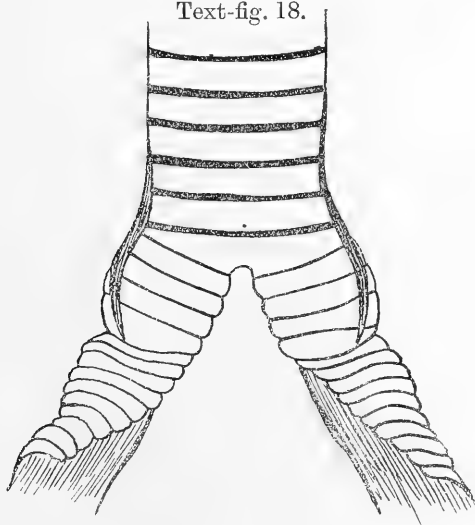
Genus MILVUS.

In this genus, at least in the species *M. ictinus*, the bronchidesmus is incomplete. There is no conspicuous membrana tympaniformis externa. The intrinsic muscles are attached to the second of the entirely free semirings, *i. e.* those which are not fused with the pessulus. The syrinx therefore is constituted on the plan of that of *Nisaëtus*.

Genus DRYOTRIORCHIS.

D. spectabilis is a Hawk with an altogether unusual form of wind-pipe (text-fig. 18): that is to say, unusual as to details, for it distinctly belongs to the Aquiline as opposed to the Falconine division

Text-fig. 18.



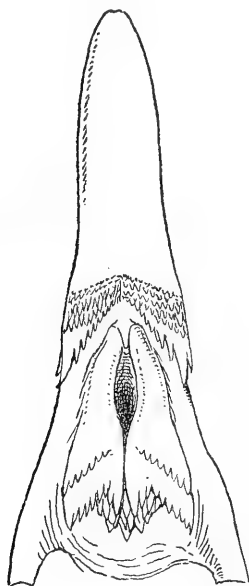
Syrinx of *Dryotriorchis spectabilis*. $\times 3$.

of the group. In this genus the bronchial character of the syrinx, suggested among the Aquiline forms, is more strongly emphasised than in any other Accipitrine genus which I have had the opportunity of examining. In fact this Hawk may be fairly described as possessing a bronchial syrinx. This syrinx is, however, an exaggeration of the conditions occurring in such a form as *Nisaëtus*. In that genus and its allies four or five rings, which

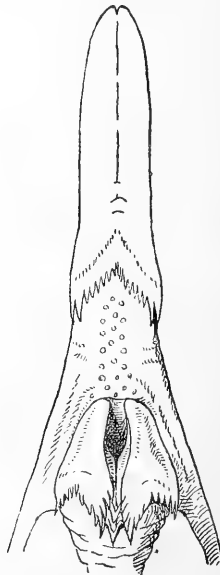
are more or less incomplete, intervene between that bearing the pessulus and that upon which the intrinsic muscles of the syrinx are inserted. The same is the case with the syrinx of *Dryobriorchis*; but the tracheal rings immediately preceding that to which the intrinsic muscles are attached lie well below the pessulus, are joined internally by the membrana tympaniformis interna, and clearly constitute a portion of the bronchi. It will be recollected that in other groups of birds*, some of the members of which possess the bronchial form of syrinx, the first semirings or rings of the bronchi are tracheal in character, and differ from the ensuing semirings which belong to the bronchi proper. In fact it appears as if the bronchi in the bronchial syrinx were partly formed by a split trachea, and partly by semirings belonging to the bronchi proper.

The tongue in the Accipitres shows characters which allow of the division of the group into a Falconine and an Aquiline series.

Text-fig. 19.

Text-fig. 19.—Tongue of *Milvago chimango*, dorsal aspect. $\times 2$.

Text-fig. 20.

Text-fig. 20.—Tongue of *Gypohierax angolensis*, dorsal aspect. $\times 1\frac{1}{2}$.

In several species of *Falco*, in *Tinnunculus alaudarius*, *Hieracidea berigora*, and *Milvago chimango* (text-fig. 19), the back part of

* Owls, Cuckoos, and Goatsuckers.

the tongue is covered by several rows of backwardly directed spines, in addition to the row of larger spines along the posterior edge of that organ. On the other hand, in one or more species of the genera *Milvus*, *Circus*, *Leucopternis*, *Spizaetus*, *Archibuteo*, *Dryotriorchis*, *Morphnus*, *Asturina*, *Gypohierax* (text-fig. 20, p. 162), and *Urubitinga*, the tongue has only the posterior row of spines. *Vultur* is peculiar in possessing, in addition to the posterior row of spines, a lateral row on each side along the thick edge of the tongue. There are traces of them in *Aquila*, *Nisaetus*, and *Gypaetus*, and perhaps in some other forms.

Conclusions.

The principal conclusion of the foregoing enumeration of facts concerns the classification of the Accipitres. It is perfectly plain, as I think, that the structure of the syrinx permits of, or indeed necessitates, the division of the Accipitres into two families or subfamilies, which may be termed Falconidæ and Buteonidæ (or Falconinæ and Buteoninæ). It is important to notice that in insisting upon such a division, I am in complete agreement with Dr. Sushkin* and Mr. Pycraft†, both of whom have lately attempted a classification of the group on Osteological grounds. This satisfactory result shows the value of the form of the syrinx in this group, as has been shown with the syrinx of other groups, such as the Cuckoos.

As to further subdivisions of these two main divisions, the facts at my disposal do not allow of any expression of opinion. Nor do I venture to lay too much stress upon the apparent agreement in the structure of the tongue with the facts derived from a study of the syrinx and bones, since the material at my disposal was not very abundant.

The next most important point which I have been able to ascertain is the development of a bronchial syrinx in *Dryotriorchis*. This makes it more plain than ever that it is dangerous to compare birds belonging to different groups which happen to possess the bronchial form of the syrinx; for while it is possible on other grounds that the Goatsuckers and Owls, both of which contain genera which have bronchial syringes, are allied, it is not probable that they, the Cuckoos, and the Hawks are *all* nearly akin. It seems to me to be a form of syrinx which has been acquired several times and independently.

* Zool. Anz. vols. xxii. & xxiii. 1899 & 1900.

† P. Z. S. 1902, vol. i. p. 315.

7. On Medusæ from the Coast of British Columbia and Alaska. By LOUIS MURBACH and CRESSWELL SHEARER, F.Z.S.

[Received April 8, 1903.]

(Plates XVII.-XXII.*)

INTRODUCTION.

The Medusæ forming the basis of the present paper were collected by one of the authors, during a short trip to the coast of British Columbia, in the summer of 1900, in company with Prof. MacBride, of Montreal. They were obtained mostly in the immediate vicinity of Victoria Harbour, Vancouver Island, and the adjoining waters of Puget Sound. The rocky nature of the coast, shelving off rapidly into deep water, combined with the strong tidal currents of the main portion of Puget Sound which sweep in close to the shore, make this a very favourable point for the collection of pelagic life. Victoria Harbour itself, almost completely land-locked and several miles in length, affords shelter for many Medusæ not found in the more exposed and open waters of the Sound.

We are indebted to Prof. Kincaid for kindly placing at our disposal a small but well-preserved collection of Medusæ from Alaska and the region of Puget Sound about Port Townsend. The range of our original collection has been considerably extended, and we have obtained valuable material for comparison from different localities. While the number of species obtained is small, we have been fortunate in securing numerous examples of almost all of these. Where only a few individuals of a species have been obtained, doubt has been expressed as to identity. Measurements apply to material preserved in 3 per cent. formalin in sea-water.

Our best thanks are due to Dr. Newcomb, President of the Natural History Society of Victoria, B.C., for the facilities he kindly afforded us in collecting and for much general information regarding the fauna, for which we feel deeply grateful, and to Mr. Adam Sedgwick, of the Morphological Laboratory, Cambridge, for placing the resources of the Laboratory at our disposal.

The list of species represented in the collection is as follows:—

Codonium apiculum, sp. nov.†

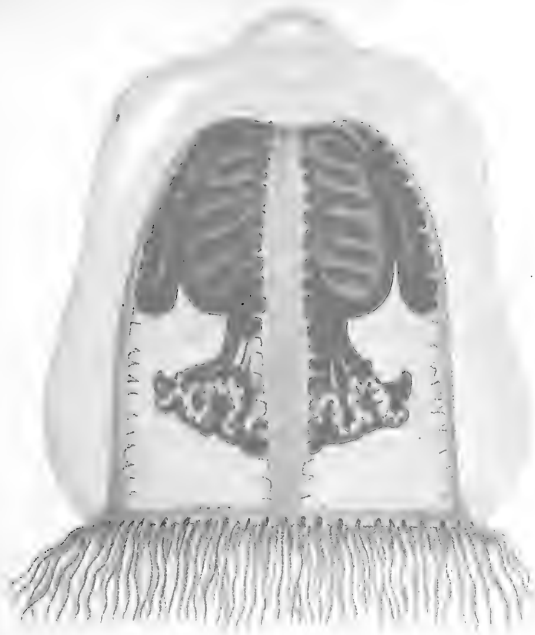
Syndictyon angulatum.

Dipurena dolichogaster.

* For explanation of the Plates, see p. 192.

† This list, with a brief notice of the new species, has been published in the 'Annals and Magazine of Natural History,' ser. 7, vol. ix. (1902).





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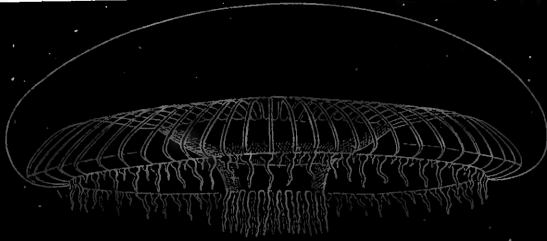


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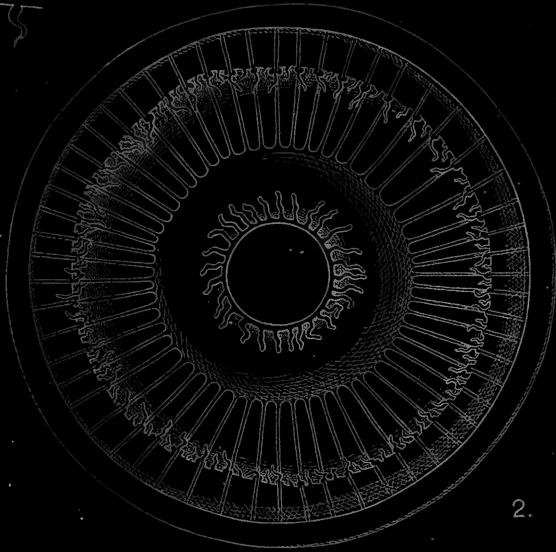
MEDUSÆ FROM BRITISH COLUMBIA
AND ALASKA.



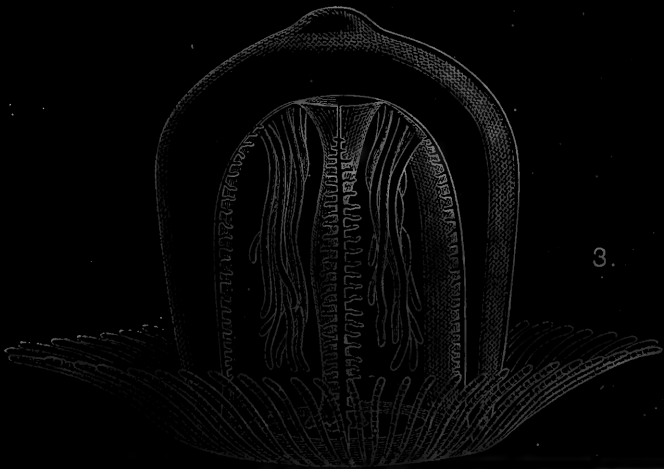
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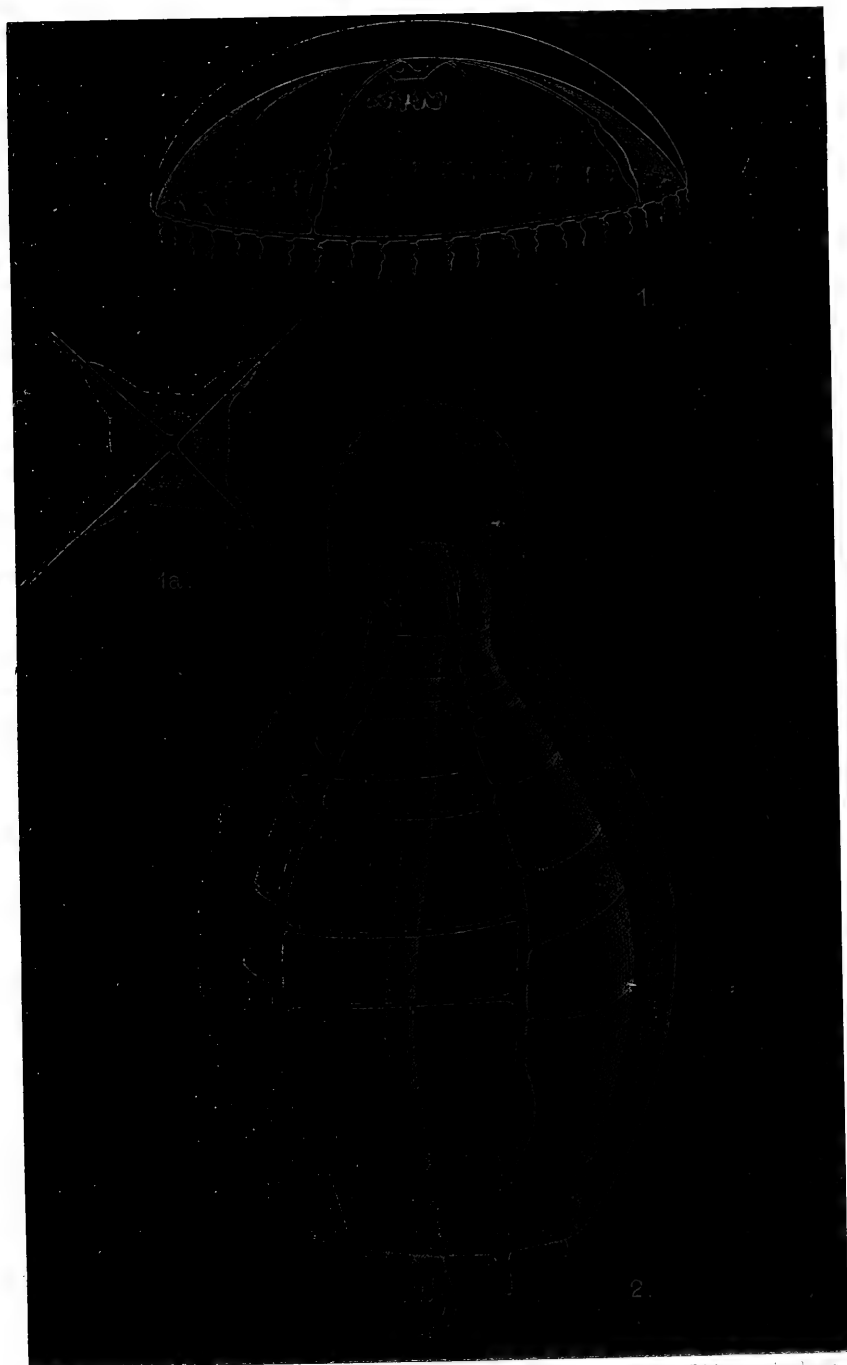
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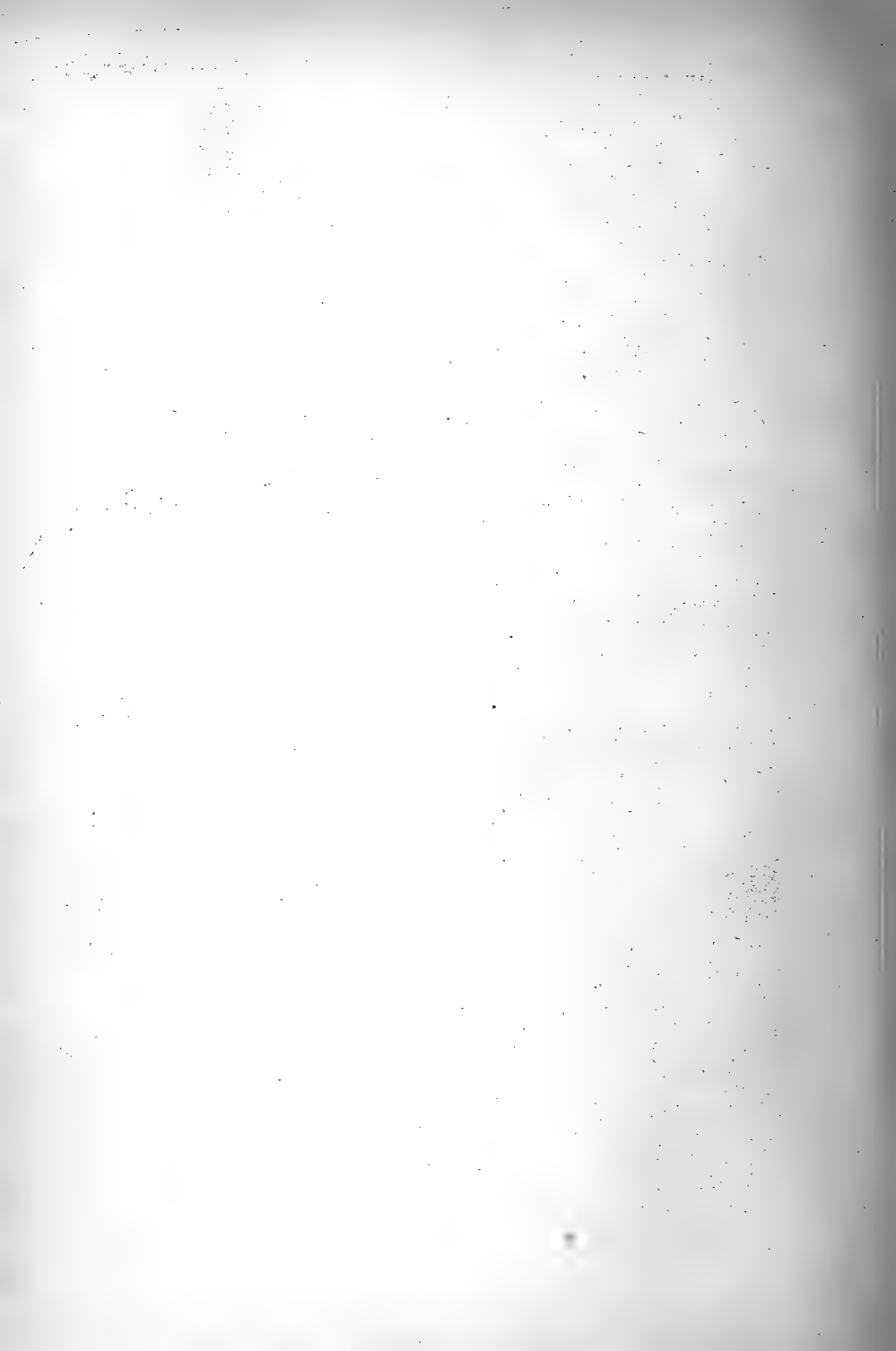


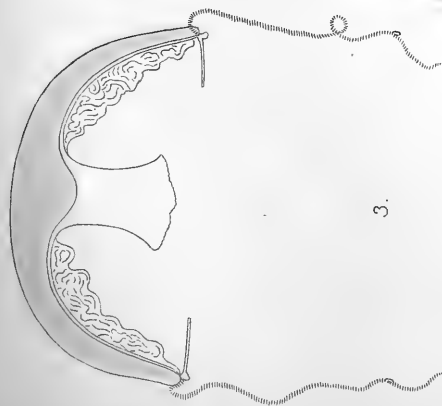
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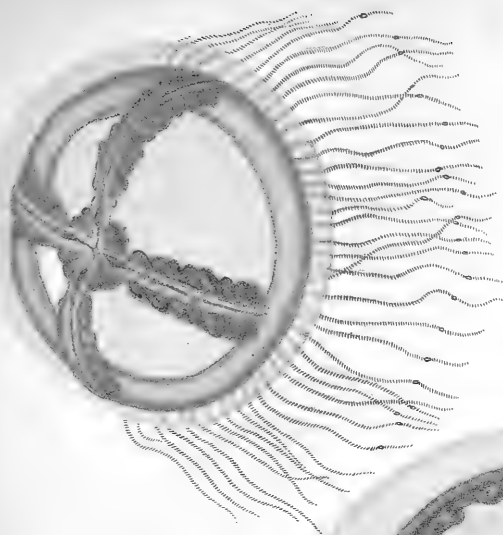
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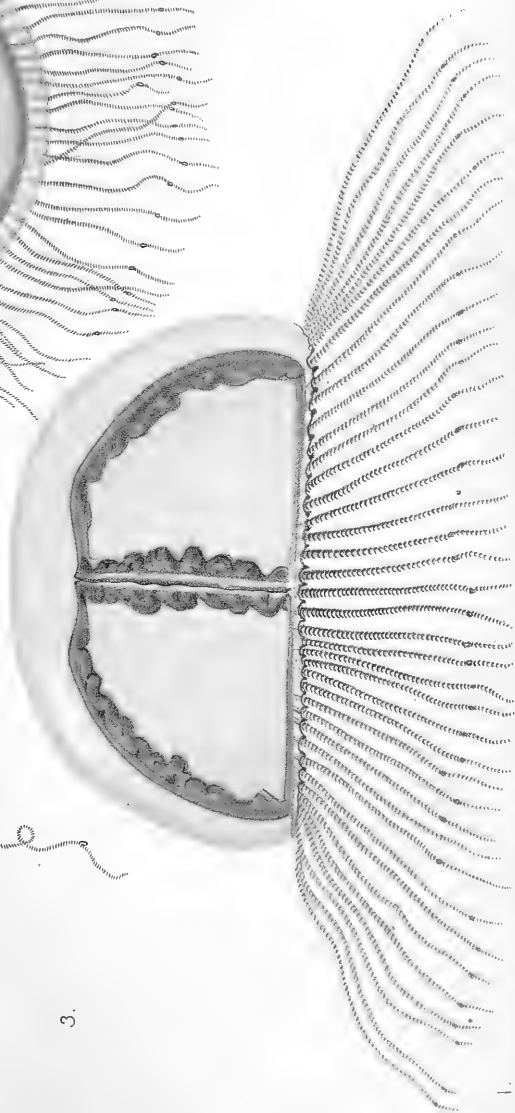




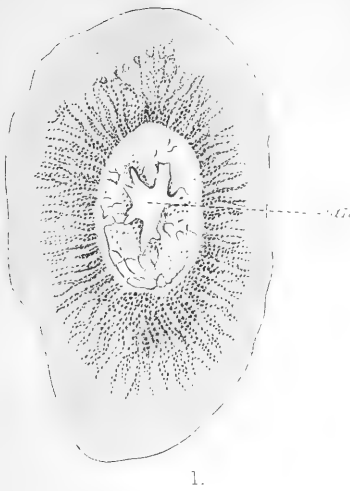
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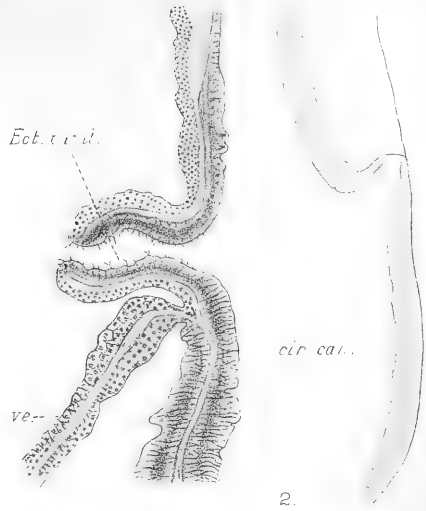
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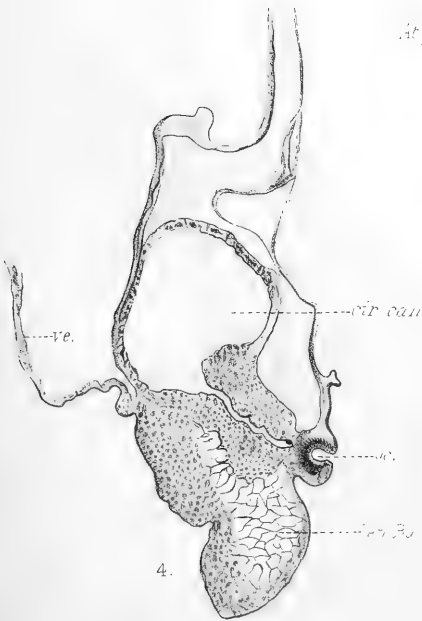
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E. Wilson, Cambridge.

Turris brevisconis, sp. nov.

Hippocrene mertensi.

Thaumantias cellularia.

Polyorchis minuta, sp. nov.

Proboscidaetyla brevicirrata.

Phialidium languidum.

„ *gregarium*.

Mesonema victoria, sp. nov.

Gonionemus vertens.

„ *agassizii*, sp. nov.

Muggiea kochii.

A. ANTHOMEDUSÆ.

I. CODONIDÆ Haeckel

CODONIUM Haeckel (18, p. 13).

1. CODONIUM APICULUM, sp. nov. (Plate XVII. fig. 1 and Plate XXII. figs. 4 & 5.)

Specific description.—The bell is nearly one-half taller than it is broad (1.5 cm. by 1 cm.). In some individuals the difference between height and breadth is not so marked. The diameter at the velum is somewhat less than it is nearer the apex. The apical process on the external surface is small and not abruptly set off. The apical canal (Stielcanal) is likewise short but always present. The velum is well developed.

The four tentacles are rather stout, and in the contracted condition are two-thirds to one and a half times the diameter of the bell in length. They are attached to the bell-margin by large prominent tentacle-bulbs, brownish in colour, having each a distinct black ocellus. On either side of each tentacle-bulb is a large nematocyst-pad (*cf.* Grönberg, 17).

The stomach passes without distinction into the proboscis, which is cylindrical and contracted into circular ridges. The thin membranous end bears the small circular mouth, which is not lobed. The stomach is very distensible, being filled in most of our specimens with a mass of small Copepods. Often it is only the upper end, near the attachment to the bell, that is so distended; when this is the case the lower end is usually contracted and collapsed, as shown partially in Pl. XVII. fig. 1. The proboscis seems seldom to be extended beyond the velum, although, if required, it can be protruded a distance of over a centimetre.

The radial canals are very slender, and terminate in circular openings in the upper end of the narrow stomach. Above the point of their entrance into the stomach is the apical canal. In the circular folds of the stomach are masses that look like gonads; the preservation, however, was not sufficiently good enough to

make certain of this in sections. No medusa-buds were observed, although they were sought for in a large number of individuals. In sections, the lumen of the stomach-cavity is seen to be quadrangular (Pl. XXII. fig. 5). In some examples the approximation of the stomach-walls forces out the corners of this quadrangle, so that they are thrown into folds something like the condition described by Linko (25) in *Sarsia brachygaster*.

Colour.—Bell-margin and radial canals pale blue, proboscis reddish violet or light purple. Ocelli black.

Habitat.—Victoria Harbour, Puget Sound, collected by Shearer.

Discussion.—This Medusa is perhaps the commonest species in the waters of Puget Sound during the month of July. It was seen every day in great numbers, frequently the shoals or banks in places so dense as to obscure the colour of the water. The Medusæ allow themselves to drift passively in the tidal currents, once in a while making a few vigorous contractions of the bell, then remaining quiet as before. While being carried along in this manner, their tentacles are extended a considerable length behind them, one individual having been noticed with its tentacles extended a distance of over 9 cm., although its bell measured less than one centimetre in height. When suddenly taken up from the surface of the sea with their tentacles in the extended condition, they contract them quite slowly and with an irregular jerky motion, the animals taking two or three minutes to contract them to the normal length.

The size and length of the proboscis and stomach in the Codonidæ seem to be subject to great variation; this is markedly the case in this species, in which it varies from a short stump several millimetres long to a condition in which the stomach protrudes almost beyond the velum. One individual of *C. apiculatum*, kept for several days in a small jar of sea-water, had a habit of resting about half a centimetre from the bottom of the jar, allowing its proboscis to drop down every now and again. As soon as this touched the bottom it was rapidly withdrawn into the bell, and then slowly allowed to drop down again. Many examples of this Medusa which have been preserved in formalin show interradial contractions of the bell-surface, giving it a cubical appearance; these contractions are not present in the living condition, and are caused by preservation. It may be contractions similar to these which Hincks (22) mentions as interradial on the bell of *Sarsia* (*Codonium*) *pulchella*, and which Haeckel calls "interradial furrows" in the same species. The examination of a large number of individuals shows considerable variation both in the size of the bell, the shape of the apical canal, the general shape of the proboscis, and in the length of tentacles. Apart from these variations, its specific distinctive characters would seem to be: the truncate shape of the bell; the small apical process on the exumbrella; the short pointed apical canal, which is never knob-shaped; the

pear-shaped tentacle-bulbs, having each two nematocyst pads; the relatively short proboscis and tentacles.

Fewkes (14) has described a Medusa from the Southern coast of California under the name of *Syncoryne rosario*, the hydroid form of which he thinks is the *Coryne rosario* of Agassiz. Although he figures it with no apical process it is undoubtedly a true Codonid. It seems to be very closely related to our species, so far as can be determined. Possibly it is a southern variety, or possibly the two are identical. From Fewkes's description it is difficult to definitely identify his species. While it is possible to determine little from his figures and description (the latter answering for almost any known Codonid), it seems his species possess a rather sharp conical bell, no apical process, and a proboscis a third shorter than in our species. On the other hand, if he identifies it with *Syncoryne* or *Coryne rosario*, then from what we know of Agassiz's (2) description of this medusa, the bell would not be so pointed, and the proboscis would be longer than in our species. In a memoir published the same year as the paper mentioned above, but in a different journal (15), Fewkes names it *Syncoryne occidentalis*, sp. nov.; no reference is made to his former paper or classification, the same drawing and description being used for both papers. It is unfortunate, after finding this Medusa in such abundance at different places on the Californian coast, he has not given us a more definite description.

Brown (8) has remarked, in speaking of *C. pulchellum*, that while he has always found the apical process (the "Scheitel-Aufsatz" of Haeckel) present, the "Stielcanal" is frequently very difficult to distinguish and is sometimes absent. In *C. apiculum* absence of the "Stielcanal" was never observed, although numbers were examined with this point in view. On the other hand, the apical process, or "Scheitel-Aufsatz," was very poorly marked in some individuals, especially in small and young specimens, some of which had the sharp conical bell shown in Fewkes's figure (14, pl. xxv. fig. 7).

Agassiz (2) in his figure of *Coryne rosario*, p. 177, represents it as possessing a "Stielcanal" but no apical process, the top of the bell being rounded. Haeckel (18) divided the original genus *Sarsia* of Forbes into the two genera *Codonium* and *Sarsia*. *Codonium* is characterised by the possession of an apical process and "Stielcanal," *Sarsia* by their absence. While Haeckel places the *Sarsia pulchella* of Forbes under *Codonium* (this species, according to Brown, sometimes having the "Stielcanal" absent), he has retained the *Coryne rosario* of Agassiz under *Sarsia*, although Agassiz plainly represented it with a "Stielcanal." Both these forms possess certain characters of each genus.

Codonium apiculum differs from *C. princeps* in the shape of the bell, the tentacles, and the tentacle-bulbs. It also differs

from *C. princeps*, figured by Grönberg (17), in the shape of the bell, the proboscis, and the tentacle-bulbs. It differs from *C. codonophorum* in the shape of the bell and of the peduncle, this species producing medusa-buds. It differs from *C. pulchellum* in the shape and size of the bell and the tentacles: this species again produces medusa-buds. Brown (8, p. 473) states that he has found medusa-buds in the young of *Amphicodon fritillaria*, *Margellium octopunctatum*, and *Lizzia blondina*. He thinks that it is probably characteristic of the immature condition to produce medusa-buds, while in the adult condition there are gonads on the stomach. For this reason he considers it probable that *C. gemmiferum* and *Sarsia prolifera*, which both produce medusa-buds, and are regarded as distinct species, will ultimately prove to be only the early stages of other known species. The peculiar shape of the bell in Haeckel's (18) *C. conicum* (Nachtrag, p. 634) can hardly be compared with *C. apiculum*. It is also different from *C. gemmiferum* in the size and shape of the bell, the tentacles, and the tentacle-bulbs. The last-named species also produces medusa-buds.

The various species at present included under the family Codonidae certainly need careful revision; until more is known of their individual life-histories it is difficult to estimate their systematic value. Undoubtedly, as Brown has suggested, many will prove to be immature stages of other species. Whether this will be the case with *C. apiculum* can only be said when its life-history is known. Without any knowledge of this it is difficult to find a place for it under any of the species already known.

SYNDICTYON A. Agassiz (Haeckel, 18, p. 20).

1. SYNDICTYON ANGULATUM (Mayer).

Specific description.—In outline the shape of the bell is that of a truncated oval, 1.5 mm. high by 1 mm. broad at the velum. In the preserved condition it has the peculiar quadrangular form mentioned by Mayer (27, p. 5) in his recently described species *S. angulatum*. The wall of the bell is thin and is usually covered with nematocysts, but these are absent in some examples. In all but one of the specimens there is a depression in the top of the bell, and this is met by a canal from the subumbrellar surface forming a complete tube through the apex of the bell. This is the remains of the canal originally connecting the animal with its hydroid form.

The velum is well developed. The four tentacles are much contracted, apparently swelling at their distal ends, and covered with rows of nematocysts arranged in a spiral manner. The tentacles are attached to the bell-margin by means of large tentacle-bulbs, which bear on their outer surface a slight elevation containing the ocellus (*cf.* Mayer, *loc. cit.*).

The base of the stomach is small, gradually enlarging into a cylindrical proboscis, which extends from nearly two thirds to the whole length of the bell. In the contracted condition it is more spindle-shaped. The mouth is small and circular, without lobes or folds.

The radial canals are four simple tubes running from the highest point of the stomach to the circular canal. The latter runs near the inner wall of the bell and makes the quadrangle that is seen from the under surface in Agassiz's figure (2, p. 178) of *S. reticulatum*. No gonads are to be distinguished.

Colour.—Bell light brown, proboscis yellow, ocelli black.

Habitat.—Victoria Harbour, collected by Shearer.

Discussion.—The presence of urticating-organs on the exumbrellar surface of the bell (unless they are arranged in a definite manner retained in the adult stage) used as a generic character by Hæckel (18) is invalidated by the fact that these structures occur in many young Medusæ, e. g. *Aurelia flavidula*, *Dinematella carcosa* (Fewkes), *Proboscoidactyla flavicirrata*, *Gonionemoides geophila*, *Polyorchis penicillata*, and the young of *Sarsia*. This is emphasised by Agassiz's statement that this character is lost in the adult *Syndictyon*. The bell in one of our examples was entirely free from nematocysts. Agassiz (2) indicates a similar apical canal in his *S. reticulatum* just freed from the polyp-nurse (fig. 291, p. 178).

The absence of gonads, the presence of this apical canal, and the presence of urticating-organs on the exumbrellar surface of the bell indicate the immature condition of our examples. Possibly they may be the young of some other species; it has been placed under the species it resembles most. *Syndictyon angulatum* was found by Mayer (27, p. 5) off Turks Islands in the Bahamas.

DIPURENA MacCrady.

1. DIPURENA DOLICHOGASTER (Hæckel, 18, p. 25).

Specific description.—The bell is a low truncated cone, 2 mm. high by 1.75 mm. broad in the region a little above the tentacles. From this, its widest diameter, the bell draws rapidly inwards, ending in a rounded cone-shaped top. The velum is narrow. The four tentacles are small and rather spindle-shaped, and in the contracted condition are surrounded by six or seven rings or welts of urticating-organs. The end-rings cause the appearance of bulbs at the base of the tentacles.

The tentacle-bulbs are very large in proportion (1.5 by 1.25 mm.) to the other organs, somewhat crescent-shaped, seated in a curved depression on the bell-margin. On the outer end of each bulb there is an eye-spot.

The digestive cavity is a large cylindrical tube hanging down a

distance of about two-thirds the length of the bell-cavity. The proboscis is long, and the mouth a plain circular opening. The radial canals run from the tubular end of the stomach slightly upwards and then downwards to the circular canal of the bell-margin. Their course is marked by refractive granules which look like nematocysts, but which are not regularly arranged. No gonads were seen; it is probable the single example obtained was immature.

Colour.—Organs pale blue.

Habitat.—Victoria Harbour, collected by Shearer.

Discussion.—Some doubts as to the accuracy of the above identification are raised by several of the characters, the most striking being the tentacle-bulbs. Only one individual was obtained and that had been badly preserved.

II. TIARIDÆ Haeckel.

TURRIS Lesson.

1. TURRIS BREVICONIS, sp. nov. (Plate XVIII. figs. 1 & 2.)

Specific description.—The bell is 4·5 cm. high by 3·5 cm. broad at the level of the velum. It is somewhat cubical and quite massive in appearance. The general shape of the bell corresponds with Haeckel's (18) figure of *Tiara pileata* (pl. 3, fig. 7). The velum is well developed and strong. On some parts of the bell-margin there appears to be but one row of tentacles; for the greater part, however, there are two rows, arranged in a zigzag manner. The tentacles are numerous, over a hundred and forty in all. They seem quite uniform in size when mature; the smaller ones are more irregular and evidently less developed. They are coiled and show the structure peculiar to coiled tentacles, as do those of *Physalia*, the ectoderm being very much enlarged on one side, while the contractile fibres of the inner side are covered with but a thin layer. There are no special tentacle-bulbs, but the tentacles spread out, clasping the bell-margin, as Haeckel (18) has described for *Tiara pileata*. In the preserved condition no eye-spots could be made out.

The walls of the stomach are very much folded, and pushed out into pouches on either side of the radial canals, forming dependent diverticula from the angles of the stomach. There are four or five pairs of these diverticula. They bear the gonads, and are suspended to the radial canal by a double band or mesentery (*cf.* Haeckel, 18). The proboscis is poorly developed.

The four rather large mouth-lobes are perradial in position, scalloped, and finely fringed.

The gonads and stomach occupy less than the upper half of the bell-cavity. The radial canals are spindle-shaped in outline, Haeckel's "lanzettformig." Throughout their length they have

well-marked unbranched lateral diverticula. These diverticula are absent on the upper margin of the circular canal, and are thus unlike the condition described in *Catablema* by Haeckel.

Colour.—Bell bluish throughout; tentacles, gonads, and stomach dark red or purplish.

Habitat.—St. Paul Island, Pribyloff Islands, collected by Kincaid.

Discussion.—The large number of tentacles in double rows and the opposite position of the diverticula of the stomach, bearing gonads, are the reasons for placing this form under *Turris*. It is true that the stomach and gonads are small for *Turris*, but the size of these organs is variable. Beyond these considerations this form seems to resemble more *Tiara pileata* than any species of *Turris*. It differs from *Turris digitalis* in the smaller apical process, the size of the gonads, the shape of the radial canals, and the length of the manubrium; from *T. neglecta* in the shape of the stomach which is not cubical, in the regular opposition of gonad-pouches, and in the number of tentacles. The specific characters are:—the short conical apex, the large number of tentacles (140), arranged in two rows, the spindle-shaped radial canals having simple lateral diverticula throughout their length, the five or more pairs of gonadial pouches from each of the four stomach-lobes, the small size of these and the stomach; in these respects it approaches the condition in *Tiara*, and, lastly, in its size. *Turris digitalis*, the original *Medusa digitale* of Fabricius, is remarkable for its extensive distribution in northern waters; it is probable that *Turris neglecta* will be found to have a similar distribution. Four out of the seven genera of Haeckel's subfamily Pandæidæ have been reported from arctic waters.

III. MARGELIDÆ Haeckel.

HIPPOCRENE Mertens.

1. HIPPOCRENE MERTENSII (Haeckel, 18, p. 92).

Synonym *Bougainvillia mertensii* Agassiz.

Specific description.—The bell is nearly spherical, somewhat flattened, and contracted at its four meridional points, having thus a cubical appearance, 5 mm. by 4 mm. The velum is well developed. The oral tentacles are situated at the upper end of the proboscis—two large, one small, and one rudimentary: this last being due possibly to imperfect preservation or an abnormality of the specimen. There is a marked inequality of the tentacles and the tentacle-bulbs. The former are stout, branched at the base, each branch dividing dichotomously about six times. Two of the tentacle-bulbs are large, horseshoe-shaped, and twice as broad as the proboscis. Each bears twenty-one tentacles and as many eye-spots. The other tentacle-bulbs could not be

clearly distinguished. The radial canals are four in number, simple, and opening into the angles of the stomach. The stomach is short and broad, a short proboscis connecting it with the lobed mouth below. The gonad-masses are interradial. No gastral peduncle could be distinguished.

Habitat.—Victoria Harbour, collected by Shearer.

Discussion.—The single specimen was so badly preserved as to render certain identification almost impossible. It has been placed under *H. mertensii*, the form it seems to resemble most. This Medusa was first described by Lesson (24) under the name of *Cyanea bougainvillii*. Brandt, five years later, described it from the drawings and manuscripts of Mertens under the name of *Hippocrene bougainvillii* Lesson, changing this again a year later to *Bougainvillia macloviana*. Lesson met with it at the Island of Soledad, while Mertens found it at St. Matthei Island, Behring's Strait. Agassiz reports this species from the region of Puget Sound, Port Townsend, and the Harbour of San Francisco. Hartlaub (20) has suggested that Agassiz is mistaken in identifying his species with that of Mertens on account of size. Agassiz states that his specimens were larger than *B. superciliaris*, while Brandt describes the species as the size of an "ordinary pea," *B. superciliaris* measuring some 8 mm. in height; this would make *B. mertensii* of Agassiz some 9 or 10 mm. in height. Hartlaub (20) has recently given an extensive description of the Heligoland species of *Bougainvillia* in the 'Meeresfauna von Helgoland.'

B. LEPTOMEDUSÆ.

I. THAUMANTIDÆ Gegenbaur.

THAUMANTIAS Eschscholtz.

1. THAUMANTIAS CELLULARIA Haeckel (18, p. 129). (Pl. XVII. figs. 2, 2 a, & 2 b.)

Synonym *Laodicea cellularia* A. Agassiz.

Specific description.—The bell is rather flat, 5 to 9 cm. broad by 2.5 to 3.5 cm. high, somewhat resembling *Staurophora* in appearance. The tentacles form a fine fringe around the bell-margin, being not more than a third of its diameter in length, coiled up to their oval spindle-shaped tentacle-bulbs, which are so numerous as to almost touch one another. The number of tentacles is about 340. In specimens preserved in formalin neither ocelli nor cirri are visible. In proportion to the size of the animal the velum is narrow and delicate, being only 5 mm. broad.

The radial canals run from the circular tube of the bell-margin to the highest point in the roof of the stomach, where they cross

as ciliated grooves, a condition somewhat like that shown by Haeckel (18, pl. iv. fig. 7, for *Catablema*) (this is not to be confused with the "gastrogenital Kreuz" of *Staurostoma*). In the preserved condition the walls of the quadrangular stomach are so low that the mouth gapes widely. The crenulated, somewhat twisted, oral fringes are very characteristic, from one to one and a half times the diameter of the stomach in length. The gonads are wavy or serpentine bands depending from the radial canals throughout almost their entire length.

Colour.—Bell pale blue, bell-margin and gonads deep violet-blue.

Habitat.—Puget Sound, Victoria Harbour, collected by Shearer; Friday Harbour, collected by Kincaid.

Discussion.—The general appearance of this Medusa is very like the figure given by Forbes (16, pl. viii. fig. 1 a) for *Thaumantias pilosella*. The bell is somewhat flatter and the tentacles more numerous, the gonads are also less developed. This flat condition of the bell is very well portrayed by Brandt's (6) figure of *Staurophora mertensii* (pl. xxiv. fig. 2), which also well represents the number, colour, and appearance of the tentacles. There is a delicate shade of blue through the substance of the bell, so that when in water they would almost escape observation, if it were not for the darker colour of the bell-margin and of the tentacle-bulbs. The colour of the bell so closely matches the blue colour of the sea-water, that the Jelly-fish become indistinguishable, nothing but the dark ring of the bell-margin showing, contracting and expanding as the animals swim.

It will be seen that the shape of the bell is somewhat different from that pictured by Agassiz for this species (2, p. 127, fig. 195). There is also considerable difference in size. Agassiz's species measured 3 cm. across the bell; the majority of our specimens measured 5 cm., and some fully 8 and 9 cm.—in fact, were so large that we had no suitable jars in which to place them. Again Agassiz states that the tentacles number about a hundred, whilst in the Victoria examples there are considerably over thrice that number, this last difference being due to increase in size. The number of tentacles in each quadrant of the bell-margin is seldom the same, and not necessarily a multiple of four, no two quadrants have exactly the same number, the average for a quadrant being 84.

This species made its appearance suddenly in Victoria Harbour on July 7th 1900, in great numbers; it was abundant for three days, after which few were seen. Agassiz (2) also found it in the region of Puget Sound, July 1859. It is remarkable how readily foreign particles adhere to the bell-surface of this Medusa, little bits of débris, sand, and seaweed sticking to it with great tenacity; many of our specimens were ruined on this account. It is difficult to say in the preserved condition whether this is due

to a sticky secretion on the bell-surface or to mere roughness of this surface on which small particles become lodged. Forbes (16), in speaking of *T. pilosella*, says of the bell: "It is transparent and smooth, except on the sides towards the margin, where it is as if woolly, being invested with minute epidermic hairs composed of fibrous cells." Perhaps the presence of these foreign bodies was due to some similar condition. The question cannot, however, be settled from formalin material, as in this fluid the bell-surface takes on a peculiar scaly appearance, no woolly or hairy condition can be made out. Haeckel (18) has called attention to the similarity between this species and that reported from Greenland. Our specimens differ from the Greenland species in the possession of broader oral lobes, the bell- or bottle-shaped tentacle-bulbs, and the fact that the gonads are situated throughout the whole length of the radial canals.

II. CANNOTIDÆ Haeckel.

Subfamily POLYORCHIDÆ A. Agassiz.

POLYORCHIS A. Agassiz.

1. POLYORCHIS MINUTA, sp. nov. (Plate XIX. fig. 3 and Plate XXII. fig. 1.)

Specific description.—The bell is 15 mm. high by 12 mm. broad, a truncated oval with thick walls. It is broadest above the middle of its height, measuring the 12 mm. already given.

A prominent cone-shaped gelatinous peduncle depends from the bell-roof, and to this the stomach, the upper ends of the radial canals, and the gonads are attached. The bell is drawn in towards the mouth so that its diameter at this point is only 9 mm. The lower truncated edge of the bell is nearly as broad as the velum. This is strong and 2.5 mm. in breadth. There are eight delicate adradial lines running meridionally in the bell-substance.

There are 55 tentacles—26 large, 20 medium, and 9 rudimentary. There are nine more spaces, so that 64 tentacles should be present in all. The hollow tentacles are stout and taper to form a rather long root at their proximal end. They are slightly swollen just at the junction of the root and tentacle proper forming the tentacle-bulb. The mature tentacles which are attached to the bell-margin by these long roots are carried very much as shown in Pl. XIX. fig. 3. Small tentacles during growth move outward on the lower truncate bell-margin, producing thus the appearance of several rows one above the other. On some of the tentacles there appear smooth areas free from nematocysts, whereas, as a rule, the whole surface of the tentacle is usually covered with large and small nematocysts.

The ocelli are yellowish green in the preserved condition, and

situated on an elevation on the outer side of the tentacle-base, where the latter leaves the margin of the bell. No otocysts are present. The stomach rests with a small angular base on the gelatinous peduncle, receiving at this level the radial canals. It then widens into a pouch, becoming again constricted into the proboscis which bears the mouth below. In the living condition the digestive cavity is circular in outline. In the distended condition it looks thin-walled. The mouth has four short lobes which turn outward. Each lobe is again lobulated or coarsely toothed. The four radial canals are well marked, cylindrical tubes running direct in their course. They pass from the angles of the stomach upward along the peduncular cone to the highest point of the subumbrellar space and then descend directly to the circular canal of the bell-margin. Along the whole course of these radial canals short lateral diverticula are given off, the ends of the canals alone being free from them. Only a relatively small number of diverticula on one side of a radial canal are placed opposite those on the other side of the canal. None are branched or have their ends enlarged in a club-shaped manner. On either side of each radial canal there are about 32 of these diverticula. They are shorter near the ends of the radial canals, where these approach the bell-margin being mere protuberances. Gradually towards the middle of the bell they increase in length, until they measure about twice the diameter of a radial canal in length.

The gonads are long finger-shaped processes dependent from the proximal part of the radial canals, the part most free from diverticula. There are eight gonads in each of the four groups, the central ones being the longest and reaching to the level of the velum. The outer shorter gonads may be mere rudiments. The latter cannot be mistaken for diverticula, being thicker and hanging free in the subumbrellar cavity. There are a few small diverticula on the radial canals over the region where the gonads are attached.

Colour.—Transparent and colourless except the gonads and tentacles, which are tinged a pale yellow in preserved material.

Habitat.—Puget Sound, collected by Kincaid.

Discussion.—In Agassiz's figure (2) of *P. penicillata* only 22 of the diverticula are on an average arranged opposite one another on the sides of the radial canals. It is very doubtful if any importance can be attached to the position of these diverticula; certainly their opposite arrangement is unworthy the generic importance assigned it by Haeckel (18). In the generic diagnosis, p. 149, he says of the radial canals of *Polyorchis*: “. . . im Distal-Theile mehrere Paar von gegenständigen geschlechtslosen Fiederästen tragen.” Both Eysenhardt & Chamisso (12) and Eschscholtz (11) represent the diverticula on the course of the radial canals, in their figures of these Medusæ, by cross-lines drawn at right angles to the canals; this produces the appearance

of the greatest regularity in the arrangement of the diverticula, exactly opposite one another. As a matter of fact, this opposite character arises only from a crude manner of representation. Probably this kind of symmetry is as little marked in them as in *P. penicillata* or *P. minuta*; for these reasons in future this character should be omitted from the generic diagnosis. Fewkes (14) draws the diverticula in his species opposite, yet identifies it with *P. penicillata* of Agassiz. Our specimens approach the species of Fewkes more than they do the original descriptions given by Agassiz for this same species. Agassiz (2) obtained *P. penicillata* in the region of Puget Sound, and also on the coast as far south as the Harbour of San Francisco, where he found it very abundant; Fewkes collected his examples at Santa Barbara and Santa Cruz on the southern coast of California. He does not doubt that these southern examples belong to the same species Agassiz described as *P. penicillata* from a more northern range. As already stated, this revised version of *P. penicillata* by Fewkes approaches very closely *P. minuta*; in fact we have only ventured to give it separate specific rank on account of size, a feature of no very great importance. We only attach importance to it here because our form was evidently mature, the great development of the gonads, the number and length of tentacles making this almost certain. Yet the height of the bell is 15 mm. in *P. minuta*, as compared with 40 or 50 mm. in the *P. penicillata* of Agassiz and Fewkes. While Fewkes identifies his species with that of Agassiz, as already stated, if his drawings and descriptions are accurate there would seem to be striking differences between the two. Some of these are the shape of the bell, which is broader, a less developed condition of the diverticula on the ends of the radial canals next the circular canal of the bell-margin, the club-shaped even branched ends of these diverticula, the position of the gonads on the part of the radial canals descending to the stomach, while Agassiz (2) states they are "attached at the highest point of the four chymiferous tubes."

Agassiz figures four gonads in each group, and these reach halfway to the velum; Fewkes figures eight, and these reach almost to the level of the velum. Although Agassiz only figured four gonads, Fewkes says he subsequently found their number to be much greater. We should hesitate, however, in emphasising these distinctions, for Fewkes, as assistant to Prof. Agassiz, had doubtless ample opportunity of referring to the original specimens and notes of Agassiz.

Agassiz considers his species to be the same as that described by Eschscholtz (11) under the name of *Melicertum penicillatum*, p. 106. Eschscholtz gives a very short description and poor figure, from which it is hard to determine anything exact. It was found by Eschscholtz on the coast of California. Haeckel (18) follows Agassiz in arranging this species under *P. penicillata*,

although he thinks they may possibly be different; in this event he proposes that it should be called after Eschscholtz. Blainville (4) gives a description and coloured figure of the *Melicertum penicillatum* of Eschscholtz, but these are copied directly from Eschscholtz without further additions.

So far as can be judged, the species figured by Eschscholtz was not based on immature specimens, considering the number and length of the gonads, the tentacles, and the height of bell. From the papers of Agassiz and Fewkes we are familiar with the young stages of the Pacific species of *Polyorchis*; these are quite different in essential points from Eschscholtz's drawing of the form which he took off the coast of California (11, fig. 4, pl. viii.). The eight long tentacles, four radial and four interradiar, are out of all comparison with the four rather large tentacles at the ends of the radial canals in the young stages figured by Fewkes. It is to Agassiz (2) that we owe the present name of *Polyorchis*, Hæckel (18) retaining this name and placing it under the Leptomedusæ, family Cannotidæ.

Of the three species already known, by far the most interesting is *P. campanulatus*, originally described as *Medusa campanulata*, by Eysenhardt and Chamisso (12). Here the bell is much lower and more conical than in the other species. It is eight-sided, and the sides meet in angles. These characters, combined with the position and structure of the gonads as found in all *Polyorchis*, are remarkably like what is found in the Aglauridæ. For instance, the long finger-shaped gonads of *Aglantha* in position and structure are very strikingly similar to the gonads in *Polyorchis*, although they are more numerous. While there are never more than four radial canals in *Polyorchis*, as compared with the eight of the Aglauridæ, no great significance can always be attached to the number of radial canals.

The possession of free "Hörkolbchen" by the Aglauridæ would seem to separate them definitely from *Polyorchis*, although there are Leptomedusæ, such as *Laodice*, which possess the true endodermal sense-clubs of the Trachomedusæ. The most distinctive character between these two groups is the possession by *Polyorchis* of diverticula on the radial canals, but these undergo marked change during the growth of the animal. Hardly distinguishable in the young, they become apparent as the animal increases in age; this points to their being a recent acquisition in the evolution of the race, probably within the limits of this particular group.

Of the three species of *Polyorchis* at present known, two are from the Pacific, the third from the Adriatic. It has already been mentioned that Agassiz (2) found *P. penicillata* in the region of Puget Sound, while Fewkes (14) found it as far south as Santa Cruz on the southern coast of California; it would seem to be, therefore, one of the few *Medusa*-forms common to both the northern and southern fauna of the West Coast of N. America.

PROBOSCIDACTYLA Brandt.

1. PROBOSCIDACTYLA BREVICIRRATA Haeckel (18, p. 160).

Synonym *P. flavicirrata* A. Agassiz.

Specific description.—The bell is a truncated oval, 7 mm. high by 6 mm. broad; the subumbrellar cavity occupies less than half this bell, leaving a clear thick mass of jelly forming the roof of the dome. Agassiz has well represented this in his figure in the *N. A. Acalephæ* (2, fig. 280, p. 173). The velum is quite narrow. The tentacles are short, and number in our largest specimen 54, being half as long again as the diameter of the bell. Small tentacle-bulbs bear the dark ocelli, and young tentacle-buds are seen between some of the older ones. Seen from the aboral side, an opaque cross marks the position of the four lobes of the stomach, on which a portion of the gonads rest. The lower portion of the stomach is more cylindrical, ending in the tubular much-folded mouth. This sometimes appears as four double folds, curved outwards and upwards. The gonads lie in the interradial folds of the stomach, and pass out along the unbranched portion of the radial canals. The radial canals branch twice dichotomously, and then somewhat more irregularly, so that there is finally a canal for each tentacle. Between the terminal branches of the radial canals are blind delicate canals running in centripetally from the margin of the bell, reaching halfway up. These canals are on the exumbrellar surface, and do not appear to be hollow in section; the radial canals are nearer the subumbrellar surface. Nematocysts are seen scattered in clusters along these tubes at varying intervals, so that many masses of nematocysts may be found along the course of one tube.

Colour.—The stomach is a dirty yellow. Agassiz (2) states that this Medusa is quite transparent. Whilst this is true of the upper part of the bell, the thick yellow mass of the stomach renders the lower portion quite opaque. Preservation in formalin seems to have caused considerable shrinkage: our measurements apply to preserved animals.

Habitat.—Victoria Harbour, collected by Shearer; Pleasant Beach, collected by Kincaid.

Discussion.—Nothing was seen answering to Agassiz's (2) description of the granular covering of the bell, except the patches of nematocysts already mentioned scattered here and there along the centripetal canals. Haeckel (18) has thrown doubt on the presence of nematocysts on these canals; they are so well marked in all our examples that it seems strange he should have overlooked them.

This Medusa was first found by Mertens on the coast of Kamchatka. Agassiz (2) reports it from the region of Puget Sound, but Haeckel considers Agassiz's species different from that of Mertens, naming it *P. brevicirrata*. These names are liable to give rise to some confusion. It is very doubtful if this

separation is justifiable, seeing that Brandt seems to have misunderstood the structure of his species. We should hesitate, therefore, to base any distinctions on his account.

III. EUCOPIDÆ Gegenbaur.

PHIALIDIUM Leuckart.

1. PHIALIDIUM LANGUIDUM Haeckel (18, p. 185).

Synonym *Oceania languida* A. Agassiz.

Specific description.—The bell is hemispherical, about 12 mm. in diameter by 6 mm. high. It is folded in the peculiar manner described by Agassiz (2).

The velum is narrow and delicate. The tentacles all told number sixty, some closely coiled, others straight. The tentacle-bulbs are somewhat smaller here than in *P. gregaria*, the tentacles being sharply set off from the bulbs. There are two otocysts between each two tentacles.

The stomach is small and cross-shaped, the arms of the cross receiving the radial canals. There is no proboscis. The curled and fringed oral lobes are about the same length as the arms of the stomach cross. The four radial canals bear the gonads on their distal half. They are oblong linear bodies, one-third the length of the radial canals, attached to their outer half, but not reaching quite to the circular canal of the bell-margin.

Colour.—Greenish blue.

Habitat.—Victoria Harbour, collected by Shearer.

2. PHIALIDIUM GREGARIUM Haeckel (18, p. 188). (Plate XX. figs. 1 & 1 a.)

Synonym *Oceania gregaria* A. Agassiz.

Specific description.—The bell is 12 mm. by 7 mm., and so nearly hemispherical. The velum is quite small. Of the tentacles and buds destined to develop there are sixty. The tentacle-bulbs are spherical and relatively large. The otocysts are evenly distributed, one or two between consecutive tentacles; they usually contain one, sometimes two otoliths.

The stomach is very small, quadrangular, receiving the delicate radial canals at its angles, and ending in the four perradial, moderately long, curled, and fringed oral lobes. There is no proboscis. The four radial canals run from the angles of the stomach to the circular canal, bearing on their distal half or third the gonads, which, however, do not reach quite to the circular canal. As the gonads are very narrow linear bodies, our specimens may be immature. This is borne out by the size and number of small tentacles.

Colour.—White, becoming slightly brown on preservation in formalin.

Habitat.—Puget Sound, collected by Kincaid; Victoria Harbour, collected by Shearer.

Discussion.—The principal points in which this species approaches the Pacific form given by Agassiz and Mayer (3) are the large size of the tentacle-bulbs, the distribution of the otocysts and their contents. It differs from it in the shape of the simple oral lobes, the tentacle-bulbs, and the position of the gonads. Several of our specimens seemed to agree more closely with *P. variabile* than with *P. gregarium*, apparently the only difference being in the number of tentacles. From Claus's paper (10) it would seem that cirri are present in all the *Phialidia*, and that they are usually on the sides of the tentacle-bulbs.

Haeckel distinguishes three species of *Phialidium*—*P. variabile*, *P. languidum*, and *P. gregarium*. Maas (26) departs from Haeckel in retaining the species *P. flavidulum*, with its larger number of otocysts and tentacles, Haeckel placing it under *P. variabile*. Haeckel has arranged some twenty or twenty-five names under *P. variabile* as synonyms; the original descriptions of many of these, as Brown has remarked, are far too vague for their identification to-day. Brown (8) distinguishes as distinct from Haeckel's species *P. buskianum*, *P. temporarium*, and *P. cymbaloideum*. The great variability in the members of this group renders it especially difficult to determine the value of the various species until their hydroid forms are recognized.

Agassiz (2), in speaking of *Oceania languida* (*P. languidum*), remarks on the extraordinary attitudes assumed by this Medusa. One of these attitudes is given in fig. 102, where the animal is rolled up upon itself, the opposite edges of the bell coming together. Many of our examples exhibited this peculiar attitude, while others were folded in a three-cornered manner, something like the attitude in which Brandt (5) pictures his *Staurophora mertensii* (pls. 24 & 25).

The specimens from Prof. Kincaid's collection also exhibited these attitudes. They were taken from a different part of Puget Sound.

IV. ÆQUORIDÆ Eschscholtz.

MESONEMA Eschscholtz (Haeckel, 18, p. 225).

1. *MESONEMA VICTORIA*, sp. nov. (Plate XIX. figs. 1, 1 a, & 2, and Plate XXII. fig. 2.)

Specific description.—The bell is hemispherical, 7 cm. broad by 3.5 cm. high, tapering to a thin flexible margin. A well-developed velum is present. Tentacles numerous, over 100, shorter than the diameter of the bell. In the same row with the tentacles are found numerous small papillæ, sometimes between the tentacles, sometimes below them. Otocysts and excretory papillæ are present. The gastric cone is not pedunculated, but is lens-shaped and almost hemispherical. Stomach about the

same depth as the oral peduncle, being very wide at the top, almost half the diameter of the bell. Mouth much lobed, the lobes being narrow, pointed, and finely toothed. There are half as many lobes as there are radial canals. There are about a hundred radial canals; these run from the peripheral canal inwards and upwards to the highest point of the stomach. Each radial canal is covered on its outer surface by a ridge of glandular cells. Sometimes these are continued over the stomach and oral peduncle down to the lobes of the mouth, giving an appearance similar to that presented by the ovaries of *Orchistoma*. The two kinds of umbrellar papillæ are present.

Colour.—Organs and bell-margin white, with a very slight trace of blue in the larger tentacles.

Habitat.—Victoria Harbour, Esquimalt Harbour, collected by Shearer; Pleasant Beach, collected by Kincaid.

Discussion.—On first examination this Medusa was taken to be *Orchistoma*. That it is an undoubted *Æquorid* is borne out by the presence of marginal vesicles, of which there are one or two between successive tentacles, the absence of eye-spots, and the presence of excretory papillæ under the velum. The papillæ which are in the same row as the tentacle-bulbs are young tentacles. Brandt describes (6) bodies on the inner side of the bell-margin which Haeckel is probably right in considering to be excretory papillæ. Brandt speaks of them as follows (p. 361):—"An der innern Seite der Basis des Saumes findet sich eine Anzahl kleiner, tassenförmiger, an Gestalt der Cupula einer Eichel nicht unähnlicher Körperchen." No mention is made as to their relation with the circular canal, and Brandt thinks they are the rudiments of a third row of tentacles. Evidently Mertens did not observe whether they were inside the velum, and perhaps his remarks refer to the young tentacle-bulbs we have described above in *M. victoria*, and not to the true excretory papillæ under the velum. Some slight confusion has arisen over the position of these papillæ. Haeckel (18) and Hertwig (21) describe umbrellar papillæ, which are outside the velum (centrifugal), which are, according to them, blind tentacle-bases, or spurs, possessing no openings. Distinct from these are the subumbrellar papillæ, inside (centripetal) to the velum, arranged one opposite each marginal tentacle-spur on the outside; they are connected by an opening at their apex with the circular canal of the bell-margin, and have been interpreted as excretory in nature. Haeckel (18) expressly states (p. 119) that they are inside the velum, and thus in the subumbrellar cavity; yet in pl. xi. fig. 13 of the same work he shows them as if they were in the same row with the tentacles on the external surface of the bell-edge, and thus outside the velum; from his figure it is impossible to make out their true position under the velum*. Mayer (28) has described centrifugal excretory papillæ on the

* Since the above was written, it has been found that Claus (10, p. 13) makes practically the same comment, although his figures 29 and 30 are not clear.

tentacle-bulbs of *Zygodactyla cyanea*, which are not true excretory papillæ in which an opening is present, but probably simple tentacle-buds or spurs. Agassiz (2) has described similar structures in a number of *Æquorids*, as *Rhegmatodes tenuis*, *Zygodactyla grenlandica*, *Æquorea albidula*. Possibly in some cases these may be the true excretory papillæ which he has seen but misunderstood, or they may be simple tentacle-spurs, and so entirely different structures; his descriptions and figures do not make this clear: if they are excretory papillæ he does not recognize their structure and proper position. Milne-Edwards (30) speaks of tubercles on the bell-margin of *Æquorea violacea*, "ayant la forme d'un petit mamelon" (pl. i. fig. 1 c, d), which may be these excretory papillæ, but here, again, their structure is not recognised. It is to Metschnikoff (31) that we are indebted for the first correct description of these structures; he was the first to recognise their position under the velum, the opening in the apex, and their connection with the circular canal. His figures are by far the best, although fig. 2, pl. v., is open to the same objection as Haeckel's figure; fig. 7 is, however, very plain.

In *M. victoria* these structures seem to have a very regular arrangement, one opposite each tentacle-bulb and one in the middle of the space between consecutive tentacles. In Plate XXII. fig. 2 is represented a section passing through the bell-margin in the plane of one of these papillæ; the opening in the apex is distinct, being connected with the circular canal by a passage lined with strong cilia. These papillæ do not seem to be present in young specimens, only the larger and older examples appear to possess them. It is doubtful if their function is purely excretory. Brandt (6, pl. v. fig. 4) shows the continuation of the radial canals into the mouth-lobes of his *Mesonema* (*Zygodactyla*) *cærulescens*, similar to their continuation into the mouth-lobes of *M. victoria*, as already described. He also shows a peculiar rectangular communication of these canals, on the mouth-lobes, which is not present in our species. While collecting off the inlet of Victoria Harbour early in July, on several occasions lens-shaped masses were picked up, they were about 3 cm. broad; towards the end of the month, when this Medusa was obtained, they proved to be the central gastric peduncle from which the peripheral parts had been worn and macerated away, leaving a hard, smooth, lens-shaped mass. Fewkes has well described these from *M. cyaneum* as "... flat, slightly convex above, rounded convex below." He regards them as probably homologous with the gelatinous peduncle of genera like *Lirope*, *Geryonia*, and *Carmarina*. *M. victoria* frequently contracts the bell when disturbed in a characteristic manner, the thin flexible margin being folded in, the tentacles almost rolled under the velum, the gastric peduncle making a rounded protuberance on the upper surface of the bell. Huxley (23, pl. xxxvii. fig. 11) shows this attitude in his drawing of *Oceanira*? Although the

tentacles are not rolled in and contracted, this Medusa is evidently a species of *Mesonema*. Great difficulty was found in preserving our specimens; they seemed to become very brittle on short preservation by the ordinary method in formalin, the slightest shaking of the bottle in which they were preserved causing them to break up into small fragments; the majority of our jars reached home with nothing but a mass of débris at the bottom. This Medusa was quite common about Victoria during July, and is evidently as abundant on the opposite shore of Puget Sound, being represented by numerous examples in Prof. Kincaid's collection from the vicinity of Port Townsend. When kept in captivity they can be readily observed opening the mouth widely right back to the commencement of the radial canals and then rapidly closing it again, wrapping the oral lobes into a corkscrew-shaped mass, as Haeckel (18) has represented the oral lobes in his plate of *Polycanna fungina* (pl. xiv. fig. 4). This may be repeated rapidly over and over again. Possessing about an equal number of radial canals and tentacles, this species comes under Haeckel's subgenus *Mesonemella*, but is different from either of his two species *M. eurystoma* and *M. cyaneum* (*Zygodactyla cyanea* of Agassiz). Nor does it agree with Fewkes's new species (13), *M. bairdii*, because in this there are four times as many radial canals as tentacles.

C. TRACHOMEDUSÆ.

I. PETASIDÆ Haeckel.

GONIONEMUS A. Agassiz.

1. GONIONEMUS VERTENS A. Agassiz.

Specific description.—The bell is described by Agassiz as "an oblate spheroid cut in two by a plane passing through the north and south poles, the plane of intersection containing the circular tube." He also gave other features that will be embodied in this account. Preserved specimens are 1.75 cm. tall and 1.50 cm. broad, being about the same size during life. The bell is considerably taller than a hemisphere, is rather thin, and tinged a yellowish green during life. There is a slight conical depression in the roof of the stomach. The velum is well developed and rather broad stretching almost halfway across the opening of the subumbrellar cavity. The tentacles are twice the longest diameter of the bell in length, and look wiry and somewhat heavy for the size of the animal. They show the ringed welts of nematocyst well developed, standing out very prominently. There are no true tentacle-bulbs, the tapering ends of the tentacles being inserted directly in the bell-margin; but below their insertion there are rather large, oval, brown basal papillæ. Some distance from the outer end of

the tentacles there is a little nodule, the glandular sucker. There appears to be a otocyst between each pair of tentacles. The stomach appears quadrate, but is attached only along the lines of the radial canals. The proboscis is of moderate length, bringing the fringed manubrium near the velum. The four radial canals pass to the highest point in the bell and then dip under the conical depression above mentioned. The gonads are a very closely folded band hanging from the radial canals, their free border being longer than the attached border; they are thrown into folds (sinusoidally) backwards and forwards across the radial canals, like a ruffle or frill*.

Colour.—Gonads deep red, the radial canals as deep brownish lines; bell yellowish green.

Habitat.—Gulf of Georgia, collected by Agassiz; Victoria Harbour, collected by Shearer; Matsmets Bay and Puget Sound, collected by Kincaid.

Discussion.—This is the first notice of this Medusa since its discovery by A. Agassiz in the waters of Puget Sound some forty-three years ago. They were found swimming vigorously in groups of threes and fours in the outer part of Victoria Harbour at McCauley's Point, July 14, 1900. It is hard to convey an idea of the remarkable beauty of this animal as it swims with its dark crimson gonads and dense mass of tentacles thrashing the water at every contraction of the bell. Agassiz (2) also states that he never found them swimming singly, but always in numbers. He says:—"It at once attracted my attention by its peculiar mode of moving. I could see these jelly-fishes, with the tentacles spread out to the fullest extent, sinking slowly to the bottom, the disk turned downward; the moment a blade of kelp touches the disk, they stop, bend their tentacles like knees, and remain attached to the sea-weed by means of their lasso-cells, which are arranged in rings scattered thickly over the surface of the tentacles; after remaining attached in this way a moment, with their tentacles extended and mouth turned upwards, they suddenly let go their hold, turn upside down, contract their tentacles to a third of their former length, and begin their upward movement by means of short, rapid jerks, given by the sudden expanding and contracting of the tentacles as they are violently thrown out from the cavity covered by the veil. They keep up this rapid motion until they reach the surface of the water; at the instant the upper part of the disk touches the top of the water, the Medusa inverts itself,

* Haeckel (18) understood this condition to represent lateral diverticula in the radial canals something like those of *Polyorchis*. For this reason he has placed it near *Polyorchis* under the Cannotidae, whereas its true relationship seems to be under the Trachomedusae, as we have arranged it above, and not under the Leptomedusae, although it has undoubted characters of this class. It would seem to be similar to Medusae, like *Laodice*, which do not find a natural place under any of Haeckel's four orders. For Brooks (7) has shown that *Laodice* possesses the true endodermal sense-clubs of the *Trachylinae*, despite the many features that rank it with the Leptomedusae under the *Leptolinae*.

and sinks, with its tentacles fully expanded, until it reaches the bottom, or another piece of sea-weed where it attaches itself, and after remaining suspended a little while, repeats the same operation." Agassiz has emphasised this habit of turning over in the specific name *vertens*. This power of attachment is not, however, due, as Agassiz states, to the lasso-cells, but to a definite structure—an adhesive pad, an enlarged view of which is shown in Pl. XXII. fig. 3, which is situated near the ends of the tentacles, and acts like a sucker, which is sufficiently strong to tear the tentacles without loosening its hold.

This power of attachment must be of great service to the animal, for it prevents its being carried away by any struggling animal it may capture. It is quite probable this Medusa often captures animals fully as large as itself, as it readily tries to digest pieces of meat, almost twice its size, which are dropped into the bell-jars in which they are kept during captivity. These Medusæ seem remarkably hardy and remain alive in small jars of sea-water without change of water for several days.

2. *GONIONEMUS AGASSIZII*, sp. nov. (Plate XXI. figs. 1, 2, & 3, and Plate XXII. fig. 3.)

Specific description.—The bell is 9 by 17 mm., or a little taller than a hemisphere. The subumbrellar surface dips down in the centre forming a gastral cone.

The velum is rather broad, strong, and well developed.

The tentacles are shorter, more numerous than in any other species of this genus described. They number eighty in specimens of the above size. They are inserted into the bell-margin at different levels, giving the appearance of one row above another. In a moderately contracted condition they are not more than two-thirds the diameter of the bell in length. They are much thicker at the base, and taper more gradually towards the tips, than in any of the species already known. Each is provided with a small glandular attachment-pad some distance from the end (Pl. XXII. fig. 3). As already remarked, the proximal end of the tentacle is slightly enlarged just before entering the margin of the bell as in other species. This end of the tentacle is a tapering root connected with the circular canal. Just at the outer margin of the velum, under the circular canal, is a small ridge or welt of ectoderm filled with urticating-organs. It is reddish-brown in colour, the same as the papillæ below.

There are papillæ under the circular canal on the bell-margin, just below the insertion of the tentacles, containing diverticula of this canal. Their outer layer is composed of the same tissue as that composing the nettle-ridge, and of a similar brown colour. There are not so many otcysts as tentacles, though there is no definite regularity. The pigment-spots at the bases of the tentacles are not visible in the preserved condition.

The stomach is much distorted with food, but is of the usual quadrangular shape, with oral lobes finely crenulated. The four radial canals pass from the circular tube upwards to the gelatinous peduncle, under which they pass downwards to the stomach; their crossing lies deeper on this account than the point where they enter the stomach (Pl. XXI. fig. 3). They are simple.

The gonads have the frill-like arrangement on the course of the radial canals, from side to side, similar to their arrangement in other species of this genus, but they are denser and run closer to the circular canal.

Colour.—This is hard to determine from preserved material, but it is doubtless somewhat similar to the bright colours in other species of this group.

Habitat.—Unalaska, Aleutian Is., collected by Kincaid.

Discussion.—Prof. Kincaid states that this species was collected in a small salt lake in the Aleutian Islands, which was doubtless connected directly with the sea by some underground passage, as its surface rose and fell with the tide. These Medusæ were found clinging to stones by means of their attachment-pads, and when disturbed moved a short distance, then re-attached themselves again. This species probably possesses the same swimming-movements so characteristic of the other species of this genus.

As already stated, the genus *Gonionemus* was founded by A. Agassiz for *G. vertens*, which he procured in the Gulf of Georgia, July 1859. The peculiar angle formed by the tentacles being bent at the adhesive pad or sucker was sufficiently striking to suggest the name *Gonionemus* for the genus. Haeckel (18) subsequently, understanding this name to mean "knead threads," changed this to *Gonynema**, under which name it appears in his 'System der Medusen.' The resemblance of *Gonionemus* to *Melicertum* led A. Agassiz to place it with the latter genus in the family Melicertidae, the elder Agassiz (1, p. 348) placing it under the suborder Sertulariæ.

Haeckel (18) arranges four of Agassiz's genera among the Trachomedusæ, but placed *Gonionemus* in the family Cannotidae, subfamily *Polyorchinae*, believing, from Agassiz's description or drawing, that it possessed lateral diverticula on the radial canals as already mentioned.

No further notice was taken of this Medusa until one of the present writers, Murbach (32) published a short preliminary report of the occurrence of the genus in the Atlantic at Woods

* As Agassiz derived the name *Gonionemus* from γωνία and νῆμα, Haeckel's assumption that the first part of the name is derived from γόνυ is wrong, only the last part of his name is right. Yerkes, in a recent paper (Am. Journ. of Phys. vol. vii. p. 181), has changed the name to *Gonionema*, in this being followed by Perkins (Johns Hopkins Univ. Cir., June 1902). Since they correctly derive the first part of the name from γωνία, why does this become *Gonionema* and not *Gonianema* in the full name? In preference to further change we have retained the original name.

Holl, Mass. Here it was represented by what was thought to be a second species. Two years later Dr. Mayer confirmed this opinion, adding that Prof. Agassiz pronounced the Woods Holl form different from the Pacific form *G. vertens*, and Mayer (29) proposed the name *G. murbachii*.

Agassiz and Mayer (3) described a new species, *G. suavensis*, from Suava Harbour, Fiji Islands. Again, Mayer (28) concluded that his *Cubaia aphrodite* was really a species of *Gonionemus*. The development of *Gonionemus* seems to indicate that it belongs to the lower Trachomedusæ; there are also other features that put it in the lower Trachomedusæ, such as the position of the otocysts, gonads, the marginal welt of netting-organs, and the insertion of the tentacles. Until the life-history of one of the species is better known it is difficult for the present to determine its further position.

Provisionally, Haeckel's family Petasidæ, subfamily *Petachninae*, with four radial canals, otocysts either free on the margin or enclosed, tentacles hollow, is best fitted for its reception. It might then be placed between the genera *Aglauropsis* and *Gossea*.

With the exception of the number and position of the tentacles, the above characters are so constant in the four species now known that we can look forward to their being found in all true members of the genus. The position and insertion of the tentacles will vary most.

Only a few Medusæ are recorded, *Bathycodon*, *Pectantis*, &c., in which the ends of some or all of the tentacles are provided with means for clinging to foreign objects. But these are not of the same nature nor in the same position as are the suctorial pads of *Gonionemus*. Recently, Mayer (27) has found a new Medusa, in which every fourth tentacle has an adhesive pad that corresponds somewhat with the position of that in *Gonionemus*, though unlike it in appearance. This Trachomedusa, he thinks, is closely related to *Gonionemus*, and has indicated this in calling it *Gonionemoides*. There is no reason why the presence of these pads, if morphologically the same, may not be one of the marks of relationship. The fact that the young of *Gonionemoides geophila* have pads on every alternate tentacle, not on every fourth as in the adult, may indicate that in the ancestral form they were so arranged. In this case Medusæ having adhesive pads on every alternate tentacle would be more closely related to *Gonionemoides* than to *Gonionemus*, or possibly would be intermediate forms such as *Gonionemus (Cubaia) aphrodite* Mayer, in which every other tentacle possesses an adhesive pad. Behaviour, where it is well marked or there are special habits as in this case, should enter into the characters of the genus or at least the species description. The peculiar habit of swimming to the surface of the water and turning over to float lazily downward is well marked in both *G. vertens* and *G. murbachii*, and we may

expect to find it in the other species when these are closely studied. The four species of *Gonionemus* at present known are as follows:—

1. *Gonionemus vertens* A. Agassiz (2).
2. " *murbachii* Mayer (29).
3. " *suavensis* Agassiz & Mayer (3).
4. " *agassizii*, sp. nov.

In general appearance and structure the four species differ as follows:—

Gonionemus vertens has much the tallest bell and heaviest tentacles, longest digestive cavity, and oval large marginal papillæ.—Pacific.

Gonionemus murbachii has the bell low, the velum well developed, the tentacles very flexible, the proboscis short.—Atlantic.

Gonionemus suavensis differs from the other species in the presence of four green spots on the proximal ends of the radial canals, in the absence of subumbrellar papillæ, and the extent and position of the ovaries.—Pacific.

Gonionemus agassizii has the bell lower than in *G. vertens*, yet taller than in either of the other two species. It has a larger number of tentacles (in fully grown specimens probably over a hundred), which are shorter and smaller than in the other species. The depression in the roof of the stomach is more marked in this species than in the others with the exception of *G. suavensis*.—Pacific.

Species incerta. (Plate XX. fig. 2.)

The following description refers to a peculiar form, a single individual of which was collected by Prof. Kincaid at the St. Paul's Island, Pribyloff Islands. It is very badly preserved, and on this account no definite identification has been attempted.

Description.—The bell is 18 mm. high by 10 mm. broad at its widest part, a little above the region of the velum. The general shape and proportions of the bell are represented in Pl. XX. fig. 2. The bell is drawn in somewhat towards the mouth, and through this the smooth cylindrical proboscis extends a short distance. The proboscis bears four well-marked cylindrical mouth-lobes, one of these being much larger than the others and rolled up on itself, looking like a small contracted tentacle.

Connecting the four radial canals and running in the bell-substance are delicate transverse lines represented in the figure. Some of these are larger than others, and look almost like small connecting canals. The radial canals are thick, and along their

course are numerous irregular masses or enlargements, which may be gonad masses; preservation is not sufficiently good to make certain of this. They are a bright orange-yellow in colour, and become more numerous on the upper part of the radial canals towards the apex of the bell. The four short tentacles are thick and tightly contracted up to their small rounded tentacle-bulbs.

Colour.—Radial canals, and the masses along their course, bright orange-yellow. Proboscis, tentacles, and tentacle-bulbs yellowish brown.

Habitat.—St. Paul's Island, Pribyloff Islands, collected by Kincaid.

D. SIPHONOPHORA.

I. MONOPHYIDÆ Claus.

MUGGIÆA Bausch.

1. MUGGIÆA KOCHII Chun.

Synonym *Diphyes chamissonis* Huxley.

Specific description.—The single specimen obtained is nearer *M. kochii* than any other Monophyid, although not agreeing with Chun's description in all respects. Only one nectocalyx is present and there is no sign of another being detached. It is more pointed at the apex, and the oil reservoir is larger in proportion than those of *M. kochii*. The wings of the nectocalyx are almost smooth, except that portion below the hydræcium which is wavy in outline. The contracted condition of the hydrosoma will not warrant a more definite determination.

Habitat.—Puget Sound, collected by Shearer.

Discussion.—*Muggiæa kochii* is of great interest, as it was from the study of this form that Chun (9) found the interesting life-history of the Monophyids to consist of three generations, in this case of *M. kochii*, *Eudoxia eschscholtzii*, and *Monophyes primordialis*.

Chun's statement (9) that the nectocalyx of *Muggiæa* is very similar to the anterior swimming-bell of *Diphyes* and *Diphyopsis* is confirmed in this case. The position and shape of the parts correspond almost precisely with Mayer's figure (28) of *Diphyes bipartita*, sp. nov. (fig. 114).

In this connection it may be noted that Fewkes (13, p. 834) in a footnote records that "specimens of a *Diphyes* (?) with but one nectocalyx are very common in the Bermudas and Tortugas." Mayer also says he found a *Diphyopsis* which has no posterior swimming-bell, and suggests the possibility that "no such structure exists." May not both these species be *Muggiæa*? The specimen above described differs from Haeckel's (19)

M. pyramidalis in its shorter hydræcium, and from his other species in the toothing.

In addition to the foregoing there are a number of specimens, not in a condition for definite identification or description. So far as can be determined they seem to belong to the following species:—

- Sarsia eximia*. Two specimens
Sarsia rosario. One specimen.
Atollia bairdii. One specimen.
Obelia polystyla. One poorly preserved specimen.

Vanhoeffen (33) gives a good figure of *Atollia bairdii*, with which our specimen seems to closely correspond.

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EXPLANATION OF THE PLATES.

PLATE XVII.

- Fig. 1. *Codonium apiculum*, sp. nov., p. 165.
 2. *Thaumantias cellularia*, p. 172.
 2 a. " " oral lobes expanded.
 2 b. " " oral lobe contracted.

PLATE XVIII.

- Fig. 1. *Tunis brevicornis*, sp. nov., p. 170.
 2. " " view of oral surface.

PLATE XIX.

- Fig. 1. *Mesonema victoria*, sp. nov., p. 180.
 1 a. " " portion of bell-margin.
 2. " " oral surface.
 3. *Polyorchis minuta*, sp. nov., p. 174.

PLATE XX.

- Fig. 1. *Phialidium gregarium*, p. 179.
 1 a. " " crossing of radial canals on stomach-roof.
 2. Species incerta?, p. 188.

PLATE XXI.

- Fig. 1. *Gonionemus agassizii*, sp. nov., p. 185.
 2. " " aboral surface.
 3. " " section of bell.

PLATE XXII.

- Fig. 1. *Polyorchis minuta*, sp. nov., p. 174. Transverse section of a gonad showing the continuation of the cavity of the radial canal into the gonad.
 2. *Mesonema victoria*, sp. nov., p. 180. Section of bell-margin.
 cir.can.=circular canal of bell-margin.
 ect.papil.=excretion papilla.
 ve.=velum.
 3. *Gonionemus agassizii*, sp. nov., p. 185. Attachment pad.
 4. *Codonium apiculum*, sp. nov., p. 165. Section of bell-margin.
 cir.can.=circular canal.
 oc.=ocellus.
 ten.ba.=base of tentacle.
 ve.=velum.
 5. *Codonium apiculum*, sp. nov. Section of stomach.
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November 3, 1903.

Dr. W. T. BLANFORD, F.R.S., Vice-President, in the Chair.

The Secretary read the following reports on the additions made to the Society's Menagerie during the months of June, July, August, and September, 1903:—

The number of registered additions to the Society's Menagerie during the month of June was 200, of which 38 were by presentation, 14 by birth, 10 by purchase, 111 were received on deposit and 27 in exchange. The number of departures during the same period, by death and removals, was 100.

Amongst the additions attention may be called to a fine pair of Grévy's Zebras (*Equus grevyi*), presented by Lt.-Col. J. L. Harrington, C.V.O., C.M.Z.S., on June 5th. There are now in the Society's Gardens one male and three females of this Zebra.

The number of registered additions to the Society's Menagerie during the month of July was 98, of which 46 were acquired by presentation and 10 by purchase, 39 were received on deposit, and 3 were bred in the Menagerie. The number of departures during the same period, by death and removals, was 163.

The number of registered additions to the Society's Menagerie during the month of August was 130. Of these 39 were acquired by presentation and 11 by purchase, 1 was born in the Gardens, 77 were received on deposit and 2 in exchange. The number of departures during the same period, by death and removals, was 180.

Amongst the additions attention may be called to:—

1. Three fine specimens of the Elephantine Tortoise (*Testudo elephantina*), deposited by the Hon. Walter Rothschild, M.P., F.Z.S., on August 8th.

2. An Echidna (*Echidna hystrix*), deposited by the Hon. Walter Rothschild, M.P., F.Z.S., on August 20th.

3. Four Cyprus Spiny Mice (*Acomys nesiotus*), presented by R. L. N. Michell, Esq., on August 27th.

The number of registered additions to the Society's Menagerie during the month of September was 167, of which 43 were by presentation and 5 by purchase, 4 were born in the Gardens, and 115 were received on deposit. The number of departures during the same period, by death and removals, was 142.

Amongst the additions attention may be called to:—

1. Two Masai Ostriches (*Struthio camelus*, var. *massaicus*), presented by A. Marsden, Esq., on September 8th.

2. A fine male Chimpanzee (*Anthropopithecus troglodytes*), deposited by the Hon. Walter Rothschild, M.P., F.Z.S., on September 14th.

3. An interesting collection of animals from the Harrar district of Somaliland, presented by William Northrup McMillan,

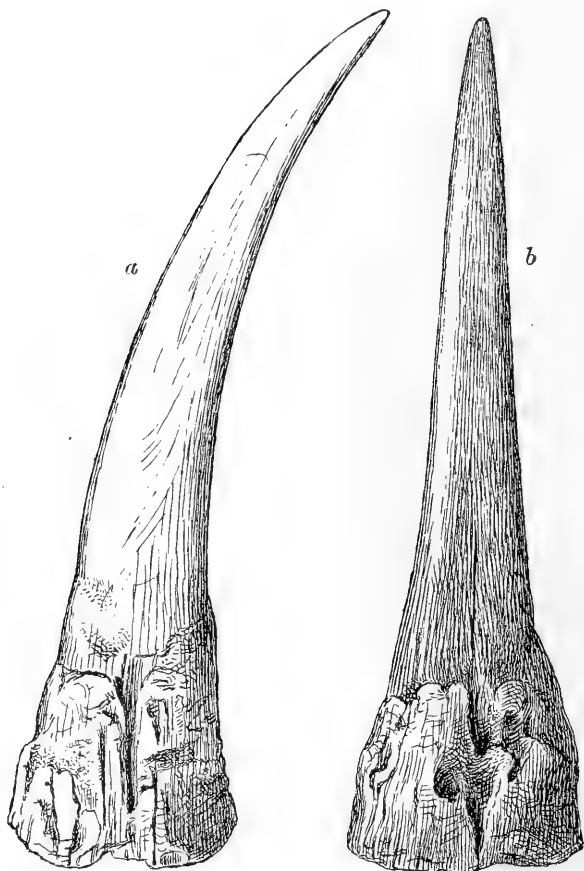
Esq., on September 21st. Amongst these the Abyssinian Duiker (*Cephalophus abyssinicus*) is exhibited for the first time.

4. Two Wagler's Pit-Vipers (*Lachesis wagleri*), presented by A. Herbert, Esq., on September 30th.

Dr. P. L. Selater, F.R.S., exhibited the front horn of a Rhinoceros (text-fig. 21), lately obtained on the White Nile, and made the following remarks:—

“So far as I know, the only specimen of the Square-nosed or White Rhinoceros (*Rhinoceros simus*) obtained anywhere north

Text-fig. 21.



(a) Lateral and (b) front views of horn of Rhinoceros from the White Nile.

of the Zambesi, of which the locality is *absolutely certain*, is the skull of an individual shot by Major A. St. H. Gibbons, F.R.G.S.,

near Lado, on the White Nile, which, by the owner's kind permission, I exhibited at a meeting of this Society on Dec. 18th, 1900 (see P. Z. S. 1900, p. 949). Its identity had been previously established by Mr. Thomas, who had recorded its occurrence in 'Nature' of Oct. 19th of that year ('Nature,' vol. lxii. p. 599). This skull is now, I am informed, in the Carnegie Museum at Pittsburg, U.S.A. The horn of an example of the same species, which I now exhibit, was obtained by my friend Capt. Claude Hawker (Commander of the 10th Soudanese Battalion) from the Belgian Officers at Lado in the autumn of 1902, and was taken from a specimen unquestionably shot in that district, on the left bank of the White Nile. The Belgians did not distinguish it from the ordinary *R. bicornis*, and seemed to believe that all the Rhinoceroses of that district belong to one species.

"The present specimen is a front horn of *R. simus*, or, at any rate, of a closely allied form. It agrees very well with the front horn of the mounted specimen of *R. simus* in the gallery of the British Museum, but is rather longer, measuring 31 inches in a straight line from the base to the end. The front horn of *R. simus* may always be distinguished from the corresponding horn of *R. bicornis* by its broad, flattened surface at the base in front, the basal front of this horn in *R. bicornis* being more or less smooth and rounded and projecting in the centre.

"Capt. Hawker has returned to the Soudan, and will probably visit the southernmost station of the Anglo-Egyptian forces at Mongalla, 15 miles north of Gondokoro, again this winter. I have requested him to obtain further information about this Rhinoceros, and have little doubt that he will do so."

The Secretary exhibited a series of photographs of the Indian Elephant in the act of congress, which had been presented to the Society by Mr. H. Slade, of Rangoon, Burma.

Mr. Henry Scherren, F.Z.S., exhibited some specimens of the Edible Crab (*Cancer pagurus*) and the Lobster (*Astacus gammarus*) showing meristic variations, and made the following remarks:—

"Both these variations are in the left chela. That of the Crab I received from Mr. Arthur Patterson of Yarmouth, in whose name it will be handed over to the British Museum (Natural History). A process grows from the lower edge of the palm, resembling, though not very closely, the fixed and movable fingers. It is, I suggest, a case of a rudimentary extra pair of fingers, of which many examples have been figured by Bateson. The variation in the Lobster, also in the left chela, is more complex. There is a process growing from the upper edge of the meropodite, having three spines round the anterior margin, and a soft, articular membrane arising therefrom. Beyond this is a three-movied process—a duplicate carpopodite, which must have been movable in the living animal. On the normal meropodite,

near the base of the outgrowth, the shell presents an appearance not unlike that of a snail-shell which has undergone repair, so that this variation would seem to lend support to the theory that such duplicate parts may arise from injury. This, however, cannot have been the case. The animal would scarcely have survived such an injury. The specimen was the property of Mr. G. A. Doubleday, who has kindly presented it to the British Museum."

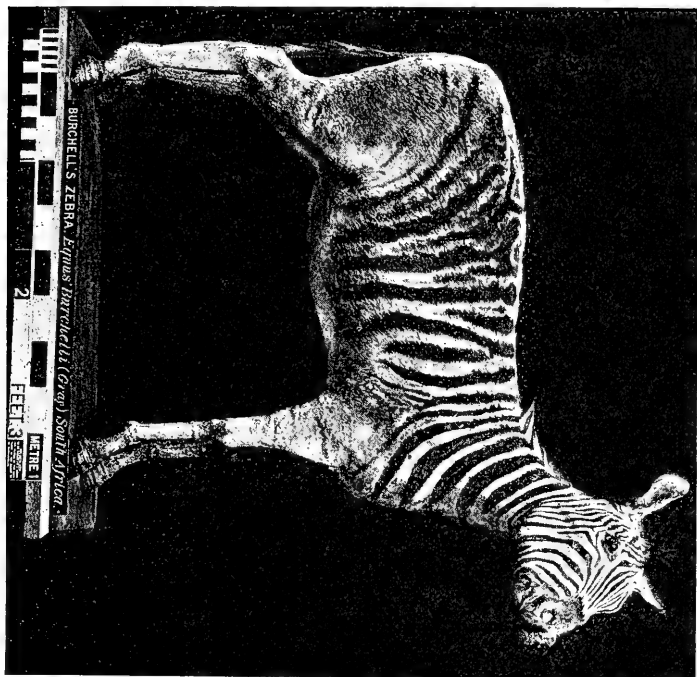
Mr. R. I. Pocock, F.Z.S., exhibited two photographs (text-fig. 22, opposite) of a specimen of Burchell's Zebra which has been preserved for many years in the City Museum at Bristol. The photographs were kindly taken by Mr. William Moline, and every facility for doing so was afforded by the Secretary and Curator, Mr. Bolton, F.R.S.E., with the sanction of the Committee of the Bristol Museum.

The specimen is a small male, probably not quite full-grown, standing 44 inches at the withers. Unfortunately, its locality is unknown and nothing of its history can now be traced. Its importance and interest, however, lie in the fact that it belongs to the typical race of Burchell's Zebra, or, as it should be more properly called, Burchell's Quagga (*Equus quagga burchelli*), which is either extinct as a wild animal or, at all events, verging on extinction. Hence it is desirable that the characters of every specimen now living in captivity or exhibited in museums should be permanently recorded by photography.

A marked difference between the Bristol example and the typical example described and figured by Gray, but now unfortunately lost, is to be found in the distinctness and distribution of the paler, narrower, intermediate stripes. In the specimen sent to the British Museum by Burchell these stripes, as attested by the figure, were long, sharply defined, and extended without a break from the hind-quarters to the head. In the Bristol specimen, on the contrary, they are short and pass from the hind-quarters only halfway along to the shoulder. Owing to scarcity of material of this rare animal, the exact systematic value of this difference is unknown.

Mr. Pocock also exhibited an example of a species of *Notiphilides*, one of the Geophilomorphous Centipedes. The specimen came from Venezuela, and is remarkable for its great length. It measures 283 mm. (or nearly 11 inches) long and 9 mm. (or about $\frac{1}{3}$ of an inch) broad—that is to say, it is, roughly speaking, twice as long as the average-sized specimens of the largest species hitherto recorded.

Mr. Oldfield Thomas, F.R.S., exhibited specimens of three new Mammals, two of them representing new genera, which had been collected by Mr. A. S. Meek in British New Guinea. Besides these new forms Mr. Meek had obtained in the same region examples of several very rare species, such as *Dorcopsis macleayi*,



Text-fig. 22.



Mounted Burchell's Zebra in the City Museum, Bristol.

Phalanger carmelitæ, *Pseudochirus corinnæ*, *Dasyurus albopunctatus*, and *Leptomys elegans*, the last two having been previously unrepresented in the National Museum.

The new forms were described as follows:—

HYOMYS, g. n. (Muridæ).

Size very large; form bulky. Fur coarse and harsh. Feet proportionally short; pollex with a broad nail. Tail of medium length, very coarsely scaled, practically naked. Mammæ 0—2=4.

Skull stout and heavily built. Nasals very broad in front, narrowing rapidly behind to a point. Postorbital processes present, quite separate from the supraorbital ridges, which, though distinct, are not heavily developed. Palatal foramina short; posterior palate cut out to level of front of m.³ Bullæ small, little inflated, each with a raised rim running along its inner margin. Paroccipital processes strongly developed.

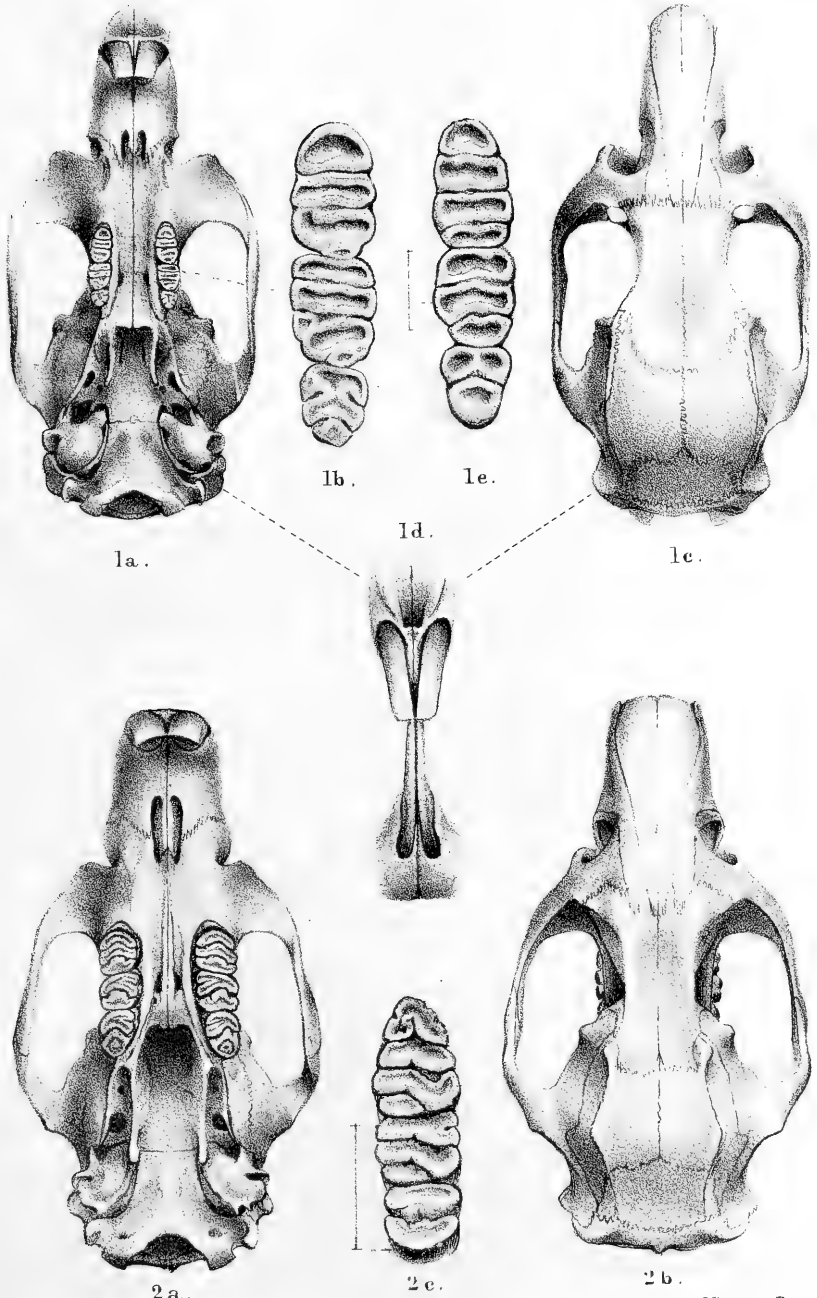
Incisors large, equally broad above and below, and of normal depth. Molars (see Pl. XXIII. figs. 2 a & 2 c) very large and heavy, their length one quarter the basilar length, and their breadth nearly equal to that of the palate between them; very distinctly laminate, though the laminae have got the normal murine curvature. M.² and m.³ each with a well-developed antero-internal cusp so joined with the anterior lamina as to form a distinct Y-shaped structure when worn; no antero-external secondary cusps. M.³ with the posterior overhang very unusually developed. Two anterior lower molars with the normal posterior supplementary cusp very large, so as to form a short extra lamina extending from the centre of the tooth to its inner edge.

Type, *Hyomys meeki*.

This genus was not distinguished by any single character of marked importance, but the gigantic Rat on which it was based could not be referred to any of the known Papuan genera of Muridæ. Its molars, while enormously larger, had the general appearance of those of *Mus* or *Uromys*, and had nothing of what might be called the zigzag character exhibited in *Crateromys*, *Lenomys*, and *Mallomys*, to none of which did it seem specially allied.

HYOMYS MEEKI, sp. n. (Plate XXIII. figs. 2 a-2 c.)

Fur harsh, general body-hairs about 25 mm. in length, but a number of bristles 60 to 70 mm. long intermixed with the shorter fur. General colour dark slaty greyish, the hairs grey proximally, with black or brown ends; longer bristles dark with whitish or buffy ends. Under surface dirty greyish, not sharply defined, the bases grey, the ends dirty buffy. Head like back; whiskers very numerous, stiff, black. Ears short, rounded, naked; a small tuft of whitish hairs above their anterior base. Limbs uniformly brown throughout; upper surface of hands and feet nearly naked, blackish; palms and soles naked, pads broad and fleshy; fifth hind toe reaching to the end of the first phalanx



H.Grönvold del.et lith.

Mintern Bros.imp.

1.ANISOMYS IMITATOR.
2.HYOMYS MEEKI.



of the fourth; claws of medium strength and curvature. Tail about as long as the body without the head, practically naked, the two or three minute hairs which project from below the point of each scale only from $\frac{1}{4}$ to $\frac{1}{2}$ the length of a scale; scales very large, perhaps the largest among the Muridae, only about 5 to the centimetre; arranged diagonally, their points unusually perceptible to the touch. Proximal third of tail black, terminal two-thirds yellow.

Skull and teeth as described above. Posterior ends of nasals just level with those of premaxillary processes. Interorbital region narrow, parallel-sided, strongly concave mesially; its edges raised up into vertical ridges which run backwards to the lambdoid crests, and have two lateral projections, one at the fronto-parietal suture, and the others in the middle of the parietals. Palatal foramina shorter than $m.^1$ and $m.^2$ combined, narrow, parallel-sided.

Dimensions of the type, measured on the skin:—

Head and body 390 mm.; tail 345; hind foot (s. u.) 63; ear (wet) 26.

Skull—greatest length 74 mm.; basilar length 64.5; greatest breadth 41; nasals 28×12.3 ; interorbital breadth 9; interparietal 10.5×14.5 ; palate, length from hensilion 37; diastema 23.3; palatal foramina 8.3×4 ; length of upper molar series 17; breadth of $m.^1$ 5.7; combined breadth of upper incisors 8.6.

Hab. Avera, Aroa River, British New Guinea.

Type. Female. B.M. No. 3.12.1.12. Collected by A. S. Meek. One specimen.

This huge Rat looked not unlike one of the Indian Bandicoot-rats, but had probably no real affinity with them. It was quite unlike anything hitherto described from the Papuan region, except perhaps Dr. Jentink's *Mus armandvillei* of Flores, which differed from it, however, in many details. *Mallomys rothschildi* Thos., another large Papuan rat, had molars of quite a different pattern.

Hyomys meeki was no doubt an arboreal animal, as indicated by its shortened hind feet, and it was probable that the large pointed scales of its tail served a purpose analogous to that of the caudal "climbing-irons" of *Anomalurus*.

ANISOMYS, g. n. (Muridae).

Size large, form less bulky than in *Hyomys*. Fur coarse. Pollex with a broad nail. Tail of medium length, smoothly scaled, thinly hairy. Mammæ 1—2 = 6.

Skull large, stout and heavy. Nasals long, parallel-sided behind and but little broadened in front. Supraorbital region broad, flat, with heavy edges which are continued backward as low, evenly curved ridges to the back of the skull; a vertical postorbital projection connected with the main ridge on each side. Palatal foramina very small. Palate with raised lateral ridges edging it between the foramina and the molars; behind, it extends

some way behind m.³ Bullæ but little swollen. Lower jaw remarkably high anteriorly, the usual deep hollow in front of the molars largely filled up.

Incisors very peculiar in that while the upper ones are of about normal breadth and depth, the lower are quite disproportionally narrow and deep; in most Rodents the upper and lower incisors are of approximately equal transverse dimensions, but here the two lower ones combined are of only the same breadth in front as a single upper one, while in depth the lower teeth exceed the upper by a third, and nearly resemble in shape those of *Daubentonia*. Their roots are carried unusually far up at the back of the jaws, so that their basal inflation is at the level of the yoke between the coronoid and condylar processes. Molars very small, their length less than one-fifth the basilar length, and the palate between them about twice their breadth. Their laminae directly transverse, with simple raised enamel-edges and concave dentine-spaces; last lamina of m.¹ and m.² each with a small additional internal ring inserted in front of it, the homologue of a supplementary cusp; lower molars with four, three, and two simple laminae respectively.

Type, *Anisomys imitator*.

This genus seemed to be even less allied to any known one than *Hyomys*, and it could not be said what were its nearest relations. Perhaps when young specimens were obtained, so that unworn molars could be examined, some light would be shed on this problem. In any case the genus might be readily distinguished by the peculiar characters of incisors and molars above detailed.

ANISOMYS IMITATOR, sp. n. (Plate XXIII. figs. 1 a-1 e.)

Size and other external characters remarkably like those of the large *Uromys* (*U. validus* or *papuanus*), with which it is associated. Fur short and coarse; hairs of back about 10-12 mm. in length, unmixed with longer piles. General colour above coarsely mixed blackish and fawn or buffy, the resulting mixture approaching "mummy-brown" of Ridgway. Under surface dull buffy white, the hairs slightly darker at their bases. Head rather more greyish than back, heavily lined with black. Eyes surrounded by indistinct black rings. Ears of medium size, their fine hairs blackish. Arms and legs dark grizzled grey, the inner sides rather lighter; hands and feet brown, becoming whitish at the ends of the digits; claws rather delicate and sharply pointed; palms and soles naked, with large smooth pads: fifth hind toe reaching nearly to the end of the first phalanx of the fourth. Tail fairly long, set with medium-sized scales set in alternating rows, and averaging about 9 to the centimetre; very thinly hairy, the short whitish hairs becoming rather longer towards the tip; its colour dark brown for its basal fourth, the remainder yellowish white.

Skull smooth and rounded; nasals and premaxillary processes

of about equal extent; interorbital region broad, scarcely concave, its edges thickened, but without distinct beading; palatal foramina minute, narrow, of about the same length as m^2 ; anterior palate concave mesially, with swollen ridges laterally; posterior palate extending behind m^3 a distance equal to the length of m^2 . Bullæ small, smooth.

Dimensions of the type, measured in skin :—

Head and body 300 mm.; tail 320; hind foot (s. u.) 60; ear 24.

Skull—greatest length 68 mm.; basilar length 65; greatest breadth 35; nasals 27×8.6 ; interorbital breadth 11.3; interparietal 8.3×14.5 ; zygomatic plate 9.2; palate, length 33; diastema 20; palatal foramina 3.7×3.1 ; length of upper molar series 10.2, breadth of m^1 3.1. Upper incisors, combined breadth 4.7, depth 4.9; lower incisors, combined breadth 2.4, depth 5.3.

Hab. Avera, Aroa River, British New Guinea.

Type. Male. B.M. No. 3.12.1.10. Collected by A. S. Meek. Two specimens, male and female.

So like was this Rat to the large Papuan *Uromys*, of which Mr. Meek also obtained examples, that it was taken for the same species until a closer examination showed its many peculiar characters. Externally, indeed, it could only be distinguished by its rather darker colour and its slightly hairy tail.

It would be of interest to find out what this Rat fed on to account for the peculiarities of its dentition. Perhaps hard-shelled nuts, such as cocoanuts, might demand these powerful cutting-incisors, while the small and delicate molars would be sufficient to deal with the soft contents.

PERAMELES ORNATA, sp. n.

A small species with prominent black markings.

Essential characters all very much as in *P. longicauda* Peters & Doria*, to whose immediate neighbourhood it is brought by all the characters used in the synopses of species, both external and cranial, of the 'Catalogue of Marsupials'†. Coloration, however, quite unique, for with a pale brown general body-colour there is a prominent deep black mesial line running from the muzzle down the back to the base of the tail; this line commences between the eyes, broadens to about half an inch on the crown and nape, narrows on the anterior back, and broadens again on the rump. Through each eye there is also a black streak, starting at the root of the whiskers, and running to the base of the ears; between the median and lateral dark bands the head is grizzled whitish. Under surface dull creamy whitish throughout, not sharply defined laterally. Rump with an additional black line on each side, running downwards parallel to the mesial line and passing on to the back of the hind legs. Ears of medium length, rounded, dark brown, a small blackish mark behind their posterior bases; metatragus short, triangular. Arms

* Ann. Mus. Genov. xvi. p. 672 (1881).

† P. 229 (1888).

and legs dark brown externally, grizzled whitish internally; upper surface of hands naked, flesh-coloured, of feet pale brown, lightening terminally to whitish; soles quite naked, finely granulated. Tail long, finely haired, yellow for its terminal two inches and along its under surface; the remainder dark brown.

Skull and teeth agreeing word for word with the description of those of *P. longicauda* given in the 'Catalogue of Marsupials.'

Dimensions of the type, measured in skin:—

Head and body 300 mm.; tail 177; hind foot (s. u.) 59; ear (wet) 28.

Skull—basal length 57.2 mm.; greatest breadth 23.3; nasals 27×5.2 ; interorbital breadth 12.8; palate, length 37; combined length of three anterior molariform teeth 10.

Hab. Avera, Aroa River, British New Guinea.

Type. Adult male. B.M. No. 3.12.1.23. Collected by A. S. Meek. One specimen.

In the conspicuous striping of its dorsal surface this handsome species differed from all known Bandicoots, though it was possible that when dried skins of *P. longicauda* were examined, some indication of a similar pattern of coloration would be found to exist in that animal.

EXPLANATION OF PLATE XXIII.

- Fig. 1 *a.* *Anisomys imitator* (p. 200). Lower view of skull, natural size.
 1 *b.* " " " Left upper molar series, $\frac{4}{5}$.
 1 *c.* " " " Upper view of skull.
 1 *d.* " " " Front view of incisors.
 1 *e.* " " " Right lower molar series, $\frac{4}{5}$.
 2 *a* & 2 *b.* *Hyomys meeki* (p. 198). Lower and upper views of skull, natural size.
 2 *c.* *Hyomys meeki* (p. 198). Right lower molar series, $\frac{2}{3}$.

The following papers were read:—

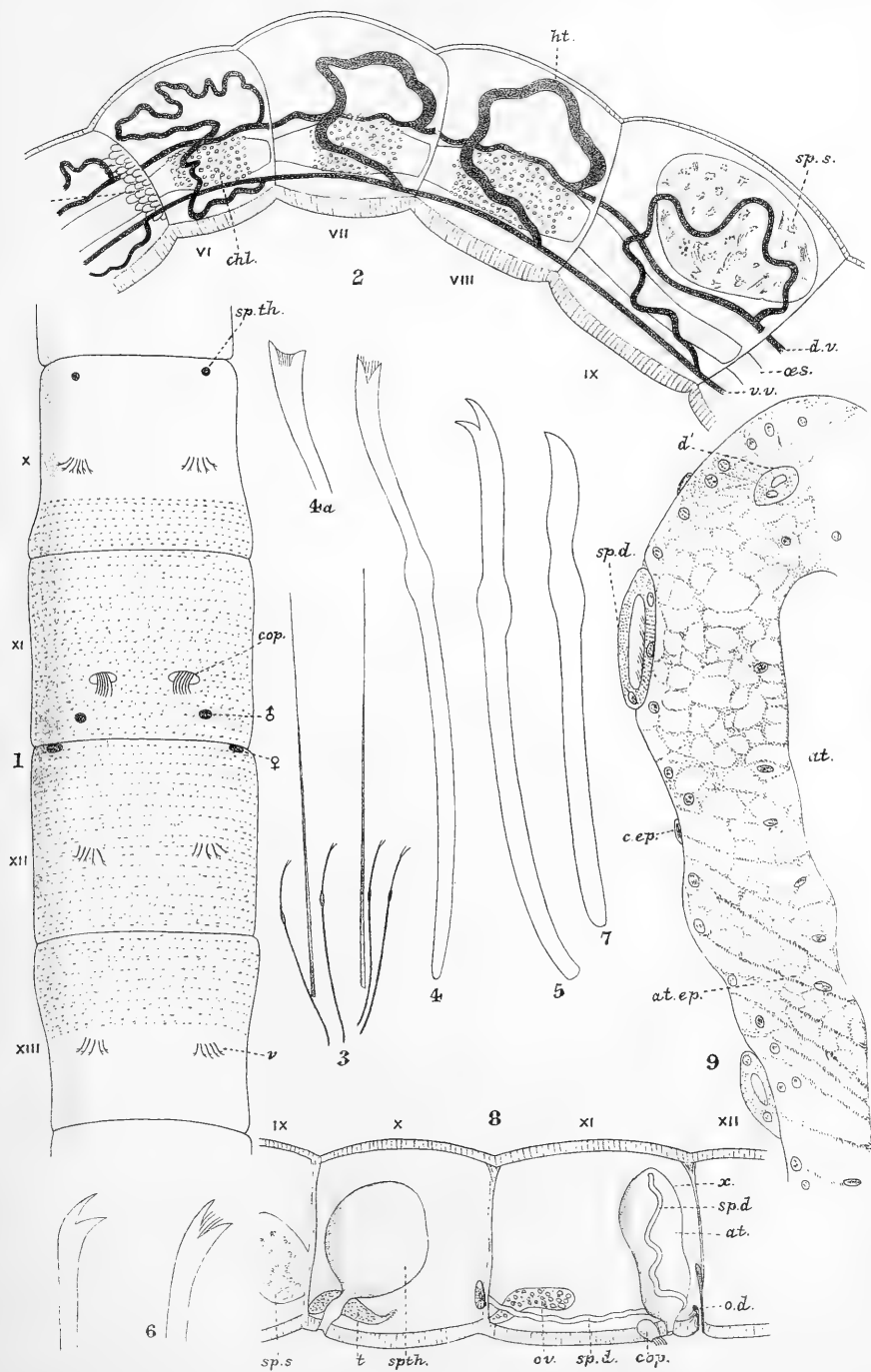
1. On some new Species of Aquatic Oligochæta from New Zealand. By W. B. BENHAM, D.Sc., M.A., F.Z.S., Hon. M.R.S. Tasm.; Professor of Biology in the University of Otago.

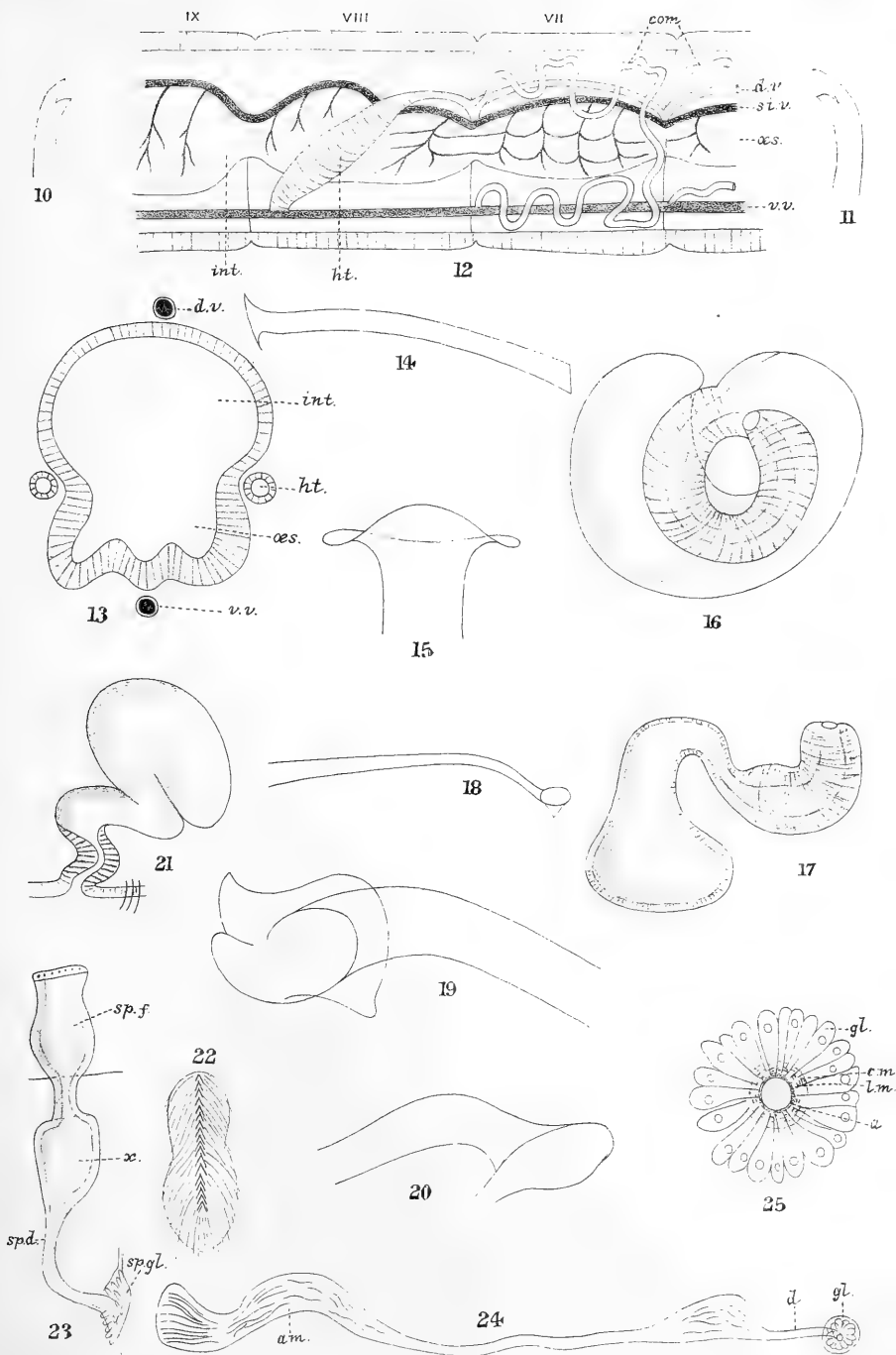
[Received July 24, 1903.]

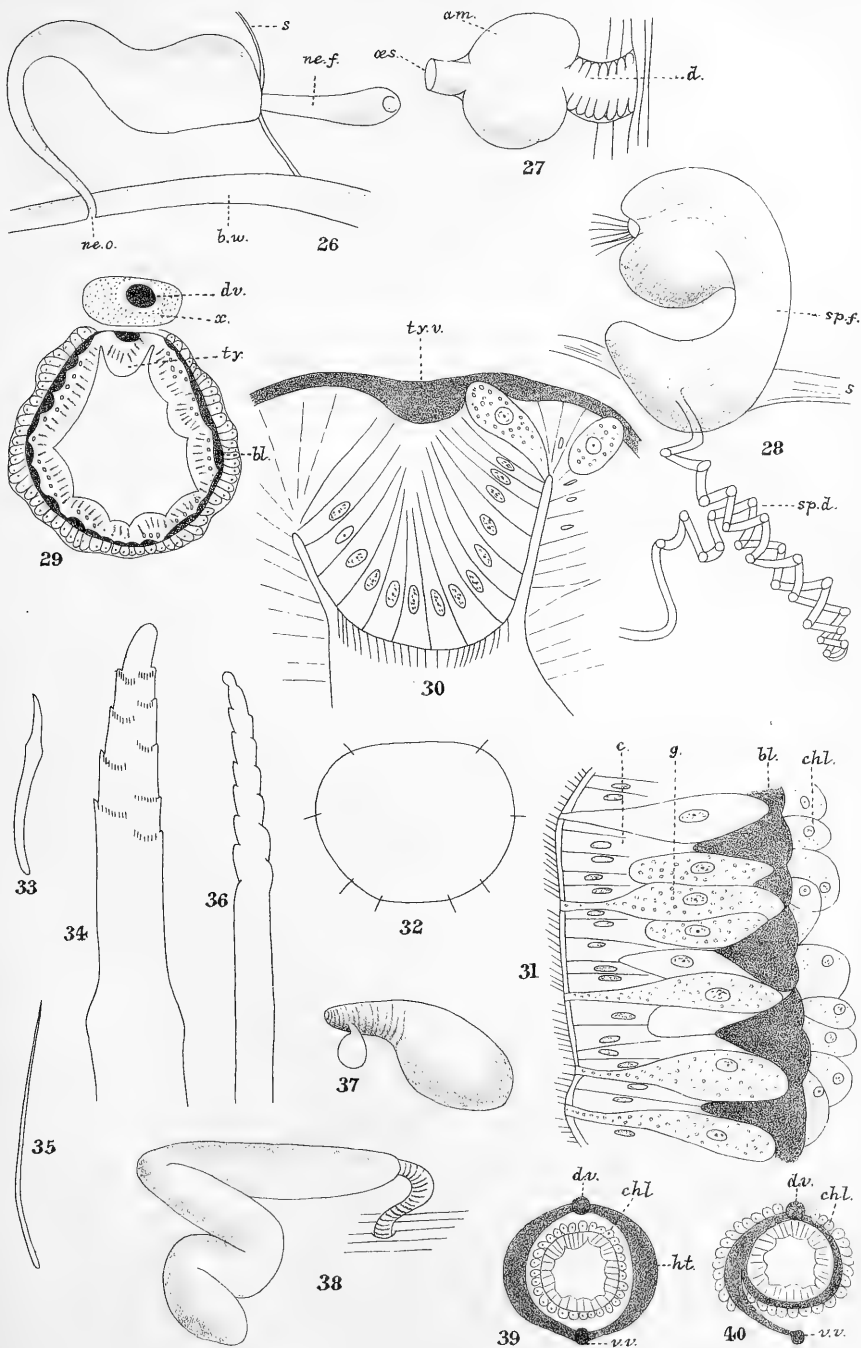
(Plates XXIV.—XXVI.* and Text-figure 23.)

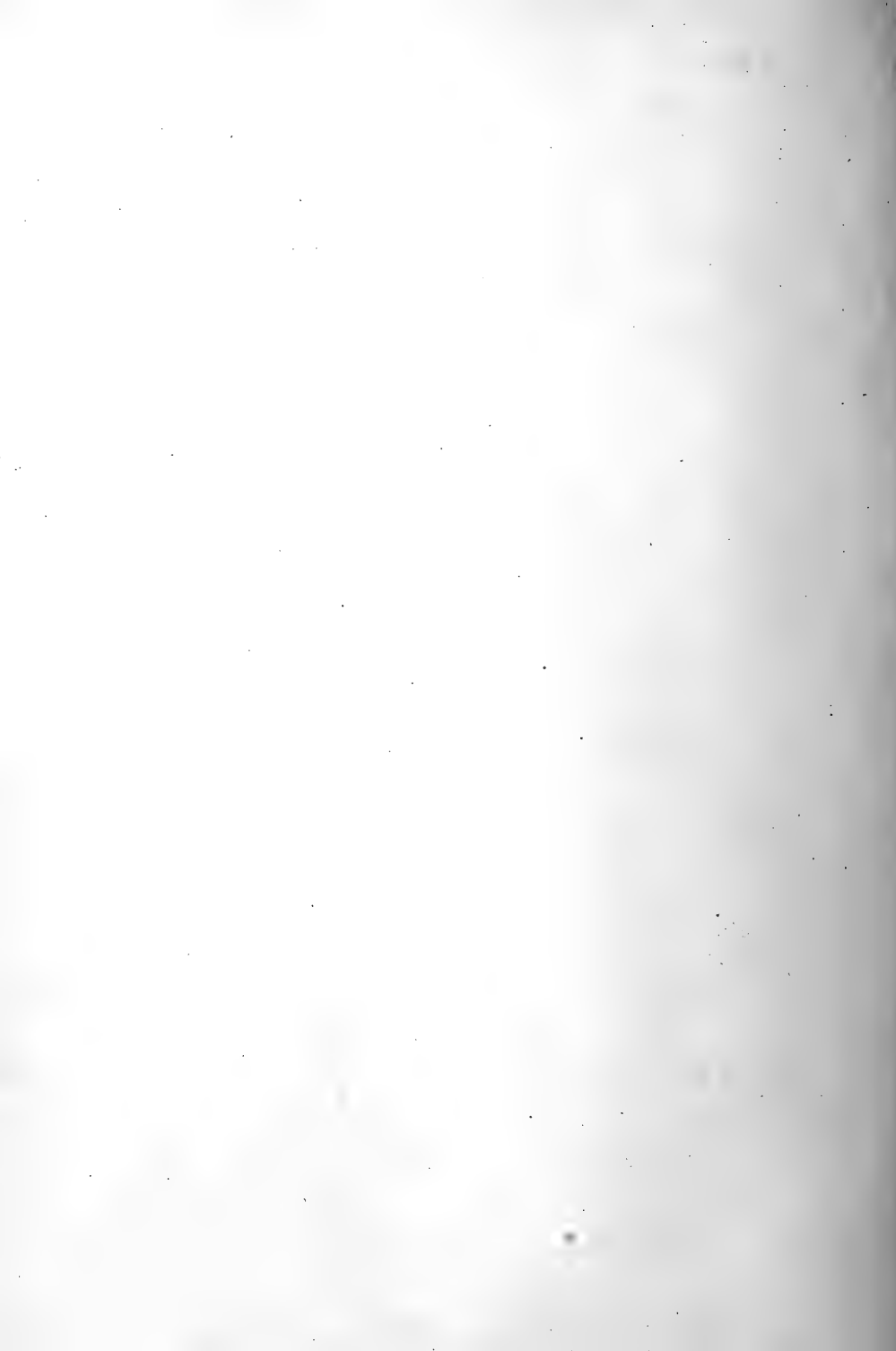
In the course of a biological survey of the New-Zealand lakes undertaken, during the year 1902, by Messrs. K. Lucas and Hodgson, of Cambridge, a considerable number of specimens of Oligochæta were obtained which were placed in my hands for identification. My best thanks are due to Mr. Lucas for his

* For explanation of the Plates, see pp. 231, 232.









generosity in thus affording me an opportunity, for many years to come likely to remain unique, of examining the deep-water Oligochæta of our lakes.

In view of the extremely interesting character of the terrestrial Oligochaetes of New Zealand, both from a morphological and a zoo-geographical aspect, it seemed probable that our deep lakes of the South Island would contain equally interesting species; but the result of my investigation, though not wholly without interest, is rather disappointing. For, whereas our terrestrial fauna includes several endemic genera, like *Maoridrillus*, *Plagiochæta*, *Neodrillus*, *Deinodrillus*, and *Octochaetus*, our lacustrine genera are, with one exception, of an exotic character; and even the single new genus that I have ventured to create, viz. *Taupodrillus*, is very near akin to a European worm, *Branchiura coccinea* of Vejdovsky.

But amongst the new species that are here enumerated, some are of considerable interest. Of the genus *Phreodrillus* Beddard, originally founded for a New-Zealand worm, but now extended to include certain South-American aquatic species previously placed by Beddard in the genus *Hesperodrillus*, I find two new representatives: one of which is "Hesperodrilid" in the nature of the male efferent apparatus, and therein agreeing with the Kerguelen-Island form and South-American species, rather than with the original representative from New Zealand. This genus thus has a distribution similar to that of our earthworms belonging to the genus *Notiodrilus*.

Two other species deserve mention here: *Diporochæta aquatica*, sp. n., and *Plutellus lacustris*, sp. n., for both of these genera are characteristically Australian.

The genus *Diporochæta* was founded originally by Beddard for *D. intermedia* from Lake Brunner in this colony; but it has now been extended so as to include a number of Australian species, and hitherto Beddard's species has been the only representative on this island. It is worth noting that both our species occur in water, whereas the majority of the species are terrestrial.

As to *Plutellus lacustris*, it differs from the rest of the species in certain characters, viz., the loss of gizzard, and the absence of nephridia in the pregenital segments; and at first I was inclined to form a new genus for it, but these features, in which it approaches *Pontodrillus* (an inhabitant of the sea-shore in various parts of the world), appear correlated with an aquatic habit.

These two genera, *Diporochæta* and *Plutellus*, belong to the subfamily Megascolecinae, and they are the only representatives of this subfamily in New Zealand. It is true that Schmarda attributed *Notoscolex* (*Hypogæon*) *orthostichon* to New Zealand, but this appears to have been due to an error—to a *lapsus calami*. He gives as the locality "Mt. Wellington": now, there is no such mountain in the district visited by Schmarda in New Zealand, but he did visit Mt. Wellington at Hobart, Tasmania; and there is no doubt in my mind that he obtained "*H. orthostichon*" in

Tasmania, and not in New Zealand, for the genus *Notoscolex* is common in the former locality, and has never been recognised amongst the numerous collections of New-Zealand worms examined by Beddard or by myself.

Again, Baird described "*Megascolex antarcticus*" from New Zealand—this in all probability should be placed in my genus *Plagiochaeta*. With these two doubtful exceptions, then, the only representatives in the New-Zealand area of the extensive sub-family Megascolecinae are:—

Diporochaeta intermedia Beddard,

D. chathamensis Benham,

D. aquatica, sp. n.,

and *Plutellus lacustris*, sp. n.;

and the occurrence of these four species is rather difficult of explanation, for the subfamily is characteristic of Australia, and, if we except the Malayan *Pheretima*, is almost confined to Australia and Ceylon.

The remaining species belong to common and probably widespread aquatic genera, viz., *Limnodrilus*, *Tubifex*, *Enchytræus*, *Achaeta*, and *Haplotaxis*.

Of the first two genera, representatives have already been referred to by Beddard as occurring in this colony, but no description of the species has been published. Of the *Enchytræidæ* Beddard* has recorded *Henlea ventriculosa* and *Fridericia galba* (= *F. antarctica* Bedd.), both of which are terrestrial species living in swampy places; while of *Haplotaxis* we already know *H. smithi* Beddard from this country.

A special interest appears to be connected with some of the new species described in this paper, in that they were obtained from very considerable depths; at any rate the soundings given by Mr. Lucas for the hauls enumerated below imply that the worms were obtained from the bottom, and, moreover, the intestine is loaded with mud- and diatom-valves; although I do not know what means, if any, were employed to prevent the entrance of organisms as the dredge was pulled up through the water. The absence from this collection of the families *Naididæ*, *Æolosomatidæ*, and *Lumbriculidæ* seems to indicate that some such means were employed, as these families occur in shallower waters amongst water-weeds; and representatives of *Naiids* and *Lumbriculids* do occur in New Zealand, as I have collected them in the neighbourhood of Dunedin, but I have not yet worked them out.

*List of Worms obtained by Mr. K. Lucas, and described
in the present paper.*

Fam. PHREODRILIDÆ.

1. *Phreodrilus lacustris*, sp. n.
2. *P. maurianus*, sp. n.

* Beddard, Proc. R. Phys. Soc. Edinb. xii. p. 41.

Fam. TUBIFICIDÆ.

3. *Taupodrilus simplex*, gen. et sp. n.
4. *Limnodrilus vejdoskyanus*, sp. n.
5. *L. lucasi*, sp. n.
6. *L. sp. inc.**
7. *Tubifex sp. inc.**

Fam. ENCHYTRÆIDÆ.

8. *Enchytræus simulans*, sp. n.
9. *Achæta maorica*, sp. n.

Fam. HAPLOTAXIDÆ.

10. *Haplotaxis heterogyne*, sp. n.

Fam. MEGASCOLECIDÆ.

Subfam. MEGASCOLECINÆ.

11. *Diporochæta aquatica*, sp. n.
12. *Plutellus lacustris*, sp. n.

The total number of individuals examined is about 150, and these were obtained at 27 stations in six lakes; of which two are in the South Island, and four in the North Island.

The following table shows the distribution of the above species in these lakes, the depth at which they were obtained, and the number of stations at which each species occurred.

Table showing Distribution of the Worms.

Name.	No. of Specimens.	No. of Stations.	Lake.	Depth in feet.
<i>Phreodrilus lacustris</i>	16	{ 4	Wakatipu.	300-1000
<i>mauianus</i>	1	{ 1	Manapouri.	150-500
<i>Limnodrilus vejdoskyanus</i> .	30†	1	Taupo.	150-500
<i>lucasi</i>	many	{ 1	Waikare.	9
<i>sp. inc. (A)</i> ...	1	{ 1	Taupo.	300-450
<i>" " (B)</i> ...	1	{ 1	Rotoiti.	100-228
<i>" " (C)</i> ...	1	1	Wakatipu.	1000
<i>sp. inc. (A)</i> ...	1	1	Manapouri.	150-500
<i>" " (B)</i> ...	1	1	Waikaremoana.	200-750
<i>Tubifex sp. inc.</i>	1	1	Taupo.	150-500
<i>" "</i>	2	1	Rotoiti.	100-228
<i>" "</i>	1	1	Waikaremoana.	200-750
<i>Taupodrilus simplex</i>	6	2	Manapouri.	10-1000
<i>" "</i>	11	2	Taupo.	150-500
<i>" "</i>	1	1	Waikare.	9
<i>Enchytræus simulans</i>	7	1	Taupo.	?
<i>Achæta maorica</i>	1	1	Manapouri.	350
<i>Haplotaxis heterogyne</i>	2	1	Wakatipu.	550
<i>Diporochæta aquatica</i>	2	2	Manapouri.	350-550
<i>Plutellus lacustris</i>	17‡	7	Wakatipu.	300-1200

* The specimens being immature are not named.

† Together with six immature specimens probably of this species from Waikaremoana, 800-840 ft.

‡ Also some cocoons, which appear to belong to this worm.

Analysis of the Oligochaete Fauna of each of the Lakes.

Lake Wakatipu, South Island.

Greatest depth, 1242 feet.

Number of stations at which worms were obtained, 10.

Total number of specimens, 37.

The commonest worm appears to be *Plutellus lacustris*, which was obtained from 7 stations at different parts of the lake, so that it is evidently widespread throughout; but it appears to be limited to this lake, as none were obtained elsewhere.

Phreodrilus lacustris also occurred at three stations, and appears to be somewhat less widely distributed, though living at the same depth. *Haplotaxis heterogyne* was obtained only at one station, and a single undetermined immature specimen of *Limnodrilus*.

Lake Manapouri, South Island.

Greatest depth, 1458 feet.

Number of stations, 6.

Number of specimens, 16.

This, the deepest lake, so far as this survey is concerned, contained a greater variety of Oligochaetes than any of the other lakes, for it yielded 6 genera.

Phreodrilus lacustris and *Taupodrilus simplex* account for twelve out of the sixteen specimens; the former was obtained once only, the latter at two stations. At two other stations *Diporochæta aquatica* and at another *Achaeta maorica* were captured, while an immature *Limnodrilus* completed the list.

Lake Taupo, North Island.

Greatest depth, 534 feet.

Number of stations, 4.

Total number of specimens, 32.

Taupodrilus simplex and *Limnodrilus lucasi* account for more than two-thirds of the total, the former occurring in two hauls, the latter in one only. With the former, *Phreodrilus mauianus* was obtained, while at another spot *Enchytræus simulans* occurred, and an undetermined species of *Tubifex* completes the list.

Lake Rotoiti, North Island.

Greatest depth, 228 feet.

Number of stations, 2.

Number of specimens, many.

This lake is characterised by *Limnodrilus lucasi*, of which 3 or 4 dozen were obtained at one spot; while at the other station immature specimens of *Tubifex* occurred.

Lake Waikaremoana, North Island.

Greatest depth, 846 feet.

Number of stations, 3.

Number of specimens, 16.

Unfortunately these were very poorly preserved, much broken

and immature specimens of *Tubifex* sp. and of *Limnodrilus*, amongst which some appear to be *L. vejdoskyanus*.

Lake Waikare, North Island.

Greatest depth 9 feet. Only one haul was taken, which yielded numerous specimens of *Limnodrilus vejdoskyanus* and one individual of *Taupodrilus simplex*.

It will thus be seen that the lakes in the North and South Island respectively differ considerably in their Oligochætes, so far as research has yet gone.

The two species of *Phreodrilus* are very distinct, one confined to the north, and the other evidently common in the southern lakes.

Of *Taupodrilus*, the northern and southern representatives may be distinct, though I have included them in the same species, as the southern material was not in sufficiently good condition to permit me fully to investigate the details of the reproductive organ.

Unfortunately the southern representatives of *Limnodrilus* are immature, but they appear to differ in the form of their chætæ from each of the northern species, *L. vejdoskyanus* from Waikare and *L. lucasi* from Taupo.

PHREODRILUS LACUSTRIS, sp. n.*

A very narrow worm in which the ventral chætæ are in couples of two kinds: each couple consists of (a) a simple hook-like bristle and (b) a hook with a very minute tooth in the back. These chætæ measure 0·06 mm. in length.

The ventral chætæ are absent on segments xii., xiii., though on the latter segment they are replaced by special copulatory chætæ.

Dorsal chætæ solitary, capilliform, beginning on segment iii.

The *chitellum* covers the hinder part of segment xii. and the whole of xiii.

The *male pores* are in line with the ventral chætæ at the hinder margin of segment xii.

The *oviducal pores* are in the same line, at the boundary of segments xii./xiii.

The *spermathecal pores* are in line with the ventral chætæ at the anterior margin of segment xiii.

Copulatory chætæ, a pair of couples; each pair in a special ovoid glandular follicle just behind the spermathecal pore.

The *preclitellar nephridium* appears to extend through segments vii. to x.

No sperm-sacs; but loose developing spermatozoa in segments viii. to xii.

Spermiducal gland of large size, filling segment xii., slightly convoluted, receiving the sperm-duct at its short, narrow neck, where it enters a large protrusible penis, enclosed in a muscular

* A detailed account of this species has been sent to the Editor of the Quart. Journ. Micros. Sci.

penial sac. There is no atrial sac, and the atrium itself is not longer than the penis. In its general arrangement it resembles the apparatus in *Hesperodrilus albus* of Beddard.

The *spermathecae* (one pair) extend through segments xiii. to xv.; the pore leads into a very slightly dilated muscular duct which soon becomes narrow and is much arched dorsally; on passing through the septum xiii./xiv. the duct, still narrow, becomes glandular, and then opens into the ampulla, which occupies the hinder part of segment xiv. and the whole of segment xv.

Dimensions. 20 mm. \times $\frac{1}{4}$ mm. 75 segments.

Localities. Lakes Manapouri and Wakatipu, South Island of New Zealand.

Remarks.—This worm agrees closely with those South-American worms for which the genus *Hesperodrilus* was founded by Mr. Beddard*; but Dr. Michaelsen† has shown good reason for merging this genus with *Phreodrilus* owing to the discovery, in Kerguelen, of a worm which in certain respects presents the characters of both the genera.

The discovery in New Zealand of two new species, this and the following, belonging to the section of the genus hitherto found in the Falkland Islands, South America, and Kerguelen, is a most interesting additional fact in our knowledge of the geographical distribution of the Southern Oligochaeta.

PHREODRILUS MAUIANUS‡, sp. n.

This new species is founded on a single immature individual, which, however, differs from any hitherto described.

The ventral chaetae are, as usual, of two kinds, one of each in each bundle, viz.—(a) a simple hook-shaped, single-pointed bristle, and (b) a similar bristle with a very distinct tooth on its upper, convex, surface. These chaetae measure 0.15 mm., and are thus much longer than those of the species just described.

The dorsal chaetae are capilliform, solitary, and commence in segment iii.

The oesophagus is narrow up to segment vi., where it dilates, and is then constricted by the following septa. In the middle of segment ix. the gut presents a slight constriction, and the epithelium suddenly changes in its character—the oesophagus passing suddenly into the intestine. The dorsal vessel lies free of the gut in segment x. and forwards; a supra-intestinal vessel is recognisable in segments vii. to xv. An enlarged commissural vessel exists in segment x., and a contorted, swollen, heart-like organ in the following segment (xi.), which appears to be connected

* Beddard, Ann. Mag. Nat. Hist. (ser. 6) xiii. p. 206; & Ergeb. Hamb. Magalhaen. Sammelreise, 1896—"Naid. Tubificid. u. Terricolen," p. 9.

† Michaelsen, Oligoch. d. deutsch. Tiefsee Exped. 1902.

‡ The specific name "*mauianus*," in which the syllable *au* has the sound of *ow* in *cow*, refers to the mythical Hercules of the Pacific, known to the Maoris as Maui. The North Island of New Zealand owes its origin to Maui, who, while fishing from a boat at sea, hauled up the land at the end of his fishing-line. Hence the original Maori name for this island was "Te ika a Maui"—the fish of Maui.

with the supra-intestinal vessel. As I have studied the specimen only as an entire object, I cannot say anything as to the structure of this organ, but it seems to resemble in its external features the "blood-gland" which Beddard describes as occurring in segments xii., xiii. in *P. subterraneus*.

Dimensions. 15 mm. $\times \frac{3}{4}$ mm. It is much stouter than *P. lacustris*, and consists of 70 segments.

Locality. Lake Taupo, North Island, New Zealand.

TAUPODRILUS, gen. nov.

TAUPODRILUS SIMPLEX, sp. n. (Plate XXIV. figs. 1-9.)

Of this worm I found about a dozen individuals, most of which are only the anterior ends, and a few are entire. They are all much coiled, rendering it a matter of some difficulty to make sagittal sections.

The following account is based on the study of three individuals, more or less sexually mature, stained and mounted in Canada balsam, and a series of longitudinal sections through the anterior segments, and transverse sections of the middle region, in addition, of course, to the usual glycerine and potash preparations.

The *prostomium* is conical and relatively long.

Chætæ.—The dorsal bundles consist of capilliform (at any rate in the anterior segments), accompanied by bifurcate chætæ (Pl. XXIV. fig. 3), with a few delicate intermediate teeth. Such chætæ may be termed "multidentate" or "ctenate," and occur also in *Tubifex rivulorum*.

The ventral bundle consists almost wholly of crochet-shaped chætæ, with intermediate teeth. In the dorsal bundle there are one or two capilliform and usually three or four ctenate chætæ (in one individual the former were only present on segments v., vi., vii.; in another they did not begin till the fourth segment, and in one specimen I was unable to detect them), and typically they occur only on the first 12 to 15 chætigerous segments.

In the "ctenate" set the chief teeth or prongs are scarcely curved (Pl. XXIV. figs. 4, 4a), and the number of intermediate teeth varies from two or three to several; usually they all separate, but in a few instances a delicate striated membrane unites the chief teeth as in "*Psammoreyctes*." The dorsal chætæ of segment ii. are smaller than the rest.

In the ventral bundle there are from 4 to 6 chætæ in the anterior segments, diminishing to 3 or 4 in the mid-body. The chief teeth are curved as in normal forked bristles or crochets; the upper tooth is less stout than the lower, and over the greater part of the body the two teeth are of the same length, but in the anterior segments the upper tooth is slightly the longer (Pl. XXIV. figs. 5, 6). Generally, all the crochets in a bundle have intermediate teeth, which lie in a different plane from the main teeth; but in the anterior segments a minority in each bundle are normal crochets.

The *clitellum* envelops the body, and extends over three segments, from the middle of x. to the middle of xiii. (Pl. XXIV. fig. 1).

The *male pores* are near the posterior margin of segment xi. and lie outside the line of ventral chaetæ, which in this segment are modified to form a bundle of copulatory bristles.

The *oviducal pore* is at the anterior margin of segment xii., practically intersegmental, and further laterad than the male pores.

The *spermathecal pores* are close to the anterior boundary of segment x.

Internal Anatomy.

The pharynx, in segment iii., is provided with the usual dorsal, ciliated pouch, whence radiating muscles pass to the body-wall. The œsophagus is quite narrow; the chloragogen cells begin in segment vi.; the gut suddenly enlarges in the tenth segment, and food occurs there consisting, amongst other things, of diatom-valves; this intestinal region is thereafter wide, but septally constricted.

The *Vascular System*.—The dorsal vessel is distinct throughout the body; it is connected with the ventral vessel by undulating commissurals in each of the segments ii. to x., while the dorsal vessel bifurcates in the first segment, and each branch passes forwards into the prostomium, bends downwards and backwards to unite to form the ventral vessel in segment ii.

Of the commissural vessels, those in segments vii. and viii. are slightly larger and less extended than the rest; they, however, are not dilated to form "hearts" such as occur in *Limnodrilus* and other Tubificids (Pl. XXIV. fig. 2). A pair of vessels passes backwards on the sperm-sacs to segment xvii., but as to the exact origin of them, or whether there is a second pair supplying the ovisacs (as in *Branchiura coccinea*), I am unable to ascertain. Nor can I state whether any of the commissurals connect with the supra-intestinal vessel which is present in at least part of this region. I have not been able to detect any integumental vessels, either in sections, or in the glycerine and potash preparations. I do not think they exist.

The *Reproductive System* (Pl. XXIV. fig. 8).—The testes, ovary, and oviducts are in the positions usual in this family.

There are two pairs of sperm-sacs, one in segment ix., the other extending through segments xi. to xvii. and constricted by each septum through which it passes, while segment x. is filled with loose masses of developing spermatozoa, not enclosed in a special sac. Large ova, contained in an ovisac, occupy segments xvi., xvii., xviii., in one specimen; but in another, in which the sperm-sacs are not so extended, the ovisac is not so far back.

The condition of the male efferent apparatus is the most interesting feature of this new genus.

The sperm-funnel, on the hinder wall of segment xi., is flat and

moderately extensive. The sperm-duct is comparatively thick; it passes below the ovary nearly directly backwards to the hinder septum of the twelfth segment; there it makes a single loop round the neck of the atrium, and then runs up it to enter its distal extremity.

This atrium (or spermiducal gland—for it is both) is a large pyriform or sausage-shaped sac, with a capacious cavity; its broader end is directed upwards, its narrower end is suddenly constricted to form an extremely short and narrow duct, just long enough to pass through the body-wall. In its microscopic structure the atrium presents what is probably to be regarded as an archaic character; at any rate, it is simpler than that of any Tubificid hitherto described. The epithelium consists of a single layer of tall, glandular, and much vacuolated cells, outside which is a thin peritoneal membrane with flat nuclei (Pl. XXIV, fig. 9). There is apparently no muscular coat, except for a few circular fibres near its lower end where it is about to penetrate the body-wall.

In the figure (fig. 9, which is drawn under a camera, and represents as accurately as may be the arrangement of the nuclei and vacuolation of the cytoplasm) two kinds of nuclei are to be seen in the epithelium: most of them are circular and situated towards the outer surface of this epithelium; others, however, are oval, elongated in a direction vertical to the surface, these lie nearer the inner ends of the cells. These latter suggest a columnar epithelium distinct from the gland-cells; but I have been unable to detect any cell boundaries corresponding to these oval nuclei, which, moreover, are not arranged in close array to suggest an epithelium. It may very well be, however, that some of the epithelial cells are short and have not become glandular.

The sperm-duct opens into this atrium at its apex, *i. e.* at the point furthest from the external opening. In this feature it bears a nearer resemblance to *Branchiura coccinea* than to *B. sowerbyi*; but even in the former species the duct enters the side, rather than the apex, of the nearly spherical atrium.

The *copulatory chaetæ* form a bundle (varying from only 3 to as many as 7 or 8) of simple bristles, lying in a pit or depression near the male pore. Viewed from the side in a mounted specimen, the two organs appear coincident; but sections show the true relation. Each of these chaetæ, one of which is figured (Pl. XXIV, fig. 7), is a nearly straight rod, thicker than the other chaetæ, terminating in a point, which is not terminal, but directed to one side.

The *spermatheca* is globular, with a well-marked duct about half as long as the diameter of the ampulla. The neck of the latter is provided with a ring of elongated glandular cells, forming a prominent, valve-like structure (in longitudinal section). The duct is lined by cubical gland-cells, and is provided with a muscular coat. There are no spermatophores.

Dimensions. Length of an entire individual 15 mm.; diameter $\frac{1}{2}$ mm. Number of segments 70.

Locality. Lake Taupo, North Island, New Zealand. Also one individual from Lake Waikare, and some immature and imperfect individuals from Lake Manapouri, in the South Island, belong to this genus, but I am unable to say whether they are identical with the above.

Remarks.—This new genus appears to be most nearly allied to the genus *Branchiura* Bedd. *, as extended by Michaelsen to include "*Ityodrilus coccineus*" Vejdovsky. But it will not fit into this genus, chiefly on account of the structure of the atrium.

In *B. coccinea* the spherical atrium is lined by a layer of ciliated cells, outside which is a layer of vesicular cells, corresponding to the compact "prostate" (Cement-drüse) of *Tubifex*, &c. Apart from this fact, the general arrangement of the male efferent apparatus is like that of the new genus: the thick sperm-duct, and the short atrial-duct, with muscles at its base, forming a slightly protuberant papilla.

With this species, too, *B. coccinea* agrees in the presence of copulatory chætæ on segment xi., but in the form of these there is considerable difference: for in *B. coccinea*, according to fig. 13 d_1 , d_2 on pl. iv. of Štolc's memoir †, they are of two kinds, both sigmoid and crochets; while in the new species they are of neither of these two forms, but simple pointed, straight rods, with a nodal swelling. There are other points of difference, as in the undulating, instead of simple, form of the commissural vessels, in the position of the spermathecal pore, and the presence, in *Taupodrilus*, of a distinct muscular duct.

From *B. soverbyi* there are more numerous differences, apart from the presence in this species of the gills.

So far as the atrium is concerned, the new genus exhibits points of resemblance to *Clitellio arenarius* ‡, in which a thick and relatively short sperm-duct enters the apex of an elongated, dilated, glandular "atrium," which appears rather as a swelling in the course of the duct. Of its minute structure we have no account; but in the total absence of a "prostate" there is a close similarity to the new genus. But in all other points there seems to be no close affinity between the two, for there are no capilli-form bristles in the dorsal bundles; the chætæ being "only forked"—both Beddard and Michaelsen give this as a generic character. Further, two pairs of dilated hearts exist in segments viii., ix.

It is difficult to separate generic from specific characters, but probably we may regard as in the former category:

- (a) the presence of fan-shaped chætæ dorsally;
- (b) presence of copulatory chætæ on segment xi.;
- (c) character of the atrium.

The structure of the atrium of *B. coccinea* has hitherto been regarded as the simplest amongst the Tubificidæ (Beddard, Monog.

* Beddard, Quart. Journ. Micr. Sci. 1892, xxxiii. p. 325.

† Štolc, Abhandl. Böhm. Ges. 1888.

‡ Cf. Beddard, P. Z. S. 1888, p. 491.

p. 233), and indeed agrees with that of certain of the Naididæ, such as *Stylaria lacustris**, though I should place *Clitellio* at a lower grade even than *B. coccinea*, for in it apparently, and at any rate in the new genus, the atrium is still simpler, and approaches that found in *Nais elinguis*, or in *Dero*, or in *Chaetogaster*. In the first named, Štolc† shows the atrium as a dilatation of the sperm-duct, from which it is not distinctly marked off; its lining appears to consist of low, cubical cells (? glandular), outside which is a layer of flat, peritoneal cells.

In the atrium of *Chaetogaster*, as described and figured by Vějdovsky‡, the glandular lining and flat epithelial cells are distinctly shown; while Beddard§ thus describes the organ in *Dero*:—"The atria are lined by a columnar epithelium, but I could observe no layer of cells covering this organ externally and forming the structure which has sometimes been termed prostate."

In these forms, and in *Tarupodrilus*, the atrium, indeed, is in its most simple form, as a distinct and definite organ—definitely marked off from the sperm-duct, but still, evidently, a dilatation of its distal extremity.

LIMNODRILUS VEJDOVSKYANUS, sp. n. (Plate XXV. figs. 10–17.)

From Lake Waikare I received about two dozen stout, greyish worms, in which the cuticle is much wrinkled, the body-wall thick, and the segments distinctly bi- and tri-annulate.

The *prostomium* is conical, with a rather acute point; it is relatively long, and exceeds the length of the first segment.

The *chaetæ* are in the usual four bundles: 4 and 5 per bundle; even 6 in the bundles of segments ii. to vi.; but throughout the greater part of the body there are 4 ventrally and 3 dorsally.

The dorsal *chaetæ* are slightly smaller in all dimensions than the ventral, but in form they are similar (Pl. XXV. figs. 10, 11). The upper tooth is very distinctly longer and less robust, and has a sharper point than the lower tooth.

The ventral *chaetæ* are absent on segment xi.

The *clitellum* covers segments xi. and xii., and does not encroach at all on segment x. The genital pores have the usual position.

Internal Anatomy.

This was studied both in entire specimens—stained in alum-cochineal, and mounted in Canada balsam—and in serial transverse and longitudinal sections.

The *alimentary canal* is without a distinct muscular pharynx; the buccal region passes through segment i. into the commencement of segment ii.; its wall is here folded and provided with a few retractor muscles. Following this is the beginning of the

* Vějdovsky, Syst. u. Morph. d. Oligoch. 1884, pl. iv. fig. 10.

† Štolc, SB. Böhm. Ges. 1887, p. 228, fig. 7.

‡ Vějdovsky, Syst. u. Morph. d. Oligoch. 1884, pl. v. fig. 7.

§ Beddard, P. Z. S. 1889, p. 444.

œsophagus, in the hinder part of segment ii.; it thickens out considerably, right and left, in segment iii., forming a somewhat quadrangular organ, looking—in an entire specimen—like a pharynx. The walls of this organ are comparatively thin, somewhat folded laterally, and lined by tall, columnar, ciliated epithelium*, which is surrounded by a very feebly developed muscular layer; the floor is raised into a ridge in the median line. The structure recalls that described by Nasse for *Tubifex*†. In segment iv. the œsophagus, retaining the same structure, diminishes in size vertically, but is still rather wide laterally.

The chloragogen cells—which are quite pale—begin in segment vi.

In the eighth segment (Pl. XXV. fig. 12) the œsophagus passes into the intestine. The former region reaches into the first half of the segment, then suddenly, at about the middle of the segment, dilates to about three times its former size. The epithelium, anteriorly high, is there quite low, and the cells contain blackish granules. The chloragogen granules have been dissolved out in the sections, but these dark intestinal granules remain.

The intestine is greatly dilated in each segment, and constricted by the successive septa.

The *Vascular System*.—In the œsophageal region the dorsal vessel is free from the wall of the gut, as is the case in *Oligochæta* generally. In the eighth segment it presents an arrangement which appears to be, in its details, unique (Pl. XXV. fig. 12). In the anterior (œsophageal) moiety of segment viii. the vessel becomes very muscular, and at the junction of œsophagus with intestine the dorsal vessel bifurcates; each branch, one on either side, passes downwards and *backwards*, along the line of union of œsophagus with intestine, to join the ventral vessel. This connecting vessel adheres closely to the wall of the gut, lying in a furrow therein, and has a very thick muscular wall (Pl. XXV. fig. 13); it is, however, not specially dilated in the way that the “lateral heart” of *Tubifex* is, and, further, it is connected with the dorsal vessel, and not with the supra-intestinal as is the case in other Tubificids [*vide* Štolc; Beddard, Monog. p. 240].

Behind the eighth segment, the dorsal vessel comes to lie below the peritoneal cells, above the gut-wall, in the usual way. Anteriorly to the eighth segment there is a “supra-intestinal” vessel adhering to the œsophageal roof; it passes forwards through several segments, but I did not ascertain how far it reaches.

In the intestinal region the vascular network on the gut-wall is connected with the dorsal vessel; while in the œsophageal region it is, as usual, connected with the supra-intestinal vessel.

Commissural vessels, undulating along the inner surface of the body-wall for the whole length of the segment, occur in segments

* This arrangement reminds one of the condition found in *Æolosoma*, and described in detail by Vejdovsky in his ‘Syst. u. Morph. d. Oligoch.’ p. 101, but in that low form there is no preceding buccal region.

† Nasse, ‘Beit. z. Anat. d. Tubificiden,’ 1882.

ii. to vii. They are all narrow, of about the same diameter, and put the dorsal and ventral vessels into communication at the hinder part of each of these segments. It appears to me that in this region the dorsal and supra-intestinal vessels are connected at the septum, and that it is at this point of fusion that the commissural vessels start. This union does not occur in *Lophochaeta* or *Bothrioneuron*, in which the vascular system has been so well figured by Štolc.

I cannot detect any integumental network in spite of repeated examination of various individuals, in different media.

The *nephridia* are not enclosed in vesicular cells.

The *brain* is very slightly notched posteriorly.

The *Reproductive System*.—The spermiducal funnel is large and flat, and has the usual position on the hinder wall of segment x. The sperm-duct takes a much undulated course, pushing the septum xi./xii. backwards. The duct gradually widens in this region to form the atrium, which receives a quite small lobulated "spermiducal gland" (prostate, Cement-drüse); it then passes forwards to become the penis.

The muscles of the penis are spirally disposed, as in some other species.

The chitinous penial tube is of considerable length, about 10 times as long as the basal diameter, and when the worm is compressed it extends through segments xi. and xii., reaching nearly to the posterior end of the latter. The free extremity is suddenly expanded to form what appears in side view to be a thin flat plate, the margin of which may be even slightly reflexed (Pl. XXV. figs. 14, 15).

The *penis* is almost straight, its slight curvature being possibly due to compression, as it is not constantly identical in amount; but there is no sudden bend as in the species next to be described. I could detect no "valvular apparatus" at the aperture of the penis.

The *spermatheca* appears to be variable in form; in one entire individual it was spirally coiled, so that the ampulla—an elongated ovoid—formed the larger coil, and the narrower duct an inner, smaller coil; while in another case the ampulla was more globular (Pl. XXV. figs. 16, 17). The duct is about half the length of the ampulla.

I observed no spermatophores.

Dimensions. Length 20–25 mm.; diameter $\frac{3}{4}$ to 1 mm. The number of segments in one specimen was 66 + a regenerated tail of 33 very short ones; and in another 75 + 40 very small segments.

Localities. Lakes Waikare and Waikaremoana, North Island, New Zealand.

Remarks.—This species, so far at least as the general form of the penial tube is concerned, is most nearly allied to *L. clappare-dianus* Ratzel; but the latter species is of much greater size, viz., from 50–80 mm., and its chætæ are from 5 to 10 per bundle;

but how far the number is liable to variation is a subject that has received but little attention. In my specimens they are pretty constantly 4 ventrally and 3 dorsally, except the very anterior ones. At any rate, Vejdovsky's figure (pl. viii. fig. 22) gives a form very different from that of the new species; for the upper tooth is not pointed, but blunt, and much larger than the lower tooth, the proportions being very different from those in my species.

The presence of a single pair of hearts in this and the following species, which, at any rate in *L. vejdoskyanus*, have a peculiar form and arrangement, would appear to demand the creation of a new genus for this worm; for Michaelsen, in 'Das Tierreich,' gives two pairs of hearts in segments viii. and ix. as a character of the genus *Limnodrilus*. But in the character of the chætæ, and still more in the chitinous penial tube, this species agrees so precisely with *Limnodrilus*, that I deem this procedure unnecessary.

LIMNODRILUS LUCASI, sp. n. (Plate XXV. figs. 18-22.)

A slender worm with thick body-wall; the segments are not annulated.

The *prostomium* is short and rounded; the *peristomium* is as long as segment ii.

The *chætæ* are 5 in each bundle in the most anterior segments (ii., iii., iv., v.), then diminish to 4; and later (in segment x. and posteriorly) to 3 in each bundle.

The dorsal and ventral *chætæ* on segment ii. are rather shorter than on the other segments. All the *chætæ* are alike; the prongs or teeth are nearly equal in length, but the lower or proximal tooth is slightly the stouter, and in the posterior segments it is a trifle longer than the lower prong. But even in one and the same bundle the relative length of the two prongs exhibits various proportions.

Ventral *chætæ* are present on segment xi. even in the adult.

The *clitellum* occupies two segments, extending from $\frac{1}{2}$ x. to $\frac{1}{2}$ xii.

Internal Anatomy.

The pharynx extends through segments ii. and iii.; the chloragogen granules are dark brown and commence in segment v.

A large heart exists in segment viii., but I have not been able to make out, in the entire individuals, the exact relations of this organ. The blood has accumulated in the vessels at the posterior end of the body, and the vessels are empty anteriorly. I did not investigate this species by means of sections. The usual undulating commissural vessels are present in the anterior segments, but I find no integumental vessels.

The dorsal blood-vessel shifts from its proper position in the intestinal region, and takes up a lateral position as in *Branchiura sowerbyi* (which, according to Beddard, is the only instance amongst the Turbificidæ of this arrangement).

Sperm-sacs occupy segments xii., xiii., and eggs lie free in segments xiv., xv.

The chitinous *penis* is about ten times as long as the breadth of its base (Pl. XXV. fig. 18); it is distinctly bent at a point just below its outer end, and terminates in an asymmetrical, somewhat trumpet-mouthed expansion, which is apparently imperfect on one side, as the chitin here becomes very thin (Pl. XXV. figs. 19, 20); there appears to be a "valve-like" arrangement, somewhat like that figured by Vejdovsky for *L. clapedianus* (pl. xi. figs. 7, 8). The muscles surrounding the penis are spirally wound.

The *spermatheca* (Pl. XXV. fig. 21) has an irregularly pyriform ampulla, connected to the pore by a narrow neck passing into a short muscular duct, which is rather wider in the middle of its course than at either end. The duct is much shorter than in the previous species. The spermatophores (Pl. XXV. fig. 22), which I observed in one instance, are dumbbell-shaped—i. e., an oval constriction round its shorter diameter.

Dimensions. Length 15–35 mm.; diameter $\frac{1}{4}$ mm. or $\frac{1}{2}$ mm. With 60 to 80 segments.

Localities. Lakes Rotoiti and Taupo, North Island, New Zealand. Obtained in considerable numbers at both places.

Remarks.—This worm is much more slender than *L. vejdoskyanus*, and, like it, differs from the majority of species of *Limnodrilus* in possessing no integumental vessels, so far as can be made out in preserved specimens. As the blood was distinct enough in the intestinal network, it seems unlikely that I overlooked the vessels on the body-wall, or going thereto. It appears to approach *L. dugesi* Rybka*, from Mexico, from the diagnosis given by Michaelsen; but I have not access to the original paper in which it is described.

LIMNODRILUS sp. inc.

From Lakes Wakatipa, Manapouri, and Waikaremoana some immature specimens were obtained to which I will not give a specific name, but which differ from either of the preceding species.

The chaetae are in bundles of 4 or 5 anteriorly, but soon decrease to a couple: or in some instances (the single individual from the southern lake) the maximum, anteriorly, is two per bundle, and posteriorly, both dorsally and ventrally, a single cheta. But in both cases the form of the crochet is the same; the upper prong is much larger than the lower, indeed as much as twice the length, and is much more slender and more elegantly curved, as it seems, than in the preceding species; the lower tooth is slightly stouter than the upper.

A more important difference from the preceding species is the possession of two pairs of swollen hearts in segments viii. and ix.

In one case, although only the rudiments of the generative organs are present, the epidermis is slightly, but definitely, thickened on segments $\frac{1}{2}$ x., xi., $\frac{1}{2}$ xii.

* Rybka, Mém. Soc. Zool. France, xi. p. 330.

Remarks.—In 1889 (P. Z. S.) Mr. Beddard recorded the occurrence in New Zealand of "*Limnodrilus* sp. inc.," but gave no details as to its anatomy; but in 1892 (P. Z. S. p. 354) he states that the New-Zealand *Limnodrilus* possesses two pairs of greatly dilated hearts in segments viii., ix. In his Monograph, p. 247, he repeats this; and both on this page and p. 230 he refers to this worm as "*L. novæzelandiæ*." Possibly this is a MS. name and crept into the Monograph unintentionally; but it is regrettable that no further details have hitherto been published, and as his specimens are stated to be immature, it is probable that we shall never know what "*L. novæzelandiæ*" is: it is a name that has to disappear. It is quite likely, of course, that the present "species" is identical with Beddard's, and I hope to obtain more material before giving it any name.

In view of the general distinctness between the lacustrine worms of the Northern and Southern lakes, it is possible that two species are included here; but in the immature condition I detect no peculiarity sufficient to differentiate them.

In looking up the literature dealing with the genus *Limnodrilus* and other Tubificids, I have been struck with the paucity of information, on many anatomical points, about the common European species. It seems to me desirable to have some information as to the amount and degree of variation that may occur in the form of the chætæ of *Limnodrilus*, so as to be able to ascertain how far the relative size of the two prongs is a reliable specific character.

Another point that requires attention is the extent of the clitellum in different species of Tubificids, for in Michaelsen's and in Beddard's Monographs little attention is paid to this point; and since in the Earthworms it is of value in identification, it seems likely that here, too, it would have a certain, but perhaps more limited, value.

It is only in the case of those species that have been examined in recent years that this point has been determined. In neither monograph do I find a statement as to its extent, for instance, in the common European species of *Limnodrilus*, and, indeed, in very few members of the family. Beddard (p. 85) in a tabular statement showing the position of the genital organ in the various families of the Oligochæta, writes under the heading "clitellum":—

"Tubificidæ..... 10, 11."

But in the discussion on the characters of this family, further on in the volume, it is not stated, either explicitly or implicitly, whether the comma between the two numerals stands for the word "and" or "or"; and no details as to the point in question are to be found in the account of the genera or species of the family. But from the few records that we have, it is evident that in the family Tubificidæ the clitellum is not limited to one or even to both of these segments, and it is more extensive and variable in

its extent than would be supposed from the above scant statement. For instance, I have picked out from Michaelsen's systematic summary of the family, in 'Das Tierreich,' the following definite statements, and these are the only ones that I can find:—

<i>Branchiura sowerbyi</i>	x. to xii.	Beddard *.
<i>Tubifex (Heterochaeta) costatus</i>	$\frac{1}{n}$ x. to $\frac{1}{n}$ xiii.	Benham †.
<i>T. (Psammoryctes) velutinus</i>	$\frac{1}{2}$ x. to xii.	Randolph ‡.
<i>T. (P.) plicatus</i>		
<i>T. (Spirosperma) ferox</i>	$\frac{1}{n}$ x. to $\frac{1}{n}$ xii.	
<i>Tubifex blanchardi</i>	(ix.) x. and xi.	
<i>Rhizodrilus (Vermiculus) pilosus</i>	x. to $\frac{1}{2}$ xiv.	Goodrich §.
<i>R. lacteus</i>	$\frac{1}{2}$ x. to $\frac{1}{n}$ xiii.	F. Smith ||.
<i>Bothrioneuron americanum</i>	xi., xii.	Beddard ¶.
<i>Clitellio arenarius</i>	x. to xii.	
<i>Limnodrilus gotoi</i>	$\frac{1}{2}$ x. to $\frac{1}{2}$ xii.	Hatai **.

I have not at my command the earlier literature on the subject; but it is a curious fact that in neither of these monographs is there a record as to the position of the clitellum in such common European species as *Tubifex rivulorum*, *Limnodrilus clapedianus*, &c.

TUBIFEX sp. inc.

From Lakes Taupo and Rotoiti some immature worms were obtained which appear to belong to this genus.

The dorsal bundle contains 2 to 4 long capilliform chætæ together with 2 to 4 "ctenates"; the ventral bundle 4 crochets anteriorly, dwindling to 2 posteriorly; the two prongs of about equal length, but the lower is rather stouter than the upper. In one instance the capilliforms occur only in the first few segments, in other cases (from Rotoiti) they are present throughout the body. Only one chæta exists in the ventral bundles of segment x., and none at all in segment xi. Commissural blood-vessels are present in segments ii. to xi., those of the last two segments being very long; while in segment viii. is a large, much dilated "heart."

Though these characters are insufficient to permit me to give a name to the species, it appears to be different from *T. rivulorum*, which species has been recorded by Beddard (1889) from New Zealand.

ENCHYTRÆUS SIMULANS, sp. n. (Plate XXV. fig. 25 & XXVI. figs. 26–28.)

Seven short and relatively stout worms were amongst those

* Beddard, Quart. Journ. Micr. Sci. xxxiii. p. 325.

† Benham, Quart. Journ. Micr. Sci. xxxiii. p. 188.

‡ Randolph, Jen. Zeit. xxvii.

§ Goodrich, Quart. Journ. Micr. Sci. xxxvii. p. 253.

|| Smith, Bull. Illinois Lab. v. p. 244.

¶ Beddard, Ergeb. Hamb. Magalhaen. Sammelreise, p. 7.

** Hatai, Annot. Zool. Jap. iii. p. 5.

collected in Lake Taupo, and clearly belong to the genus *Enchytræus*.

The *prostomium* is short, rounded, and somewhat conical; the anterior segments are well marked, though the body-wall is thin and transparent.

The *chætæ* are in four bundles, of (usually) three in each bundle; they are straight rods with blunt ends; all are alike in form and size. The three *chætæ* in each bundle are arranged fanwise, *i. e.*, the middle one upright, and the other two making equal angles with it on either side. Occasionally, in the anterior ventral bundles, a fourth *chæta* was noted.

The *clitellum* covers segments xii., xiii., and part of xiv.

The *male pores*, on segment xii., are in depressions on either side and in line with the ventral series of *chætæ*, which, however, are absent in this segment.

Internal Anatomy.

The brain is convex posteriorly. Peptonephridia are absent from the back of the pharynx.

The ordinary *nephridium* has a relatively long and narrow pre-septal region (Pl. XXVI. fig. 26); the postseptal region is about twice the length of this, and is distinctly marked off from it. It consists of an irregularly pear-shaped "body," which tapers off posteriorly to form a long narrow duct, set nearly at right angles to the "body," but slightly inclined forwards.

The *spermiducal funnel* is particularly large (Pl. XXVI. fig. 28), about four times as long as its breadth; it is thick, and bent in more than a U-shaped curve (perhaps due to changes during preservation), for it appears S-shaped in longitudinal section. The entrance is narrow, but there are no columnar cells at its margin, which is not reflexed. The wall of the whole funnel consists of long glandular cells, which in their distal moities are filled with granules.

The sperm-duct is short, confined to its segment, and coiled in a close and regular zigzag; it opens in a depression which results from the contraction of several radiating muscles in this region, near a group of gland-cells which open through the epidermis on the outer side of the male pore.

The *spermatheca* (Pl. XXVI. fig. 27), which communicates with the œsophagus, lies in the usual segment. The ampulla is nearly spherical; the duct is distinctly marked off from it, is about half the length of the ampulla and much narrower than it.

Gland-cells are present around the duct throughout its length; that is, the epithelium consists of tall cells with clear contents; the greater part of each cell projects beyond the muscular wall of the duct, and these portions form a continuous extra-muscular layer (Pl. XXVI. fig. 28). The actual lining of the duct appears to be formed by a protoplasmic sheet, in which I detect neither cell-boundaries nor nuclei; and this sheet appears to result from the fusion of the internal ends of these "glandular" cells. The

condition, indeed, is similar to that figured by Michaelsen for "*E. möbi*" (= *E. albidus*).

Dimensions. Length 15 mm.; diameter $\frac{3}{4}$ mm. Segments about 58.

Locality. Lake Taupo, North Island, New Zealand.

Remarks.—It seemed likely, from a preliminary examination, that this species might be *E. albidus* Henle, which has a very wide distribution; but in the details of the more important organs there appear to be sufficient differences to permit the bestowal of a new name.

The figures of the male apparatus given by Eisen* and by Michaelsen† show a distinct everted lip to the spermiducal funnel; the sperm-duct is not so compactly coiled in a zigzag, while it may reach as far back as the eighteenth segment.

The nephridia of *E. albidus* also appear to differ from these organs in our species‡; while the absence of a peptonephridium in our New-Zealand worm appears to mark it off from *E. albidus*.

In possessing only 3 chætæ per bundle, it resembles *E. hyalinus* Eisen, and *E. adriaticus* Vejd. From the latter it is distinguished by the form and proportions of the three regions of the nephridium. With the former, however, it agrees very closely in the structure of the male efferent apparatus §, but the spermatheca in that species has an "atrium-like dilatation" on its duct, which is absent from the new species. The form of the nephridium is also a point of agreement. But the fact that *E. hyalinus* occurs in Novaya Zemlya seems to exclude the possibility of its introduction into Lake Taupo.

ACHÆTA MAORICA, sp. n. (Plate XXV. figs. 23, 24.)

A single, but fortunately a mature specimen of this small worm was obtained at Station 18 in Lake Manapouri.

It was stained in alum-cochineal and mounted entire, and its anatomy studied as far as possible. It was then unmounted, and the anterior half was cut into a series of longitudinal sections, and the rest of the body into transverse sections. Owing to the flattening to which it had previously been subjected, the former series was not very satisfactory, especially as the sections were a good deal torn by the diatom-valves and dirt in the intestine. Nevertheless the anatomy was sufficiently studied for systematic purposes.

The *prostomium* is short, rounded, and provided with the usual terminal pore.

There are no chætigerous sacs, nor could I detect any "chlorophyll-glands."

The *clitellum* appears to include only segment xii., encroaching but slightly into the hinder region of segment xi.

* Eisen, Svenska Ak. Handl. (n. ser.) xv. p. 25, pl. ix. fig. 18, pl. x. fig. 20.

† Michaelsen, Untersuch. u. *E. möbi*, 1886, p. 1, pl. iii. fig. 9.

‡ Goodrich, Quart. Journ. Micr. Sci. xxxix. p. 51, pl. v. fig. 2 (nephridium).

§ Eisen, loc. cit. pl. x. fig. 20.

I could not detect any "great cells," such as occur in the clitellum of some species of this genus.

The *male pores* are paired and situated at about the middle of segment xii.

The *spermathecal pores*, paired, lateral, lie at the anterior boundary of segment v.

Internal Anatomy.

There are septal glands on the hinder septa of segments iv., v., vi., and these septa are rather stouter than the rest.

Segments vii., viii. (as indicated by their ganglia, for the external boundaries are difficult to detect in the transparent worm) are much shorter than their neighbours; the tenth and following are almost twice the length of either of these two.

The *dorsal vessel* arises in segment x.; but I fail to discover any swellings on its course.

The *sperm-funnel* occupies about half of segment xi.; it is urn-shaped, without an everted margin (Pl. XXV. fig. 23), and its length is about equal to twice its breadth. The sperm-duct, less than twice the length of funnel, takes a nearly straight course backwards to about the middle of segment xii., when it bends downwards almost at right angles; it is dilated after passing through the septum xi./xii., but it soon narrows again, and the external opening is surrounded by a small lens-shaped mass of glandular cells (spermiducal gland), which it perforates at about the centre.

Loose masses of developing spermatozoa occur in the body-cavity of segments ix. and x., and a few even in segment viii.

The *spermatheca* is much elongated (Pl. XXV. fig. 24); its aperture (surrounded by a group of gland-cells) leads by a short canal into an ovoid dilated sac lying in segment v., thence a narrow canal passing through segments vi., vii. begins to enlarge after passing through the septum vii./viii. to form a large "ampulla" lying in segments ix. and x., which is constricted at about its middle. The ampulla contains bunches of ripe spermatozoa.

The *ovary* and *duct* have the usual positions, and the body-cavity of segment xii. is fully occupied by a couple (or more) of large eggs, which distend the body.

Dimensions. Length 4 mm.; breadth very small. Number of segments 22, with an anal segment.

Locality. Lake Manapouri, South Island, New Zealand.

Remarks.—This species agrees with *A. (Anachæta) cameranoi* Cognetti* in its smaller size and in the total absence of chætigerous follicles, but in nothing else; for its spermatheca somewhat resembles that figured by Vejdovsky (Syst. u. Morph. pl. vii. fig. 22) and labelled *A. eisenii*, but which Beddard† suggests really belongs to *A. bohémica*. But in the point of origin of the dorsal vessel it differs from each of these species.

Having only a single preserved specimen, I am unable to give

* Cognetti, Boll. Mus. Zool. Anat. Comp. Torino, xiv. 1899, no. 354.

† Beddard, 'Monograph,' p. 356.

any details as to lymph-corpuscles, nephridia, and certain other anatomical features.

HAPLOTAXIS HETEROGYNE, sp. n.*

The *prostomium* is long, but not annulated.

The *chaetæ* are four per segment, isolated, one dorsal and one ventral on each side; the form agrees with that found in *H. gordioides*. The ventral chaeta is from two to three times the length of the dorsal, but less difference exists in the anterior segments. The dorsal chaetæ occur throughout the body.

The *clitellum* surrounds segments xi. to $\frac{1}{2}$ xiv.; it is complete and thickest laterally.

The *genital pores* were not detected externally; but the ducts, traced in sections, meet the body-wall at points indicated below. There are two pairs of male ducts which reach the epidermis in segments xi., xii. anteriorly to the ventral chaetæ. There is a single pair of oviducal pores on segment xiii. laterad of the line of ventral chaetæ, but rather nearer the anterior margin of the segment than these; but they are much further back in their segment than the male pores are.

Two pairs of spermathecal pores lie at the anterior margins of segments viii., ix.

The *alimentary canal* is remarkable for possessing a strongly muscular *gizzard* in segment iv.; it is quite different from a pharynx, which is here absent. A similar, but more extensive, gizzard has been recorded by Michaelsen † for *H. gordioides*.

The first pair of *nephridia* lie in segment x.; they are rather smaller than the postovarian nephridia. These organs are absent in segments xi., xii., xiii., but reappear in segment xiv. *et seqq.*

The nephridial canal perforates a string of large cells having distinct boundaries and highly vacuolated cytoplasm. Each nephridium reaches the epidermis close to the ventral chaeta, through a short "duct" formed of a highly granular syncytium.

As in the case of the sperm-ducts, I was unable to detect an actual perforation or opening through the epidermis.

Reproductive System (text-fig. 23, p. 224).—Two pairs of testes and sperm-funnels occur in the usual positions in segments x., xi. The sperm-duct leaves the large, thick, flattened sperm-funnel at its ventral edge, as Beddard ‡ found was the case in *H. smithi*. But the sperm-duct in that species has the usual structure, *i. e.* is surrounded by a definite epithelium.

In the present species the sperm-duct perforates a series of cells the boundaries of which are not distinguishable, and has an undulating course in this syncytium, which extends up to the level of the lateral line. The duct passes upwards to this level, then bends upon itself, still within the syncytium, and reaches the body-wall in front

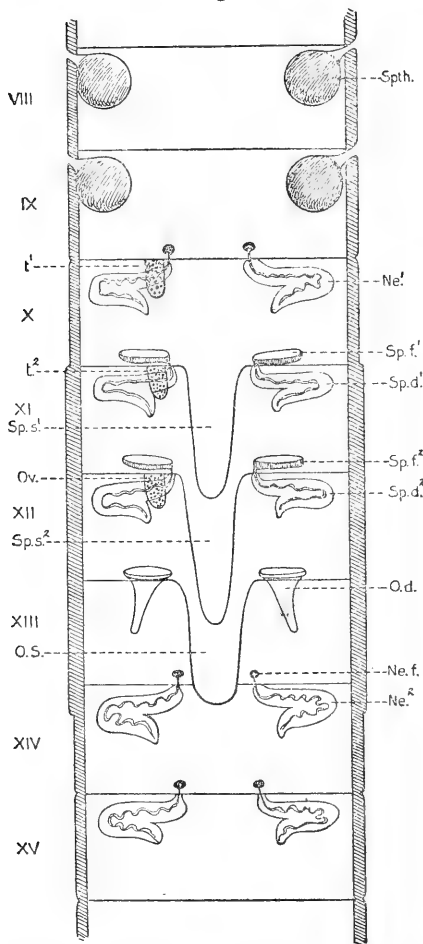
* A detailed and illustrated account of this worm has been sent to the Editor of the Quart. Journ. Micr. Sci.

† Michaelsen, Zool. Jahrb. (System.) xii. p. 105.

‡ Beddard, Ann. & Mag. Nat. Hist. ser. 6, i. p. 389 (1888).

of the ventral chaeta. A transverse section through the sperm-duct has all the appearance of a section across a nephridium: we see, not an epithelium surrounding the lumen, but a perforated cell, with rarely more than one nucleus in the plane of the section,

Text-fig. 23.



Plan of genital organs in *Haplotaxis heterogyne*, composed from study of entire worm and sections. The gonads are omitted on the right side in order to show the full course of the sperm-ducts, each of which leaves its funnel at its ventral edge; it has a course similar to that of a nephridium, and, like the latter, traverses a cord of cells.

Ne.¹, the first nephridium; *Ne.²*, the second; *Nef.*, nephridial funnel; *O. d.*, oviduct; *O. s.*, ovisac; *Ov.*, ovary; *Sp. d.*, sperm-duct; *Sp. f.*, sperm-funnel; *Sp. s.*, sperm-sac; *Sph.*, spermatheca; *t.*, testis.

sometimes none. The general disposition of the perforated syncytium is very similar to a nephridium, and the canal takes a course similar to the latter tube, but is not quite so undulating. The canal bears cilia throughout its whole extent.

So similar is this sperm-duct to a nephridium in this worm, that the differences are only perceptible when the organs are examined under a very high magnification (such as $\frac{1}{2}$ homogeneous immersion). But that this nephridium-like tube does actually serve as a sperm-duct, is demonstrated by the presence of sperms within the canal, and the fact that in the case of one funnel I noted spermatozoa entering the mouth of the canal. Though I traced the ducts to the body-wall, I was quite unable to detect the pore in either sperm-duct; nor was Michaelsen successful in finding the actual aperture in *H. gordioides*. Of the two individuals obtained by me one was fully mature; the segments x., xi. were filled with ripe and developing sperms; and the spermathecae were also filled with them; hence copulation had recently occurred. The other individual was quite immature, although the three pairs of gonads and the ducts were present; in this individual, likewise, there are no nephridia (unless the sperm-ducts are nephridia) in segments xi., xii., xiii.

It appears to me that in this worm *the nephridia do act as sperm-ducts*, as was suggested by the earlier students of *Haplotaxis*. There are two median sperm-sacs, in the form of simple pouches, formed by the septa x./xi., xi./xii., which are pushed backwards above the gut so as to reach into segments xii., xiii. respectively. Each of the sperm-sacs is filled with developing and ripe spermatozoa.

There is but a single pair of ovaries and oviducts; the former in segment xii.; the latter opens in about the middle of segment xiii. The oviduct is a wide tube surrounded by a ciliated epithelium, and opens by a wide funnel into segment xii. This duct is present in the immature specimen, and can be seen traversing the anterior half of segment xiii.

The presence of a single pair of female organs marks off this species from the two other known representatives of the genus; and in this respect our species resembles *Pelodrilus*, an allied genus, originally founded by Beddard* for a New-Zealand worm, *P. violaceus*; but the discovery by Michaelsen† of *P. ignatovi* from Central Asia, in which the two pairs of sperm-ducts open on independent segments, forms a passage to *Haplotaxis*. But in all other characters this new species agrees with the diagnosis of *Haplotaxis* and differs from that of *Pelodrilus*.

A single median ovisac, filled with eggs, passes backwards through segment xiii.

In segments xi., xii., xiii. are paired copulatory glands, similar to those present in some Enchytræids; those of segment xii. open laterally, near the ventral chætæ; the other two pairs open below

* Beddard, Trans. R. S. Edinb. xxxvi. p. 292.

† Michaelsen, Verh. naturw. Ver. Hamburg, 1903.

the nerve-cord. Each gland consists of a bundle of long club-shaped cells.

Two pairs of globular spermathecae lie in the anterior moiety of segments viii. and ix., and open laterally, at the anterior margin of these segments.

Dimensions. About 20 mm. \times $\frac{1}{3}$ mm. With about 60 segments.

Locality. Lake Wakatipu, South Island of New Zealand; from a depth of 550 feet.

DIPOROCHÆTA AQUATICA, sp. n. (Plate XXVI. figs. 29–31.)

Two individuals were obtained, of which one was entire and well preserved; the other, broken, soft, and almost useless for study. The former was cut into sections.

It is a short and relatively stout worm.

The *prostomium* is small and prolobic.

The *chaetæ* are about 28 per segment, *i. e.* 14 on each side, and the gaps $aa = ab$, $zz = 1\frac{1}{2} yz$; thus the midventral "gap" is practically absent.

The *clitellum* is not fully developed in either individual; it appears to cover segments xiv., xv., xvi. and the dorsal region of the 13th.

The *male pores*, on the 18th segment, are distinctly visible under a lens, but are not on papillæ; they are rather widely separated, so as to lie, when seen from below, on the "edge" of the ventral surface; they are on a level with the chaetal gaps d/e . There are no chaetæ visible between these pores.

The *oviducal pores* are paired, but close together on a pale oval area, in line with chaeta *a*.

The *spermathecal pores* are not visible externally, but are on the anterior margins of segments viii., ix. I did not note their position relative to the chaetæ.

The *nephridial pores* are situated about halfway up the body-wall.

Internal Anatomy.

There is no gizzard; the œsophageal wall is vascular and folded as it passes through segments x., xi., xii. It then diminishes in diameter and becomes thin-walled in the next two segments, dilating in the 15th, to attain the full diameter of the intestine in the 16th segment. There is a minute typhlosome in the form of a small, low, rounded ridge, deeply separated from the rest of the lining by a furrow on each side (Pl. XXVI. fig. 29); its epithelium differs from that of the general lining of the intestine in that it consists only of ciliated columnar cells (Pl. XXVI. fig. 30); whereas in the rest of the epithelium two kinds of cells are distinctly recognisable (Pl. XXVI. fig. 31), namely, (*a*) long, narrow, ciliated cells, and (*b*) gland-cells of considerable size, whose bases project into the blood-sinus surrounding the gut-wall.

Of the *vascular system* I noted that the last heart is in segment xiii.

There is a peculiar "glandular organ" below the dorsal vessel in the intestinal region.

The *nephridia* are of large size, and visible through the transparent wall in the entire "uncleared" worm.

The *Reproductive System*.—The two pairs of testes, the ovaries, and oviducts have the normal position.

There are two pairs of *sperm-sacs*, in segments ix. and xii., while the two intervening segments are filled with loose masses of developing sperms.

The spermiducal gland is visible through the transparent wall; it extends through segments xix. to xxiii.; it has the usual form—long, cylindrical, undulating; its curved duct is confined to the eighteenth segment.

There are no penial chætæ.

The spermathecæ, in segments viii., ix., are globular sacs, quite filling their segments, with a short duct, into which opens a small ovoid diverticulum.

Dimensions. Length 38 mm.; diameter $1\frac{3}{4}$ mm., reaching 2 mm. anteriorly. Segments 67.

Locality. Lake Manapouri, in the South Island of New Zealand, from depths of 350 to 500 ft.

Remarks.—In the absence of a gizzard this new species differs from all the known species of *Diporochæta*, and therein agrees with *Perionyx*, from which, however, it differs in all the characters that differentiate the two genera.

No doubt the absence of gizzard is related to its aquatic habit. Of the numerous species of this characteristically Australian genus, only three have so few spermathecæ as the present one—viz., *D. pellucida* Bourne *, from India, *D. moreoa* Spencer †, from Tasmania, both of which are of much greater size and have more chætæ per segment; and thirdly, *D. scolecoidea* Spencer ‡, also from Tasmania, which, although of smaller size than the new species, has many more chætæ; and in all other important respects these three differ from the present form.

It is a fact of some interest that the first New-Zealand species to be recorded, viz. *D. intermedia* Beddard §, was obtained from Lake Brunner; in it the gizzard is present, but of small size: *D. chathamensis* Benham ||, in which the gizzard is also small, came from a peat-swamp: while another species, the description of which is not yet published, has no gizzard recognisable on dissection; this is from the Otira gorge, not far from Lake Brunner. Thus, of four known New-Zealand species of this genus, two are aquatic. This may have some bearing on the sparse record of

* Bourne, Quart. Journ. Micr. Sci. xxxvi. p. 13.

† Spencer, Proc. R. Soc. Victoria, vii. p. 49.

‡ Spencer, loc. cit. p. 61.

§ Beddard, Quart. Journ. Micr. Sci. xxx. p. 467.

|| Benham, Trans. N. Z. Instit. xxxiii. p. 134.

occurrence in this country of a genus so abundant in Australia, of which the Earthworm fauna is so entirely distinct, for our aquatic worms have, as yet, been scarcely touched.

PLUTELLUS LACUSTRIS, sp. n. (Plate XXVI. figs. 32-40.)

Six hauls in Lake Wakatipu brought up specimens of a worm which in some respects resembles *Pontodrilus*.

The collection consists of 24 individuals, some few fully mature; others of full size, but without a clitellum; and still more quite young. One haul (No. 5) contains a number of cocoons, which from their size probably belong to this species.

The worms, as preserved, are robust in form, greyish in colour, but the body-wall behind the clitellum is translucent. Those that are well preserved have much annulated segments: three and four annuli anteriorly, but more in the posterior segments. The anterior segments are very short.

The *prostomium* is relatively long, equal in length to the first two segments; it is narrow, only half the breadth of the peristomium, into which it is not embedded. It is *prolobic*.

The *chaetae*, eight per segment, are isolated; their formula is approximately thus: $aa = 2ab$; $ab = \frac{1}{2}bc$; $bc = cd$; $dd =$ about $2aa$. The spacing differs somewhat in the anterior and posterior regions; aa is greater and bc is rather less anteriorly than in the greater part of the body (fig. 32).

The *chaetae* are of the usual form (Pl. XXVI. figs. 33, 34), but are ornamented with a number of extremely fine crescent-shaped marks near the distal extremity; such as occur in the genus *Rhinodrilus* and others, including *Pontodrilus bermudensis* Bedd. and *P. insularis* Rosa.

The *chaetae*, both dorsal and ventral, of segments ii., iii., iv. are smaller than those of the body generally, attaining only half the length of the latter; but the increase is gradual, as the following measurements show:—

Ventral <i>chaeta</i> of segment ii.	measures	·015	mm.
"	"	v.	" ·0225 "
"	"	ix.	" ·03 "
"	"	xvii.	" ·05 "

The ventral *chaetae* (a and b) are absent on segment xviii., being here replaced by a couple of copulatory bristles on each side in line with *chaeta b*.

The *clitellum*, in the most fully-developed individuals, *i. e.* in three out of five clitelliferous worms, extends from $\frac{1}{2}$ xiii. to end of xvi. (*i. e.* $3\frac{1}{2}$ segments), the hinder boundary being, in each case, very well marked; it completely encircles the body.

The *male genital pores* on segment xviii. are in the line of *chaeta b*; they are quite minute, and are not indicated by any papillae; but the ventral region of this segment differs in appearance from the rest, and is seen to be glandular in transverse sections. In one case this area was somewhat depressed, by the

contractions of internal muscles, but the margins were not prominent nor specially glandular.

Certain "*tubercula pubertatis*" are present in the mature worms, in the form of one or more median, oval, glandular pads, with a definite, rather raised margin and a central depression. All my specimens present one such tubercle in segment xvii.; it is prechætal, but not intersegmental in position. In one case (*a*) this alone is present. In other individuals a postchætally-situated tubercle also occurs in one or more of the segments following the male pores, viz. in (*b*) it is on segment xix., in (*c*) on xxii., in (*d*) on xix. and xx. Thus the maximum number, so far as my material enables me to ascertain, is three median tubercles.

The *oviducal pores* appear as small white spots just in front of chæta *a* on each side of segment xiv., and this is confirmed by the study of sections.

The *spermathecal pores* are four pairs, in line with chæta *a*, at the anterior margin of segments vi., vii., viii., and ix. respectively.

The *nephridiopores* are in line with chæta *b*.

The *dorsal pores* commence in the third (or perhaps the second) segment.

Internal Anatomy.

The septa forming the hinder walls of segments viii., ix., x., xi. are a good deal thicker than their immediate neighbours.

The dorsal blood-vessel is single. I did not detect a supra-intestinal vessel.

There are three pairs of *hearts*, in segments x., xi., xii. Of these, the last only has the usual form and arrangement as a semi-circular, dilated commissural vessel passing freely from the dorsal to the ventral vessel (Pl. XXVI. fig. 39).

But the other two pairs present a condition which appears to be unique: they are, for the greater part of their extent, adherent to the œsophageal wall; indeed, they appear in sections to be rather dilated, circularly disposed channels of the general peri-œsophageal plexus. Each becomes free only at its ventral end; at the same time it becomes gradually reduced in diameter, and soon becomes very narrow where it joins the ventral vessel (Pl. XXVI. fig. 40). Anteriorly to the tenth segment I find narrow commissurals of the usual character.

The alimentary canal is provided with a pharynx of the usual form; there is no gizzard nor œsophageal gland.

The œsophagus and intestine contain abundance of food, amongst which the valves of diatoms are present in considerable numbers. The œsophagus is a good deal dilated segmentally, and passes into the wider intestine in segment xviii., where the character of the epithelium suddenly changes from a high to a shorter type of cell.

The worm is meganephric, with large funnels; but nephridia are absent in the anterior segments; the first one occurring in

the 15th (or in another case the 16th) segment—a point of resemblance to *Pontodrilus*.

The *Reproductive System*.—The two pairs of testes and their funnels occupy the usual position in segments x., xi.

The spermiducal funnels are large and prominent, but are very little folded. The ducts of each side unite in segment xiii., and the single duct thus formed opens into the neck of the spermiducal gland at the junction of the latter with its muscular duct.

The gland is tubular, undulating, and occupies segments xvii. and xviii.; its muscular duct is short, narrow, and curved, opening to the exterior in segment xviii. by a very small pore. The structure of the gland is similar to that normal in the subfamily; the lumen is provided with an epithelial lining of short columnar cells, between which pass the necks of long, club-shaped gland-cells in groups; the layer of gland-cells is of considerable depth and is covered by peritoneum; no muscles are present till the duct is reached.

In connection with each of the male pores is a couple of long, delicate *copulatory chaetae* (accompanied by one or two reserves on each side). Each chaeta is about twice the length of a locomotor bristle (Pl. XXVI. figs. 35, 36) and half its width; it is nearly straight, and its terminal region presents a few lateral notches—which seem to correspond to the crescent-shaped furrows in the normal chaetae.

There are two pairs of *sperm-sacs* occupying segments ix. and xi., and the intervening segment is filled with loose masses of developing spermatozoa.

The *ovaries* and their ducts occupy the usual position. Each ovary is of considerable size and appears, in sections, nearly to fill the segment; strings of rather large ova, connected by very delicate threads, even extend upwards above the gut. An ovisac on each side contains eggs in which I note astropheres and spindles in two or three cases.

There are four pairs of *spermathecae* in segments vi., vii., viii., ix.; each consists of a relatively large ovoid ampulla and a short, distinct, muscular duct, into which opens a small globular diverticulum filled with spermatozoa.

Dimensions. Length 35 to 40 mm.; diameter $1\frac{1}{4}$ mm. Segments 85 to 90.

Locality. Lake Wakatipu, South Island, New Zealand.

Remarks.—This new species differs from the rest of the genus *Plutellus*, as enlarged by Michaelsen to include several species of *Cryptodrilus* and of *Megascolides*, in two characters, viz., in the absence of a gizzard, and in the absence of nephridia from the fourteen anterior segments. In both these points it agrees with *Pontodrilus* (a sea-shore Oligochaete), and they appear to be related to an aquatic habit. But in other points the agreement of this species is with the genus *Plutellus*.

This is the first time that a representative of this genus (on the whole an Australian form) has been met with in New Zealand.

Letters used on the Figures.

<i>am.</i> , ampulla of spermatheca.	<i>l.m.</i> , longitudinal muscles.
<i>at.</i> , atrium (spermiducal gland).	<i>nef.</i> , nephridial funnel.
<i>at.ep.</i> , atrial epithelium.	<i>ne.o.</i> , nephridiopore.
<i>bl.</i> , blood-sinus in wall of intestine.	<i>o.d.</i> , oviduct.
<i>b.w.</i> , body-wall.	<i>œs.</i> , œsophagus. <i>œs'</i> , œsophageal opening of spermatheca.
<i>c.</i> , ciliated epithelial cell.	<i>ov.</i> , ovary.
<i>c.ep.</i> , cœlomic epithelial nucleus.	<i>s.</i> , septum.
<i>chl.</i> , chloragogen cells.	<i>s.gl.</i> , septal gland.
<i>c.m.</i> , circular muscles.	<i>s.i.v.</i> , supra-intestinal blood-vessel.
<i>com.</i> , commissural blood-vessel.	<i>sp.d.</i> , sperm-duct.
<i>cop.</i> , copulatory chætæ, or sac containing them.	<i>sp.f.</i> , funnel of sperm-duct.
<i>d.</i> , duct of spermatheca.	<i>sp.gl.</i> , spermiducal gland.
<i>d.v.</i> , dorsal blood-vessel.	<i>sp.s.</i> , sperm-sac.
<i>g.</i> , gland-cells in intestinal epithelium.	<i>sph.</i> , spermatheca.
<i>gl.</i> , gland surrounding spermathecal pore.	<i>t.</i> , testis.
<i>ht.</i> , lateral heart.	<i>ty.</i> , typhlosole. <i>ty.v.</i> , typhlosolar blood-vessel.
<i>int.</i> , intestine.	<i>v.</i> , ventral chætæ.
	<i>v.v.</i> , ventral blood-vessel.

EXPLANATION OF THE PLATES.

PLATE XXIV.

Taupodrilus simplex, p. 209.

- Fig. 1. View of the ventral surface of the genital region of the body, showing extent of clitellum, the position of the genital pores, and the protruded copulatory chætæ.
2. Side view of five pregenital segments as seen in a transparent, stained specimen. ($\times 120$.) To show certain features of the vascular system.
3. A bundle of dorsal chætæ.
4. One of the ctenates from a dorsal bundle, with intermediate denticles. ($\times 700$.)
- 4a. The tip of another dorsal chætæ, showing the membrane joining the two prongs. ($\times 700$.)
5. A chætæ from a ventral bundle. ($\times 700$.)
6. The tip of another ventral chætæ with intermediate denticle. ($\times 700$.)
7. One of the bunch of copulatory chætæ. ($\times 700$.)
8. Side view of the genital organs as seen in a bisected specimen; somewhat diagrammatised. *x*, point of entrance of sperm-duct into atrium.
9. A portion of the wall of the atrium from a longitudinal section of the same. ($\times 500$.) The details studied with a $\frac{1}{12}$ homogeneous immersion of Leitz. The wall is seen to consist of a single layer of much vacuolated cells, the boundaries of which are distinctly seen in the lower half of the figure, where the cells were cut vertically. The round nuclei near the outside belong to the gland-cells; the oval nuclei towards the lumen seem to belong to compressed columnar cells, whose limits are not distinguishable.
- The sperm-duct is cut through twice as it winds up outside the wall, and again (at *d'*) where it is perforating the wall.

PLATE XXV.

Limnodrilus vejdvskyanus, p. 213.

- Fig. 10. Tip of a dorsal chætæ. ($\times 700$.)
11. Tip of a ventral chætæ. ($\times 700$.)
12. A side view of two segments of the body to illustrate the peculiar arrangement of the "heart" in segment viii., where it closely embraces the gut around the line of union of œsophagus with intestine. The anterior portion of the dorsal vessel is in outline, as is also the commissural vessel of segment vii. The posterior portion of the dorsal vessel and the supra-intestinal vessel are in black, as are also the intestinal vessels.
13. An obliquely transverse section of the gut in segment viii. The lateral heart lies in the furrow between the œsophagus and intestine.
14. The penial tube. (Camera, $\times 120$.)

Fig. 15. The distal extremity of the penial tube. (Camera, $\times 700$.)

16. A spermatheca, as seen in an entire individual.

17. A spermatheca, isolated and uncoiled.

Figs. 18 to 22 refer to *Limnodrilus lucasi*, p. 216.

18. Entire penial tube. ($\times 120$.) Note the distinct bend near the distal extremity.

19. The distal extremity of a penial tube. ($\times 700$.)

20. Another view of the same. ($\times 700$.)

21. A spermatheca.

22. A spermatophore, as seen within a spermatheca.

23. The sperm-duct of *Achaeta maorica* from an entire specimen, p. 221.

24. A spermatheca of *Achaeta maorica* as seen in an entire specimen, p. 221.

25. A transverse section of the spermathecal duct of *Enchytræus simulans*, showing the coating of glandular cells outside the muscular wall; their necks passing through this, and uniting to form a protoplasmic lining (a) round the lumen, p. 219.

PLATE XXVI.

Enchytræus simulans, p. 219.

Fig. 26. A nephridium—isolated from a bisected specimen.

27. A spermatheca—isolated; the entire duct is covered with gland-cells (Cf. Pl. XXV. fig. 25.)

28. A male duct; isolated.

Figs. 29–31 refer to *Diporochæta aquatica*, p. 226.

29. A transverse section of the intestine ($\times 80$), showing the small typhlosole (ty.); the dorsal vessel is surrounded by a structure (x).

30. The typhlosole much more highly magnified. (Camera, $\times 700$.)

31. Part of the lateral wall of the intestine (Camera, $\times 700$), showing the two kinds of cell forming the epithelium; the base of the gland-cells dip into the blood-sinus.

Figs. 32–40 refer to *Plutellus lacustris*, p. 228.

32. Outline of a transverse section of the body showing the spacing of the chætæ. (From a Camera drawing, $\times 40$.)

33. A locomotor chætæ. (Camera, $\times 120$.)

34. The tip of a locomotor chætæ. (Camera, $\times 700$.)

35. A copulatory chætæ. ($\times 120$.)

36. The tip of a copulatory chætæ. ($\times 700$.)

37. A spermatheca.

38. A spermiducal gland.

39. A somewhat diagrammatic sketch of a transverse section through the gut in segment xii., showing the lateral heart.

40. A similar section through segment x. or xi., showing the peculiar condition of the "heart" in these two segments,

2. On the Mammals collected by Mr. A. Robert at Chapada*, Matto Grosso (Percy Sladen Expedition to Central Brazil). By OLDFIELD THOMAS, F.R.S.

[Received July 23, 1903.]

(Plate XXVII, †)

By the generosity of Mrs. Percy Sladen, Mr. Alphonse Robert, who had already done such good work in São Paulo and Paraná, was enabled to make, during the latter half of 1902, a collecting expedition for the benefit of the National Museum to Matto Grosso, Central Brazil, a region in respect to which the Museum

* Chapada being a word of Portuguese origin (signifying a plateau) has its accent on the second a; Cuyabá and other names of Guarani derivation on the final a.

† For explanation of the Plate, see p. 244.



J.Smit del.et lith.

CANIS SLADENTI.

Mintern Bros. imp.

collections had hitherto been extremely deficient. Carried out as it was with all his accustomed energy and courage, Mr. Robert's expedition was completely successful in spite of the many difficulties in his way, and of his being unaccompanied by any European helper. The collection, of which the present paper gives an account, is an astonishing one for him to have been able to obtain and prepare with his own hands, in so bad a climate, especially as so many of the mammals are of considerable size. Collections of mice are much more easily made than of dogs, peccaries, coati-mondis, monkeys, &c.; and the long series of the different species here enumerated speaks volumes for Mr. Robert's working qualities.

The specimens are all prepared in modern fashion, with flesh measurements and separate skulls, and there are besides a number of skeletons, so that, bearing in mind the inaccessibility of the locality, the collection may be looked upon as one of the most valuable that the National collection has received for many years. The thanks of all zoologists are therefore due both to Mrs. Sladen for her generous help, and to Mr. Robert for the admirable way in which he carried out his instructions.

Mr. Robert started from Santos on the 15th April, 1902, and after passing through the usual difficulties and delays of quarantine &c. incidental to entering Argentina, proceeded *via* Buenos Ayres, Asuncion, and Cuyabá, Matto Grosso, to Santa Anna de Chapada, a village situated at an altitude of about 800 m., on the Serra do Chapada, some thirty miles N.E. of Cuyabá, arriving there on the 17th June, and staying there collecting until the 29th November, when he came down the river again with the results of his labours.

Mr. Robert spent most of his time collecting mammals, but he also obtained a considerable number of birds, some reptiles*, mollusca†, insects, &c., all of which have been presented to the National Museum by Mrs. Sladen.

The present is the third considerable collection of mammals that has been made in the district of Cuyabá. The first was that formed by Natterer in 1825-1829, and described in conjunction with his other Brazilian mammals by Wagner and Pelzeln. The second was that of the "American Naturalist Exploring Expedition" of 1882, under the leadership of Mr. H. H. Smith, and was made at the very village, Sta. Anna de Chapada, where Mr. Robert worked. The mammals were described by Prof. E. D. Cope† in combination with those obtained at São João, Rio Grande do Sul, where the expedition stayed before passing on to Chapada.

No other important series from single localities have ever been made nearer to the present region than those from the Rio Jordão (Robert), Lagoa Santa (Lund and Reinhardt), Paraguay (Azara, Rengger, and Foster), and those obtained along the eastern side of the Andean chain by P. O. Simons.

* Cf. Boulenger, *suprà*, p. 69; Smith, *suprà*, p. 70.

† Am. Nat. xiii. p. 128 (1889).

Cuyabá is on the river level, and the country towards Chapada is all at the same low altitude until the abrupt rise of the plateau edge is reached, comparatively close to Santa Anna.

Mr. Robert has discovered a considerable number of new and interesting species, of which the most notable is the Wild Dog (Pl. XXVII.), which I have named in honour of the late Mr. Percy Sladen.

1. *CEBUS AZARÆ* Rengg.

♂. 1022, 1041, 1083, 1085, 1093, 1188, 1143, 1171, 1174, 1196, 1197, 1198, 1208.

♀. 1045, 1082, 1086, 1094, 1104, 1105, 1152, 1175, 1176.

In the absence of any certainty that Spix's name *Cebus libidinosus* (type locality, Rio San Francisco) really belongs to this monkey, I use that of Rengger, which antedates Geoffroy's *C. elegans* by many years.

This fine series emphasizes the difficulty of working out members of the present genus, for there is considerable variation both in the general colour, in the relative distribution of black and yellow on the head, and in the length and development of the temporal tufts.

2. *AOTUS AZARÆ* Humb.

Nyctipithecus azaræ auct.

♀. 1150. 28 September, 1902.

3. *CALLITHRIX* * *MELANURA* Geoff.

♂. 1130.

♀. 1132.

4. *HISTIOTUS VELATUS* Geoff.

♀. 1186.

5. *MICRONYCTERIS MEGALOTIS* Gray

♀. 1014, 1015.

6. *HEMIDERMA PERSPICILLATUM* Linn.

♂. 1063.

♀. 1012, 1013.

7. *LONCHOGLOSSA CAUDIFERA* Geoff.

♂. 1000, 1001, 1002.

♀. 999, 1111.

8. *ARTIBEUS PLANIROSTRIS* Spix.

♂. 1089.

* For the use of *Callithrix* instead of *Hapale*, see Ann. Mag. N. H. (7) xii. p. 455 (1903).

9. *VAMPYRUS LINEATUS* Geoff.

♂. 1091, 1092, 1099, 1100, 1101, 1200.

♀. 1090, 1096, 1097, 1098.

Quite similar to topotypes from Paraguay.

10. *FELIS WIEDII* Schinz.

Flat skin, native made.

11. *CANIS CANCRIVORUS* Desm.

♂. 1139, 1184.

♀. 1170.

12. *CANIS SLADENI*, sp. n. (Plate XXVII.)♂. 1080. 11 August, 1902. *Type*. (B.M. No. 3.7.7.40.)

Allied to *C. vetulus*, but larger, with longer skull, greyer in colour and with black feet. An additional upper molar present on each side in the type.

Size rather larger than in *C. vetulus*. Fur close and uniform, not intermixed with long black piles; long hairs of back about 33–35 mm. in length. General colour above clear grey suffused with the buffy of the underfur, the net result being nearest to Ridgway's "smoke-grey." Individually the longer hairs are light for their basal and black for their terminal halves, with a white subterminal ring about a quarter of an inch from their tip. Underfur brownish plumbeous basally, buffy clay-colour terminally. Under surface little paler, dull brownish, lighter in the axillæ and groins. Muzzle and chin blackish. Crown like back, but the light ends to the underfur almost obsolete. Back of ears brown, grizzled with clay-colour; longer hairs of inner surface creamy; a large postauricular patch yellowish clay-colour. Forearms and thighs like body; hands and feet, both above and below, blackish brown. Tail brownish grey, broadly washed with black at the end and over the caudal gland.

Skull, as compared with that of *C. vetulus*, markedly larger throughout; interorbital region longer and narrower, the part behind the postorbital processes specially lengthened; frontals smooth and swollen; palatal foramina very long; palate ending opposite to middle of m.²; mesopterygoid fossa long, the distance from the hinder edge of the palate to the concavity below the hamular processes 22 mm.; front edge of præsplenoid 6 mm. behind the palatal edge. Penis-bone of the usual canine canoe-shape, but much less strongly keeled than in the one example of *C. vetulus* available.

Teeth of the general type of those of *C. vetulus*; p.⁴ short and rounded; a supplementary and probably abnormal m.³ present on each side, longer on the left than on the right.

Dimensions of the type, measured in the flesh:—

Head and body 650 mm.; tail 310; hind foot (s. u.) 130; ear 76.

Skull—greatest length 122 mm.; basal length 112; zygomatic breadth 63·5; nasals, length mesially 38; interorbital breadth 19; tip to tip of postorbital processes 26; intertemporal breadth 17·8; breadth of brain-case 43·5; palatal foramina (singly) $8 \times 2\cdot5$; palate length 56; length of os penis 47.

Teeth—p.⁴, length on outer border 8·2; m.¹ $8 \times 9\cdot5$; m.² $6\cdot4 \times 8\cdot6$; combined length of m.¹ and m.² 14·5. P.₄, length 64; m.₁ 10, m.₂ 6·7, m.₃ 4·4.

This Dog differs from *C. vetulus*, to which it is no doubt allied, in its darker and greyer general colour, its blackish feet, and larger skull. The possession by the only specimen of a third pair of upper molars is probably an individual abnormality, but occurring here in one of the most primitive types of Canidæ it presents a very interesting and suggestive case of atavism. For this reason alone further examples of this animal will be welcomed with interest, to see how frequently the extra teeth are present.

I have named this distinct animal in honour of the late Mr. Percy Sladen, whose valuable zoological work is known to all naturalists, whose death was lamented by a wide circle of friends, and whose widow has chosen the most useful and suitable way of perpetuating his memory by bearing the expense of Mr. Robert's expedition to Central Brazil.

13. CANIS VETULUS Lund.

♂. 1108.

♀. 1189.

Quite alike externally, these two specimens differ surprisingly in the size of their molars, the female having the larger. Further specimens will be needed before this difference can be explained, but it may be noted that the larger-toothed specimen agrees closely with typical *C. vetulus*, whilst that with the smaller teeth has an equal resemblance to the wrongly localized type of Gray's "*Lycalopex fulvicaudus*, var. 1. *chiloensis*."*

14. SPEOTHOS VENATICUS Lund.

♀. 1127.

The Bush-dog is seldom captured by collectors, and this excellent specimen is a valuable accession to the Museum.

15. GALERA BARBARA L.

♂. 1064, 1117.

♀. 1065.

16. NASUA NASUA L.

♂. 1043, 1054, 1056, 1057, 1069, 1087, 1164.

♀. 1055, 1070, 1071, 1129, 1136, 1137, 1141, 1142, 1156, 1157, 1163.

Among this fine series of eighteen Coatis it might be said that

* P. Z. S. 1868, p. 511; Cat. Carn. B. M. p. 198 (1869).

no two can be found that are exactly alike, the set ranging in colour from uniform red to nearly uniform black, and varying as much in details as in general tone. The skulls also vary very considerably both in size and in the development of their bullæ, the extremes appearing at first sight to be quite different species, but being connected together by every gradation.

17. *SCIURUS LANGSDORFFI* Brandt.

♂. 1088, 1154, 1177, 1182, 1195.

♀. 1081, 1124, 1155.

A valuable series representing the true *S. langsdorffi*, which name has been applied by various authors to many different members of the group.

18. *RHIPIDOMYS ROBERTI*, sp. n.

♂. 1023, 1140.

A *Rhipidomys* intermediate in size of skull between the large species of the *R. macrurus-latimanus* group, and the small ones allied to *R. phœotis*; most nearly related to the latter.

Fur of medium length; hairs of back about 7-8 mm. in length. General colour above dull fulvous or "clay-colour," finely lined with black. Sides clearer and more buffy, bordered below by a clear ochraceous-buff line edging the pure sharply-defined white of the belly. Face like back, rather less heavily lined. Cheeks buffy, like sides. Eyes without darker rings. Ears of medium length, brown, not strongly contrasting with the general colour. Outer side of arms and legs like flanks, inner pure white on the fore limb down to the wrists, but on the hind limb only halfway down to lower leg, the fulvous passing round the ankles; hands and feet dull whitish. Tail fairly long, rather less hairy than usual in this genus, its basal inch furry all round and coloured like the body; the remainder uniformly brown.

Skull shaped most like that of *R. benevoleus*, although much larger. Supraorbital ridges fairly well developed, evenly divergent backwards. Outer plate of anteorbital foramen scarcely developed anteriorly. Palatal foramina of medium length, narrow and pointed anteriorly, broadly open posteriorly; not reaching back to the level of m.¹ Interpterygoid fossa of normal shape, with rounded anterior border.

Dimensions of the type, measured in flesh:—

Head and body 110 mm.; tail 145; hind foot (s. u.) 25, (c. u.) 26·7; ear 16.

Skull—greatest length 32 mm.; basilar length 24·5; greatest breadth 16; length of nasals 11; interorbital breadth 5·6; breadth of brain-case 14; length of palate 13·6; diastema 8; palatal foramina $5 \times 3\cdot1$; length of upper molar series 4·8.

Type. Adult ♂. B.M. No. 3.7.7.67. Original number 1023. Collected 6 July, 1902.

Although Mr. Robert's trunk measurement of the type of this species is slightly less than that given by Mr. Simons for *R. phœotis*,

its skull is very markedly larger, and its teeth even more so. That is, however, the species with which it seems most nearly allied.

The presence of *Rhipidomys roberti*, like that of *Neacomys*, gives evidence of the affinity of the Cuyabá region of Matto Grosso with the eastern slopes of the Andes, from which all the previous members of this group have hitherto come.

In naming this distinct species after Mr. Robert I wish to make very special acknowledgment of the admirable work he has been doing in South America during the last three years. His collections, perfectly prepared in spite of all the difficulties incidental to a damp tropical climate and uncivilised surroundings, have revolutionised the material available in the British Museum for the study of the Mammals of Southern Brazil. Numbers of species, previously known to us only by the original descriptions or by a few unmeasured, discoloured, or otherwise imperfect specimens, are now represented by series of perfect skins with all the details incidental to good modern work. And again, the present collection, formed in a still more difficult country, links up in the centre his own Eastern Brazilian material with that obtained along the edges of the Andean chain by the late Mr. Perry O. Simons.

19. *NECTOMYS SQUAMIPES MATTENSIS*, subsp. n.

♂. 1005, 1019, 1025, 1037, 1050, 1203.

♀. 1031, 1033, 1048, 1109, 1131.

External characters as in true *squamipes* and in *garleppi*; the latter also appears to grade into *squamipes*.

Skull rather shorter and more rounded, less slender and elongated than in true *squamipes*. Nasals as usual narrow and elongate. Supraorbital edges with a marked raised bead, more developed than in *squamipes*, much more than in *garleppi*. Interparietal small, narrow antero-posteriorly, its anterior edge generally directly transverse. Palatal foramina long, widely open, with a slight angular constriction at the junction of their anterior and middle thirds. Opening of posterior nares wide, the edge of the palate squarely transverse, the median pterygoid fossa broader anteriorly than posteriorly, its breadth in front greater than the length of m.¹ Lateral pterygoid fossæ proportionally narrow and sharply pointed anteriorly. (In *N. squamipes* the median fossa is narrow anteriorly, broadening backwards, with a rounded anterior border.)

Dimensions of the type, measured in the flesh:—

Head and body 200 mm.; tail 200; hind foot (s. u.) 47 (extremes 44–47), (c. u.) 50; ear 24.

Skull—greatest length 43 mm.; basilar length 34·6; zygomatic breadth 22·2; interorbital breadth 7; interparietal 3·4 × 11·5; palate length 20·4; palatal foramina 7·5 × 3·2; breadth of posterior palatal fossa anteriorly 3·8; length of upper molar series 6·3.

Type. Adult male. B.M. No. 3.7.7.71. Original number 1050. Collected 30 July, 1902.

The difference in the structure of the pterygoid fossæ, perfectly uniform throughout the series, seems to make it necessary to give a special name to the Matto Grosso Water-rat; but as lower down the same river, in Paraguay, specimens agreeing with the true *N. squamipes* occur, I only distinguish it as a subspecies.

It may be noted as a curiosity that a very large proportion of the skulls of *Nectomys*, even when quite old, have their median interparietal suture open, a characteristic very rare in mammals generally.

20. *ORYZOMYS LATICEPS* Lund.

♂. 1003, 1007, 1008, 1020, 1052, 1053, 1062.

♀. 1004, 1006, 1010, 1016, 1026, 1049.

These specimens appear to be certainly identical with those obtained by Mr. Robert on the Rio Jordão*, S. Minas Geraes, not far from the typical locality of the species.

21. *NEACOMYS SPINOSUS AMÆNUS*, subsp. n.

♂. 1061, 1077, 1188.

♀. 1036, 1051.

Size averaging slightly larger than in the true Peruvian *N. spinosus*, and tail rather longer. General characters very much as in that animal, in spite of the great distance between the localities. Fur shorter and thinner than in *spinosus*, especially on the under surface. Colour above bright ochraceous, liberally lined with black along the back, but the dorsal area nevertheless not nearly so dark as in *spinosus*. Sides clearer fulvous, the yellowish line along their lower edge not so sharply defined as in *spinosus*. Belly and inner sides of limbs white, the hairs white to their roots; line of demarcation not very sharply defined. Face rather greyer than body. Ears uniformly brown. Arms and legs like sides, or rather duller; hands and feet dull whitish.

Skull as usual varying a good deal in size and shape, but in a general way that of subsp. *amænus* is a little larger than that of *spinosus*, with more rounded brain-case, less developed supraorbital ridges, and slightly larger palatal foramina, but none of these points can be regarded as really distinctive.

Dimensions of the type, measured in the flesh :—

Head and body 90 mm. (extremes 80–90); tail 102 (102–112); hind foot (s. u.) 23 (22–24), (c. u.) 24·5; ear 16 (14–16).

Skull—greatest length 24·6 mm.; basilar length 18·1; zygomatic breadth 12·7; interorbital breadth 4·3; palatal foramina 4; length of upper molar series 3·1.

Type. Old male. B.M. No. 3.7.7.84. Original number 1077. Collected 11 August, 1902.

The occurrence of a *Neacomys* in this region was quite

* Cf. Ann. Mag. N. H. (7) viii. p. 530 (1901).

unexpected, as also is the close resemblance it bears to the typical *N. spinosus* of Peru, from which it differs chiefly by its brighter, clearer colour.

22. *PROECHIMYS LONGICAUDATUS* Rengg.

♂. 1011, 1024, 1027, 1034, 1046, 1047, 1114, 1190, 1197, 1201, 1204.

♀. 1009, 1021, 1035, 1078, 1113, 1185, 1187, 1194.

Rengger's type was obtained on the 21st parallel of latitude, therefore not far south of Corumbá. It would be interesting to get absolute topotypes of it, but the Chapada series no doubt belongs to the same species. It is nearly allied to my *P. bolivianus*, which differs from it by the cranial characteristics given in the description of the latter.

23. *COENDOU BRANDTI* Jent.

♂. 1075, 1167, 1183.

These specimens may be considered to represent typically Dr. Jentink's species, for Brandt's figures, on which the name was founded, were from specimens in the Langsdorff collection, and as *Sciurus langsdorffi* came from Matto Grosso, the Porcupine may very likely have done so as well. The skull exactly agrees with these original figures.

C. brandti is certainly very closely allied to Gray's *C. boliviensis*, but the skull differs in certain details, as to the constancy or otherwise of which no opinion can be expressed until a much larger series has been examined.

24. *COENDOU CENTRALIS*, sp. n.

♂ 1147. 22 September, 1902. *Type*. (B.M. No. 3.7.7.102.)

A member of the group for which Dr. Jentink has used the name of *prehensilis*. The skull less swollen than in *C. brandti*.

Size about the same as in *C. brandti*; relative development of spines and hair as in that species. General colour rather darker, owing to the greater extension of the black on the spines, but there is no very material difference in this respect. Belly browner. Tail decidedly darker, especially along the middle line below.

Skull of the same less swollen type as is figured by Cuvier* and considered by Jentink to be *prehensilis*. Nasals comparatively long and narrow, parallel-sided. Palatal foramina very small as compared with those of a Rio Jordão (São Paulo) specimen of *C. prehensilis*. Teeth smaller than those of *C. brandti*.

Dimensions of the type, measured in the flesh:—

Head and body 480 mm.; tail 530; hind foot (s. u.) 80, (c. u.) 90, from back of hallucal climbing pad (s. u.) 66.

Skull—greatest length 94 mm.; basilar length 82; greatest breadth 53; nasals 32×25 ; least interorbital breadth 35; greatest

* Mém. Mus. ix. pl. 20. fig. 3 (1822).

breadth across postorbital projections 46; greatest height from palate 45; palate length 42; diastema 26.2; palatal foramina 5.4×4.2 ; length of upper molar series 19.6.

Type. No. 1147 as above. Killed 22 September, 1902.

It seems curious that two Porcupines of the *prehensilis* group should occur at Chapada, but, as pointed out by Dr. Jentink, the skull-differences between *brandti* and the less swollen headed animal are too great to be due to individual variation. That *C. centralis* is not the true *C. prehensilis* is shown by its differences from a specimen obtained in São Paulo, this latter locality being far closer to the region whence Maregrave described his "Cuandu," the original prototype of Linnæus's *C. prehensilis*.

25. DASYPROCTA AZARÆ Licht.

♂. 1209.

I can find no tangible difference between examples of this wide-ranging form from Chapada, from Paraguay, and from São Paulo. But in each locality the specimens differ considerably in colour *inter se*.

I may take this opportunity to point out how very different from all other Agoutis the long-tailed form, *D. acouchy*, is, and to suggest that it ought to form a special genus. This might be called *Myoprocta*; and its main distinguishing characters would be the well-developed tail and conspicuously smaller teeth.

26. AGOUTI PACA L.

♀. 1067, 1073.

27. SYLVILAGUS MINENSIS CHAPADÆ, subsp. n.

♂. 1059, 1076, 1107, 1119, 1121, 1122, 1123, 1168, 1206.

♀. 1042, 1066, 1153, 1165, 1173.

Closely similar in all characters to the true *S. minensis* of Southern Minas Geraes, but the colour throughout perceptibly lighter. The back, which has the even lining of *S. minensis* and not the coarse mottling of *S. paraguensis*, is several shades lighter in tone, the sides and rump are a light greyish, and the cheeks are less blackened. Terminal half of ear a lighter brown. Nape-patch nearer "ochraceous buff," though duller, while that of *minensis* approaches "tawny" or "tawny ochraceous."

In other respects, in size, proportions, length of ears, and characters of skull, I can find no difference between the Chapada Hare and the typical *S. minensis* obtained by Mr. Robert on the Rio Jordão.

Dimensions of the type, measured in the flesh:—

Head and body 355 mm.: hind foot (s. u.) 76; ear-opening 60.

Skull—greatest length 74 mm.; basilar length 59.

Type. Female. B.M. No. 3.7.7.116. Original number 1066. Collected 4 August, 1902.

This is evidently a pale form of the Hare which is found over most of Southern Brazil, the true *brasiliensis* being, as shown in

1901*, a smaller animal occurring near Rio Janeiro. It is possible that the more coarsely mottled *S. paraguensis* will also prove to grade into the present form.

Baby specimens of *minensis*, *chapadæ*, and *paraguensis* are as readily distinguishable from each other as are the adults.

28. *TAYASSU ALBIROSTRIS* Ill.

♀. 1144, with two fetuses 1145 and 1146.

29. *TAYASSU TAJACU* L.

♂. 1120, 1126, 1169.

♀. 1074.

30. *MAZAMA RUFA* F. Cuv.

♂. 1095.

Yg. ♂. 1044.

31. *MYRMECOPHAGA TRIDACTYLA* Linn.

♂. 1128, 1180.

♀. 1151, 1179.

The reasons for using the above name are given in 'American Naturalist,' xxxv. p. 143 (1901).

32. *TAMANDUA TETRADACTYLA* Linn.

♂. 1038, 1103, 1106, 1112, 1125, 1149.

♀. 1017, 1058, 1084, 1181.

33. *DASYPUS GILVIPES* Licht.

Tatou poyou Azara, Quadr. Paraguay, ii. p. 142 (1801).

Dasypus gilvipes Ill. Abh. Ak. Berl. 1811, p. 108 (pub. 1815) (nomen nudum).

Dasypus gilvipes Licht. Abh. Ak. Berl. 1815, p. 215 (pub. 1818).

Dasypus encoubert Desm. Mamm. ii. p. 370 (1822).

♂. 1138, 1166, 1199.

♀. 1072.

Under the name of *Dasypus sexcinctus* L. both the North and South Brazilian forms of this group have commonly been confounded, but since they differ conspicuously in size and are clearly different, it is necessary to consider which species should bear Linnaeus's name.

Acting on the general principle that the first reference to Linnaeus's own works should be taken as a guide in identifying his species, we get in this case a reference to the "Mus. Ad. Fr." (p. 7), and the specimen mentioned in that work would be the type. That specimen is still in the Stockholm Museum, and Prof. F. A. Smitt has been kind enough to inform me that its cephalic shield is 77 mm. in length. This corresponds closely with the

* Ann. Mag. N. H. (7) viii. p. 535.

size of examples from Pará, while those from South Brazil and Matto Grosso agree with Paraguayan specimens in having this dimension about 105 mm. *D. sexcinctus* will therefore stand for the N. Brazilian form, and *D. gilvipes*, based on Azara's Tatou pouyou, for the large southern one.

34. TATU NOVEMCINCTUS L.

♂. 1032, 1040, 1079, 1102, 1133, 1148.

♀. 1039, 1202.

35. TATU MEGALOLEPIS Cope.

♀. 1115.

As a topotype of Cope's species, hitherto unrepresented in the Museum collection, this Armadillo forms a valuable accession. The species is perhaps not so widely separated from *T. septemcinctus* as its describer supposed, for this specimen has 45-47 scales in the movable bands, and the Museum contains examples of *septemcinctus* from Rio Grande do Sul with only 54, so that the gap between the two, stated by Cope to be from 43 to 57, is thereby considerably reduced.

In size *T. megalolepis* is decidedly smaller than the older known species, the skull of Mr. Robert's example being only 63 mm. in length.

36. DIDELPHIS PARAGUAYENSIS Oken.

♂. 998.

♀. 1207.

Practically topotypes of Wagner's *D. pæcilotis*, which was collected at Cuyabá.

37. MARMOSA CONSTANTIE, sp. n.

♂. 1110. 27 August, 1902. *Type*. (B.M. No. 3.7.7.157.)

Size rather larger than in *M. cinerea*. Fur close and fine, shorter and less woolly than in *M. cinerea*; hairs of back about 9 mm. in length. General colour above paler than usual in this group, nearly matching Ridgway's "isabella," or slightly greyer. On the sides the colour gradually becomes more buffy, passing gradually into the "buff-yellow" of the under surface, the chin, chest, centre of belly, inner side of limbs, and inguinal region being all of this latter colour. On the sides of the belly the hairs are slaty at base, but on the rest of the under surface they are yellow to their roots. Face pale buffy grey; black orbital rings present, but narrow, ill-defined, and not prolonged forwards on to the sides of the nose. Cheeks to base of ear dull buffy yellow. Ears large, naked, greyish brown. Outer side of fore and hind limbs dull buffy isabella, like the sides. Tail rather shorter than usual in this group, its basal furry portion about $1\frac{1}{2}$ inches in length, brownish isabella above, yellowish below; naked portion about half brown and half white, the junction of the two colours mottled and irregular.

Skull stout and strong, with broadly spread zygomatic arches, expanded nasals, well developed postorbital processes, and broad interorbital region. Palatal vacuities about normal, opposite the first three molariform teeth.

Middle upper premolar about equal to the posterior; middle lower one rather larger than that behind it. Molars large, as in *M. cinerea*, markedly larger than in *M. regina*.

Dimensions of the type, an old male, measured in the flesh :—

Head and body 180 mm.; tail 195; hind foot (s. u.) 27; ear 31.

Skull—greatest length 45.8 mm.; basal length 42.1; zygomatic breadth 26.6; nasals, length 20.7, greatest breadth 6.8, least breadth 3.2; interorbital breadth 8.2; breadth across postorbital processes 10.1; breadth of brain-case 16; palate length 25; length of three anterior molariform teeth 7.8.

Marmosa constantiae is larger, paler, and has a shorter tail than *M. cinerea*, its nearest ally, with which it shares the characteristic shape of skull and nasals. The Bogotá *M. regina* Thos. has a narrower skull, less expanded nasals, and unicolor tail.

I have named this pretty species in honour of the donor of the present most valuable accession to the National Collection, in recognition of her enlightened method of commemorating her late husband's memory.

EXPLANATION OF PLATE XXVII.

Canis sladeni, sp. n., p. 235.

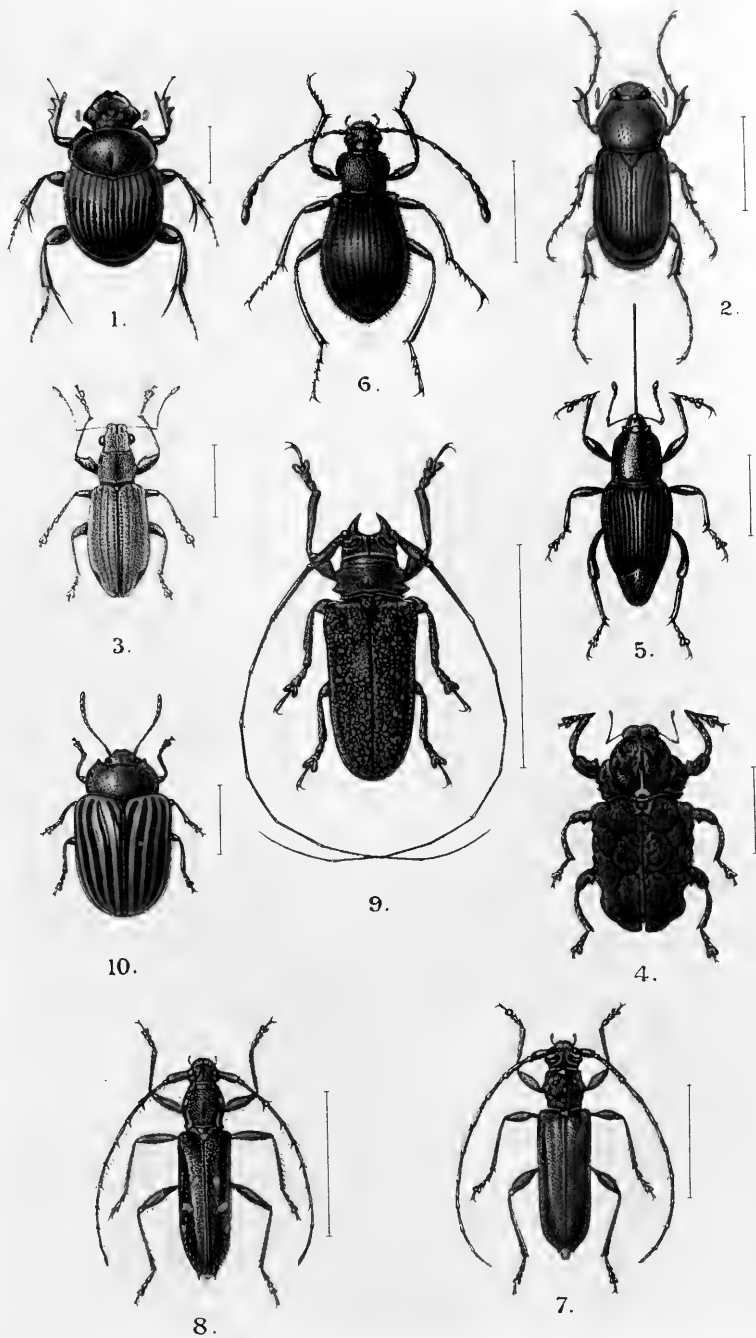
3. List of the Coleoptera collected by Mr. A. Robert at Chapada, Matto Grosso (Percy Sladen Expedition to Central Brazil). By C. J. GAHAN, M.A., and G. J. ARROW.

[Received August 18, 1903.]

(Plate XXVIII.*)

In this collection the Lamellicornia, Longicornia, and Phytophaga are especially well represented; but, since our knowledge of the coleopterous fauna of Brazil is mainly confined to more northern regions, the whole collection, which contains specimens of 175 species, forms a valuable contribution to the materials available for the study of the distribution of South American insects. New species of Lamellicornia, Rhynchophora, Heteromera, Longicornia, and Phytophaga are described, and there are in addition others which, for want of sufficient specimens or other reasons, it is not advisable at present to describe. The earlier groups, as far as and including the Rhynchophora, have been dealt with by Mr. Arrow, while for the remainder Mr. Gahan is responsible.

* For explanation of the Plate, see p. 258.





All the Coleoptera were collected by Mr. Robert in the month of November at an altitude of 800 metres.

In an Appendix a few new forms contained in a collection from Paraguay, simultaneously received from Mr. W. Foster, have been described.

CICINDELIDÆ.

Odontochila discrepans Horn.

Prepusa distigma Dej.

CARABIDÆ.

Brachygnathus sp. near *imperialis* Chaud.

GYRINIDÆ.

Enhydrus tibialis Rég.

STAPHYLINIDÆ.

Staphylinus sp.

HISTERIDÆ.

Homalodes brasilianus Mats.

NITIDULIDÆ.

Colastus latus Murray.—Murray described this species from Mexican specimens, and gave the name *C. tonsus* to an individual from Brazil, but I am unable to distinguish them and believe all will be found to represent a single widely-distributed species.

DERMESTIDÆ.

Dermestes vulpinus F.

BYRRIDÆ.

Chelonarium ornatum Perty.

EROTYLIDÆ.

Morphoides sp.

COCCINELLIDÆ.

Epilachna cacica Guér.

Poria sp.

PASSALIDÆ.

Neleus punctiger Perch.

COPRIDÆ.

Ontherus sulcator F.

O. sp.

Canthidium sladeni, sp. n.

Canthon histrio Lep. & Serv.

C. chalybæus Blanch.

C. edentulus Har.

C. sp.

Deltochilum fuscocupreum Bates.

Deltochilum cupricolle Luc.
Pinotus roberti, sp. n.
P. fissus Har.
P. nesus Oliv.
P. carbonarius Mann.
P. subcaneus Lap.
Phancæus mimas Linn.
P. palemo Lap.
P. paleno Blanch.
P. kirbyi Vigors.
Gromphas inermis Har.

MELOLONTIIDÆ.

Astæna 2 spp.
Ceraspis cornuta Blanch.
Isonychus griseus Mann. (?).
Clavipalpus tenuis, sp. n.
Liogenys sp.
Lachnosterna fulvipennis Blanch.

RUTELIDÆ.

Anomala 2 spp.
Macraspis pantochloris Blanch.
Pelidnota sumptuosa Vigors.—A series of this species was obtained showing nearly every shade of metallic colouring.
Pelidnota æruginosa Linn.
Leucothyreus pruinosus Perty.
L. sp.

DYNASTIDÆ.

Cyclocephala 14-*punctata* Mann.
C. sp.
C. ovulum Bates.
Bothynus ascanius Kirby.
B. sp.

CETONIIDÆ.

Gymnetis liturata Oliv.
G. sp.
Euphoria lurida Fab.

CURCULIONIDÆ.

Naupactus perpastus Schön.
N. 5 spp.
Pantomorus sp.
Hoplopactus lateralis, sp. n.
Platyomus transversesignatus Schön.
P. argyreus L.
Rhigus latruncularius Perty.
Homalonotus validus Oliv.
Hilipus nævulus Mann.

Hilipus validus Pasc.

H. sp.

Rhinochenus reichei Boh.

R. stigma L., var. (?).

R. 2 spp.

Cryptorhynchus 3 spp.

Celosternus sturio, sp. n.

Centrinus 4 spp.

Copturus sp.

Belopæus niger, sp. n.

Rhynchophorus palmarum L.

ELATERIDÆ.

Chalcolepidius limbatus Esch.

Pyrophorus noctilucus Linn.

P. janus Herbst.

P. sp.

Monocrepidius sp.

LAMPYRIDÆ.

Lucidota sp.

BOSTRYCHIDÆ.

Bostrychopsis uncinata Germ.

TENEBRIONIDÆ.

Epitragus sp.

Nyctobates variolosa Fab.

N. gigas Linn.

Zophobas opacus Sahlb.

Calymmus cucullatus Pasc.

Scotinus (?) sp.

Uloma retusa Fab.

U. sp.

Camaria lævipennis (Dej.).

Strongylium azureum Germ.

S. sp.

Hoploptera sp.

CISTELIDÆ.

Prostenus cyanipes Lucas.

P. sladeni, sp. n.

Lystronychus cæruleus Sol., var.

L. latipennis Mäklin.

MELOIDÆ.

Epicauta atomaria Germ.

E. strigata Gyll.

E. sp.

E. sp.

E. sp.

Tetraonyx sexguttatus Oliv.

PRIONIDÆ.

- Malodon spinibarbe* Linn.
Anacanthus costatus Serv.

CERAMBYCIDÆ.

- Achryson surinamum* Linn.
Hammaticherus lacordairei Gahan.
Butherium corvinum Germ.
Xestia suturalis Perty.
X. polita Waterh.
Sphæron sladeni, sp. n.
Trichophorus electus, sp. n.
Octoplon flavopictum Perty.
Callichroma suturale Fab.
Lophonocerus barbicornis Linn.
Dorcacerus barbatus Fab.
Oxymerus basalis Dalm.
Rhachidion obesum Newm.
Megaderus stigma Linn.

LAMIIDÆ.

- Hypsioma* sp.
H. fasciata Thoms.
Oncideres sladeni, sp. n.
Steirastoma stellio Pasc., var.
Acanthoderes lateralis Bates, var.
Edopeza pogonocheroides Serv.

BRUCHIDÆ.

- Caryoborus* sp.

CLYTHRIDÆ.

- Euryseopa proxima* Lac.
Megalostomis obesa Lac.
Tellena varians Lac.
Urodera familiaris Lac.

CHLAMYDIDÆ.

- Chlamys hieroglyphica* Koll.
C. smaragdina Klug.
C. cistella Germ.
Poropleura cuprea Klug.

CRYPTOCEPHALIDÆ.

- Griburius prætextatus* Suffr.
Metallactus kollari Suffr., var.
M. sp.

LAMPROSOMIDÆ.

- Lamprosoma chamæleon* Lac.
L. viride Lac.

EUMOLPIDÆ.

- Lamprosphaerus thoracicus* Baly.
L. scintillaris Baly.
Iphimeis fulvipes Baly.
Agbalus sp.
Colaspis 14-*costata* Lefèv.
C. flavipes Oliv., var.
C. sp.
C. sp.
Chalcophana viridipennis Germ.
Eumolpus surinamensis Linn.
E. clavipalpus Chap.

CHRYSEMELIDÆ.

- Doryphora flavozonata* Blanch., var.
Deuterocampta 12-*maculata* Stål.
D. musicalis Stål.
D. sladenæ, sp. n.

HALTICIDÆ.

- Crimissa piceicollis* Jac.
Edionychis opima Germ.
Æ. nigropunctata Clark.
Æ. 12-*notata* Clark.

GALERUCIDÆ.

- Galerucella* sp.

HISPIDÆ.

- Alurnus thoracicus* Perty.
A. nigripes, Guér.

CASSIDIDÆ.

- Tauroma* sp.
Dolichotoma strigata Hoff.
Batonota gregaria Bohem.
B. ensifer Bohem.

CANTHIDIUM SLADENI, sp. n. (Plate XXVIII. fig. 1.)

C. decorato valde affine, sed plerumque paullo minor, profundius sculpturatum aliterque coloratum. Fusco-viride, capite prothoraceque late viridibus, elytrorum dimidio basali rufo-cupreo; capite sat fortiter punctato, medio leviter tuberculato, clypeo bidentato; prothorace crebre punctato, lateraliter fere regulariter arcuato, postice medio angulato, subtiliter marginato; elytris profunde punctato-striatis, interstitiis convexis; pygidio minute punctato.

Long. 7-8.5 mm.

The elytral interstices of this insect are more convex than in any other species of the large genus *Canthidium* known to me.

It can only be compared with *C. decoratum* Perty, these two being the only forms with parti-coloured elytra, at least in the normal condition. In *C. decoratum*, however, the elytra are not coppery, and the posterior half is blue, while in the new species it is green and is bounded anteriorly by a backwardly-curved line. In *C. decoratum* the line of demarcation is angular, and its projection is in the opposite direction, so that it almost touches the base of the elytra at the suture. This line is less distinct in *C. sladeni*, owing to the deeper coppery-red colour of the anterior half of the elytra and their more deeply-channelled surface. The new species appears to be slightly smaller on the average than *C. decoratum*, judging from the series of five specimens of each in the British Museum.

PINOTUS ROBERTI, sp. n.

P. carolino atque eremitæ valde affinis, sed plerumque paullo major; crassus, niger, postice plagis griseis decoratus; capite utriusque sexus ut in P. eremita carinato, maris carinæ angulis paullo magis productis, thoracis lobo mediano minus quadrato, leviter sulcato, sulci fundo absque stria, tuberculo laterali minuto acuto, haud cariniformi.

Long. 27–32 mm.

Hab. Brazil: Chapada, Pará.

This is one of the small group of species in which the elytral striae are posteriorly dilated and filled with a greyish earthy secretion. It is very closely related to *P. eremita* Har., of Venezuela and Colombia, but the average size is rather larger and the thorax of the male shows slight differences of form. The median lobe is more rounded, its lateral angles being hardly traceable, and the longitudinal depression down its centre has no definite stria at the bottom. Above the lateral fossa of the thorax there is a short acute tubercle, which is represented in *P. eremita* by an elongate crest. I am unable to compare the female of *P. roberti* with that of *P. eremita*, the five specimens of the latter in the British Museum being all males; but the sexes of the new species differ extremely little. The head of the female is more elongate and pointed, and there is a broad crest very similar to that of the male but placed farther back. The centre part of the prothorax is only slightly less prominent. There is generally a trace of a median stria, and the tubercles above the lateral fossae are not acute. The elytral furrows which contain the remarkable earthy deposit are larger in the female than in the male in this and the other species characterised by this peculiarity.

Mr. Robert found nine specimens of this species, among which one only is a male. A second male from Pará was confused with our series of *P. eremita*, so that the species is a fairly widely distributed one. Its very close similarity to the more northern form is no doubt the reason for its having hitherto escaped detection.

CLAVIPALPUS TENUIS, sp. n. (Plate XXVIII. fig. 2.)

Elongatus, convexus, rufo-castaneus; capite parvo, crebre punctato, clypeo parabolico, margine leviter reflexo; prothorace polito, profunde irregulariter punctato, lateribus valde angulatis, angulis anticis et posticis obtusis; scutello utrinque leviter punctato; elytris haud regulariter striato-punctatis, interstitiis minutius haud crebre punctulatis, feminae interstitio secundo lato grosse punctato-rugoso; pygidio convexo, crebre punctato, linea media laevi; corpore subtus lateribusque fulvo-pilosis, segmento abdominali 5^o maximo; antennis 10-articulatis, maris clava longitudine ad stipitem aequali; tibiis anticis 3-dentatis, unguibus omnibus fissis, maris tarsis anticis et posticis quam tibiis plus duplo longioribus.

Long. 22-13 mm.

This is a more slender insect than any other species of *Clavipalpus* known to me, but conforms in all essential particulars to the generic type. It is smooth and shining on the upper surface, with rows of deep but rather irregular punctures upon the elytra. The head is small and the clypeus regularly rounded, the prothorax very convex and much narrowed in front and behind, and the elytra long and of approximately equal width throughout their length. The antennae are ten-jointed, but the articulation between the 5th and 6th joints is less distinct in the female than in the male. The former sex appears in this genus to be less easily found than the male, and I believe has not hitherto been described. The enlargement of the terminal joint of the maxillary palpus, from which the genus has received its name, occurs in the male only, but in the present species this joint is of normal size in both sexes. In all the species the 5th ventral segment is very large in the female, and the distinction drawn by Lacordaire between the Macroductylides and Clavipalpides (viz. the absence of this enlargement in the latter) is therefore misleading. The segment is enlarged in both sexes, but especially in the female.

HOPLOPACTUS LATERALIS, sp. n. (Plate XXVIII. fig. 3.)

Elongato-ovatus, fuscus, squamis griseis vel sulphureo-cinereis, aequaliter sed haud dense obtectus, margine laterali sparse viridi-squamoso, squamis marginem intus attingentibus densius aggregatis, viridi-argenteis, corporis subtus squamis viridibus et roseo-argenteis, abdomine medio denudato; capite lato, rostro breve, antice vix angustato; prothorace transverso, lateribus aequaliter arcuatis; elytris punctato-striatis, margine obscuriore irregulari, paullo ante apicem subito dilatato; pedibus rufo-fuscis, griseo-setosis, squamis pallide viridibus interspersis, femoribus magis fuscis, anticis intus spino acuto post medium armatis.

Long. (rostr. excl.) 8-9 mm.

This is the sixth species so far assigned to the genus, and is easily recognisable by the dark external margin of the elytra

expanding just before the apex, and clearly defined by the massing together and brighter coloration of the scales bordering it internally. The head and thorax are rather broader than in *H. injucundus* Schön., the rostrum shorter and the thorax as wide in front as behind.

A dozen specimens were collected.

Cœlosternus sturio, sp. n. (Plate XXVIII. fig. 4.)

Crassus, niger, argillaceo-squamulosus, subtus squamulis pallidioribus vestitus, prothoracis maculis magnis inferioribus lateralibus maculaque parva dorsali albo-flavis, hac sagittiformi ad marginis postici medium posita; elytris nodosis, squamulis argillaceis aggregatis, squamas magnas quasi-piscinas formantibus, videlicet suturalibus 5, quarum 2 internalibus acute tuberculatis, lateralibusque 4, setis minutissimis albidis ubique rare sparsutis squamulisque albidis ad margines lateralia irregulariter aggregatis; capite postice profunde sulcato, utrinque transverse carinato; prothorace medio acute longitudinaliter carinato, antice valde constricto, postice lateribus valde arcuatis et crenatis, angulis obsoletis; femoribus omnibus medio fortiter dentatis.

Long. (rostr. excl.) 10 mm.

This curious Weevil is remarkable for the manner in which the earthy-coloured scales of the elytra are aggregated into large areas resembling the scales of a Ganoid fish, and separated by a very fine network of black scales. These areas are elevated in the centre, the four median ones adjoining the suture very strongly and acutely. The posterior part of the head is furrowed and transversely elevated on each side of the furrow, and the centre of the pronotum is longitudinally elevated. The only other species with which this can be compared is *C. exornatus* Boh., which is smaller, narrower, and more brightly coloured. In this species also the scales upon the elytra tend to form isolated patches separated by darker intervals. In *C. sturio*, however, the patches have spread over the entire surface and are divided only by extremely narrow lines.

The unique type-specimen is probably a male.

Belopæus niger, sp. n. (Plate XXVIII. fig. 5.)

Ellipticus, niger, nitidus, elytris velutinis, rostro tenue, ad prothoracis et elytrorum longitudinem æquali; prothorace nitido, haud dense punctato, absque sulcis, antice constricto, lateribus ab ante medium fere parallelis; elytris opacis, velutinis, profunde striatis, interstitiis seriatim punctatis, singulo postice arcuate truncato; pygidio velutino et fulvo-setoso, grosse punctato; corpore subtus polito, sterni lateribus abdominisque segmento ultimo punctatis.

Long. (rostr. excl.) 10 mm.

Hab. Brazil: Chapada, Pará.

In all structural features this insect is similar to the only

hitherto described species of its genus, *B. carmelitus* Gyll. It is larger, however, and has a still more slender rostrum, which in a specimen brought by H. W. Bates from Pará is as long as the prothorax and elytra together. In the Chapada specimen it is slightly shorter. This may be the other sex, but I think most probably both are females. The polished surface of this species, clothed only upon the elytra with a velvety tomentum, and the uniform black colour are quite sufficient to distinguish it.

PROSTENUS SLADENI, sp. n. (Plate XXVIII. fig. 6.)

Capite pronotoque viridi-cyaneis, capitis fronte inter antennis dense fortiterque, clypeo parcius, punctato; prothorace quam latitudine basis vix brevior, ante medium latiore, supra omnino fortiter reticulatimque punctato; elytris aeneo-cuprascentibus, nitidis, subovatis, valde convexis, fortiter striato-punctatis, interstitiis inter series punctorum punctis minoribus piligeris, humeris utrisque tuberculo conico munitis; corpore subtus pedibusque cyaneis, nitidis, his longis, femoribus modice clavatis subtiliter parce punctatis, tibiis densius punctatis; antennis medium elytrorum paullo superantibus, articulis quinque ultimis sat valde dilatatis, articulo 3^o quam 4^o paullo longiore.

Long. 12, *lat.* $4\frac{1}{2}$ mm.

Hab. Central Brazil.

Head and prothorax bluish green above, elytra bronzy green and nitid. Head closely and rather strongly punctured between the antennæ, the clypeus being as strongly but less closely punctured. Antennæ reaching beyond the middle of the elytra, with the last four or five joints rather strongly dilated and the 3rd joint perceptibly longer than the 4th. Pronotum widest a little before the middle, very slightly narrowed anteriorly, but distinctly narrowed towards the base, where its width is about equal to its length along the middle; its surface strongly punctured all over, the punctures, many of which are setigerous, forming a reticulation. Elytra strongly punctured in rows, with smaller setigerous punctures on the intervals between the rows, each with a small conical tubercle or prominence at the shoulder.

SPHÆRION SLADENI, sp. n. (Plate XXVIII. fig. 7.)

♀. *Nigrum; elytris aeneo-viridescentibus pube grisea densa et setis rigidis sparsis obtectis; prothorace lateraliter obtuse tuberculato, disco utrinque leviter tuberculato, medio crebre punctulato, plaga parva postico-mediana polita; elytris sat dense punctatis; antennis quam corpore paullo longioribus, articulis 3^o-6^{um} apice vix perspicue spinosis.*

Long. 14, *lat.* $3\frac{1}{2}$ mm.

Hab. Central Brazil.

Black, with the exception of the elytra which have a somewhat brassy-green tint; the whole rather densely covered with a fine greenish-grey pubescence, with here and there some erect fulvous

setæ. The prothorax is obtusely tubercled at the middle of each side, and has two feeble tubercles on each side of the disk; the latter is finely and very closely punctulate, but has a small smooth shining space in its median posterior part. The elytra are distinctly but not very closely punctured, and each has a short exterior spine at the apex and the sutural angle obtuse. The acetabula of the middle coxæ extend outwards to the epimera, the present species agreeing in this respect with *S. cyanipenne* Serv., the type of the genus.

TRICHOPHORUS ELECTUS (Dej. MS.), sp. n. (Plate XXVIII. fig. 8.)

Fusco-brunneus; elytris, pedibus, abdomine et antennarum articulo primo plus minusve rufescentibus; pronoto lineis duabus interruptis flavo-pilosis; scutello flavo; elytris utrisque maculis tribus flavo-pilosis—prima ante medium prope suturam, secunda et tertia obliquiter positæ inter medium et partem tertiam apicalem.

Long. 15–23, *lat.* 4–6 mm.

Hab. Central and South Brazil.

This species greatly resembles *T. interrogationis* Blanch., but has no pubescent spots on the vertex of the head, and the two posterior spots on each elytron are quite separate from each other. It differs also in that the anterior part of the interrupted yellow or white line on each side of the pronotum lies farther back from the anterior margin, especially in the female, in which it forms a small round spot. The antennæ of the female are a little longer than the body, those of the male very much longer. The species has for a long time been represented in the British Museum Collection under the MS. name I have adopted, and has also been known as *T. 7-signatus* Chev. MS.

ONCIDERES SLADENI, sp. n. (Plate XXVIII. fig. 9.)

O. fasciatæ (Lucas) affinis, sed elytris haud fasciatis, prope basin densius granulato-punctatis, vittis nigris infra-ocularibus capitis latioribus.

Long. 20–28, *lat.* 8–10½ mm.

Hab. Central and South Brazil: S. Anna da Chapada, Rio Grande.

This species is the *Oncideres maculosa* of Dejean's Catalogue (*nec* Redtenbacher), and appears to be the *Oncideres amputator* of Thomson (*nec* Fab.). It belongs to the section of the genus in which the thorax is slightly wider behind than in front, and in which the frontal processes of the male are directed forwards and downwards. It is closely allied to *O. fasciata* Lucas, but easily distinguishable from it by the absence of fasciæ from the elytra, the latter being entirely covered with sparse fulvous spots with much smaller spots on the intervals between them. The basal margin of the elytra is fulvous, the scutellum grey; the black bands on the head below the eyes are wider than in the allied

species, each being almost equal in width to the eye itself. The front coxæ of the male have a more or less obtuse tubercle at the distal end.

DEUTEROCAMPTA SLADENÆ, sp. n. (Plate XXVIII. fig. 10.)

Testacea; elytris nigro-fuscis, utrisque margine basali et vittis sex (quarum prima brevissima) aureo-flavis; pronoto medio parce subtiliterque, ad latera fortiter densiusque, punctato; articulo ultimo tarsorum apice subtus bidentato.

Long. 8, lat. 5 mm.

Hab. Central Brazil: S. Anna da Chapada.

Brownish testaceous; elytra blackish brown, each with the basal margin and six longitudinal bands of a golden-yellow colour, the innermost band being very short and narrow; the 2nd and 6th bands unite at the apex, just in front of which they are joined by the 5th; the 3rd and 4th meet a little way in front of the apex, and a short common band unites them with the 5th; distinct rows of punctures mark the boundaries between the alternating yellow and dark brown bands. Antennæ with the first three or four joints testaceous, the rest black; the last five being dilated to form a club. Pronotum sparsely and finely punctured in the middle, strongly and more closely at the sides, near which it is slightly depressed.

In structural characters this species comes close to *D. musicalis* Stål, though easily distinguishable from it by the markings of the elytra, which are suggestive rather of the genus *Zygogramma* than of *DeuteroCampta*.

APPENDIX.

Descriptions of a few new Species of Coleoptera from Sapucay, Paraguay. By GILBERT J. ARROW.

The following species were contained in a small but very interesting collection of insects sent by Mr. W. Foster from Sapucay, in the (entomologically) little-known State of Paraguay.

APTERODEMA PARAGUAYENSIS, sp. n.

Ovata, convexa, fusco-rufa, elytrorum lateribus maculæ suturali postice attenuatæ vage fuscioribus; capite crebre punctato, clypeo magno, margine semicirculari, oculis parvis; prothorace transverso, perspicue punctato, lateribus antice arcuatis, postice parallelis, angulis posticis fere acutis; scutello parce punctato, lateribus valde curvatis; elytris convexis, ubique irregulariter grosse punctatis, stria suturali aliisque indistinctis lateribus fortiter sed parce setosis, ab humeris ad post medium leviter divergentibus deinde regulariter arcuatis, angulis suturalibus fere rectis; pygidio detecto, parce ac minute punctato; corpore subtus fere nudo sed femoribus longe brunneo-setoso, segmentis abdominalibus

libris, æqualibus, tibiis anticis brevibus, validissime bidentatis, tarsis omnibus longis, unguiculis integris; alis imperfectis.

Long. 10 mm.

There are three specimens of this very anomalous little beetle, which seems to form a second species of M. Fairmaire's genus *Apterodema*, although it is not altogether impossible that it may have no affinity with it, since the genus was constituted from a single specimen in such a condition, as the author says, that neither mouth nor antennæ could be seen. Enough is said, however, to show that in declaring its close relationship to *Liogenys*, one of the Macroductylides, M. Fairmaire has entirely mistaken its systematic position, all the characteristic features of the Macroductylides being absent. The specimens before me, which, like M. Fairmaire's specimen, are females, represent a very isolated type, but can only be placed in the Sericoïdes. The elytra are not fused together as in *Apterodema acuticollis* Fairm., but the wings are partially atrophied. There are six free and equal abdominal segments. The labrum is free, subvertical and emarginate, and the labium consolidated, broad, and slightly concave in front. The antennæ are nine-jointed and the claws simple.

A. paraguayensis is rather larger than the Patagonian insect, of a dark red colour, with the margins of the elytra vaguely darker, the dark sutural margins forming a broad band at the scutellum, which they enclose, but narrowing behind. The prothorax is broad behind, and the posterior angles slightly produced as in *A. acuticollis*. The only clothing consists of stiff setæ along the sides and upon the legs. The sculpture is quite different to that described by M. Fairmaire.

I may advantageously take this opportunity of making an observation upon an allied South American genus. Lacordaire and Germain many years ago pointed out the probability that the genus *Accia* of Curtis, hitherto known only from a single female specimen in the British Museum, may prove to be inseparable from *Maypa* Blanchard. Having lately been able to examine a male, I can now definitely confirm this supposition. The genus should be called *Sericoïdes*, into which must be merged *Accia*, *Maypa*, and *Macrosoma*.

MACRASPIS BRASILIENSIS, sp. n.

Niger, vix nitidus, supra ubique creberrime coriaceo-punctatus; prothoracis lateribus subtiliter rugosis; scutelli medio longitudinalinaliter leviter lineato-depresso; pygidio ubique transverse strigoso; abdominis medio vix punctato, nitido, processu mesosternali recto, haud fortiter clavato; tibiis intermediis subtus fere rectis. ♀ elytrorum lateribus medio haud explanatis.

Long. 20-24 mm.

Hab. Brazil: Ega, &c.; Paraguay: Sapucay.

Although, owing to the confusion which has prevailed as to the not easily distinguishable black species of *Macraspis*, this species has remained without a name, it is a well-known Brazilian insect and evidently ranges over a large tract of country. The specimens from Ega, referred by Mr. Waterhouse to *M. dichrous*, belong to this species. Of *M. dichrous* Mann. the British Museum contains as yet only a single female specimen, exactly agreeing with that figured by Mannerheim. This species is barely distinguishable except in colour from *M. cribratus* Waterh., but may be easily distinguished from *M. brasiliensis* when the specific characters have been recognised. The latter differs from both in having no lateral expansion of the elytra in the female. The male has the last abdominal segment rather less strongly trilobed, the middle lobe being broader and less produced; and in both sexes the rows of large setigerous punctures near the margins of the segments have almost disappeared. The sculpture of the upper surface is almost the same as in *M. cribrata*, but generally rather finer, and there is a very slight but constantly visible linear impression along the middle of the scutellum, which serves to distinguish this species from all the rest.

CYCLOCEPHALA PARAGUAYENSIS, sp. n.

Fusco-rufa, vertice nigro, elytris testaceis; capite grosse punctato, medio leviter longitudinaliter sulcato, clypeo subquadrato; prothorace scutelloque sat fortiter punctatis; elytris annulariter punctatis; pygidio crebre subtiliter punctatis. ♂ unguiculorum anticorum internalium ramis haud valde divergentibus.

Long. 12 mm.

This is one of the closely similar species forming the *melanocephala*-group. Like *C. laminata* Burm., it is distinguished from the other members of that group by the anterior claws of the male, in which the two branches of the inner member are not strongly divergent. From *C. laminata* it differs by the thicker puncturation of the thorax and scutellum and the densely and finely punctured pygidium, which, however, is not rugose as in *C. melanocephala*, *dimidiata*, and *vincentiæ*. There is no appreciable difference between the two sexes in the sculpture of the pygidium.

NAUPACTUS TUBERCULATUS, sp. n.

Niger, pallide brunneo-pubescent, capitis prothoracisque linea alba media e squamis rotundatis composita; scutello albosquamoso; elytris costatis, interstitiis squamis minutissimis rufescentibus instructis; rostro paulo lato, lateribus parallelis; prothorace (♂) quam latitudinem longiore, post medium lateraliter valde spinoso, disco leviter 6-tuberculato, tuberculis 4 medio approximatis, 2 pone marginem anticam aliisque minus evidentibus prope angulos, omnibus nudis nitidis; singulo elytro costa suturali aliisque duabus nudis, nitidis

ornato, interstitiis squamulis minutis rufescentibus vestitis, linea albo-squamosa ultra costam lateralem, humeris fortiter extus productis, tibiis anticis intus dentibus numerosis validis armatis; corpore subtus brunneo-vestito, abdominis medio depresso, nudo.

Long. (rostr. excl.) 12.5 mm.

This species is closely related to *N. nodicollis* and *perpastus* of Boheman (the former has no affinity with the species of which it stands as a synonym in the Munich Catalogue, that insect, *leucogaster* Perty, belonging to the genus *Pantomorus*). The lateral spines of the new form are longer than in the other two, and those of the thorax are placed farther back. The thorax is proportionally longer, and the smooth elevated spots on its disc are peculiar to this species, as is the single sharply elevated discoidal costa of the elytron. This costa does not quite reach either the base or apex. The pinkish colour of the scales upon the disc of the elytra is perhaps not constant. We have only a single male specimen.

EXPLANATION OF PLATE XXVIII.

- Fig. 1. *Canthidium sladeni* Arrow, p. 249.
 2. *Clavipalpus tenuis* Arrow, p. 251.
 3. *Hoplopactus lateralis* Arrow, p. 251.
 4. *Celosternus sturio* Arrow, p. 252.
 5. *Belopæus niger* Arrow, p. 252.
 6. *Prostenus sladeni* Gahan, p. 253.
 7. *Sphæriion sladeni* Gahan, p. 253.
 8. *Trichophorus electus* Gahan, p. 254.
 9. *Oncideres sladeni* Gahan, p. 254.
 10. *Deuterocampta sladenæ* Gahan, p. 255.

4. On the Lepidoptera collected at Chapada, Matto Grosso, by Mr. A. Robert (Percy Sladen Expedition to Central Brazil). By F. A. HERON and Sir GEORGE F. HAMPSON, Bart., F.Z.S.

[Received October 21, 1903.]

LEPIDOPTERA PAPILIONINA.

By F. A. HERON.

LEMONIIDÆ.

STALACTIS PHLEGETONIA Perty. ♂.

Acræa phlegetonia Perty, Del. Anim. Art. p. 153, t. 30. ff. 2, 2b (1830-34).

LYCÆNIDÆ.

LYCÆNA CASSIUS Cramer. ♂ ♂.

Papilio cassius Cramer, Pap. Ex. i. t. 23, C, D (1775).

Belongs to a section differing from *Syntarucus* in the absence of a tail to the hind wings.

HESPERIIDÆ.

HELIOPETES sp. ♂.

This form, which belongs to a species very closely allied to *H. arsalte* Linn. (*Pap. arsalte* Linn. Mus. Utr. p. 245, 1764), is represented by a single badly damaged specimen which differs from the usual form of *arsalte* in its smaller size, less pointed wings, and the extreme reduction of the dark scaling at the bases of both wings and along the inner margin of the hind wing above, and below in the absence of dark and orange scales on the fore-wing costa and along the first median and internal veins of the hind wing.

LEPIDOPTERA PHALÆNÆ.

By Sir GEORGE F. HAMPSON, Bart., F.Z.S.

NOCTUIDÆ.

ACRONYCTINÆ.

EMARGINEA GAMMOPHORA Guen. Noct. ii. p. 289 (1852).

1 ♂.

NOCTUINÆ.

GLYMPIS HABITALIS Wlk. xvi. 39 (1859).

1 ♂.

GLYMPIS sp.

1 ♀.

EREBUS AGARISTA Cram. Pap. Exot. ii. p. 112, pl. 170, A, B (1775).

2 ♀.

HYPSIDÆ.

PERICOPIS SACRIFICA Hübn. Zutr. ex. Schmett. iii. p. 21, ff. 473-4 (1825).

1 ♀.

GEOMETRIDÆ.

BOARMIANÆ.

MEROCAUSTA VINOSA Dogn. Léop. Loja, p. 62, pl. vi. f. 17 (1891).

1 ♀.

OXYDIA sp.

1 ♂ in bad condition.

LIMACODIDÆ.

SUSICA QUADRATA Wlk. v. 1132 (1855).

2 ♂.

ASBOLIA VILLOSIPES Wlk. xxxii. 555 (1865).

1 ♂.

CASTNIADÆ.

CASTNIA DÆDALUS Cram. Pap. Exot. i. pl. 1, A, B (1775).

1 ♀.

PYRALIDÆ.

PHYCITINÆ.

ELASMOPALPUS PYRRHOCHRELLUS Rag. Nouv. Gen. p. 23 (1888);
id. Rom. Mém. ix. p. 429, pl. xvii. f. 13.

1 ♀.

CHRYSAUGINÆ.

SACCOPLEURA? sp.

1 ♂ without palpi.

PYRAUSTINÆ.

GLYPHODES FLEGIA Cram. Pap. Exot. ii. p. 66, pl. 140, D (1775).

1 ♀.

TINEIDÆ.

1 ♂ belonging to a genus allied to *Tortricopsis* Newm., from Australia.

HEPIALIDÆ.

DALACA METELLUS Druce, P. Z. S. 1889, p. 509, pl. 43. f. 2.

3 ♂. Antennæ bipectinate; claspers asymmetrical, the right clasper large, the left minute.

DALACA SLADENI, sp. n.

♂. Antennæ minutely serrate; claspers symmetrical.

Head, thorax, and abdomen rufous mixed with brown. Fore wing rufous, with numerous pale striæ and reticulations, the costal area, the medial area below the cell, and the area between veins 3 and 6 suffused with dark brown; the pale striæ forming an oblique irregularly sinuous line from costa before middle to inner margin beyond middle, where it is met by an oblique slightly waved line from costa before apex; a curved whitish mark composed of two small spots at origin of veins 5 and 6. Hind wing red-brown, the costa chequered ochreous and dark brown.

Hab. Central Brazil, Chapada (*A. Robert*), 1 ♂ type. *Exp.* 34 millim.

5. Note on the Cypriote Spiny Mouse. By P. CHALMERS
MITCHELL, M.A., D.Sc., Secretary of the Society.

[Received September 10, 1903.]

Early in the summer of 1903, Mr. Roland L. N. Michell, British Commissioner at Limassol in Cyprus, wrote to me through Sir A. K. Rollit, M.P., F.Z.S., respecting a large spiny mouse, small numbers of which occurred among the rats sent in by the villagers in connection with the protective measures against plague. I asked him to send home skins and skulls, or, if possible, living specimens. He very kindly brought home a number of

living examples, four of which arrived at the Gardens in August. They turned out to be specimens of *Acomys nesiotus*, a new species described by Miss Bate* in June of this year from specimens brought by her from Cyprus and presented to the Natural History Museum, where Mr. Thomas very kindly showed them to me. Miss Bate obtained her specimens from the Kerynia Hills, not far from the village of Dikomo. She added: "I never met with or heard of it in other parts of the island, though probably it occurs at any rate over the whole of the Mesoreia, or central plain, and the southern slopes of the Kerynia Hills."

From information given me by Mr. Michell it is clear that the Cypriote Spiny Mouse has a range in Cyprus much wider than that attributed to it by Miss Bate, and probably extending to the whole of the island. The south-western portion of the island is hilly, the range separating it from the central plain running up to over 5000 feet. Some of Mr. Michell's specimens came from the village of Ayios Konstantinos, at an elevation of over 4000 feet; others were from various regions in the vine-clad hills, and others again from the low coast-area near Limassol. The mice are very timid and seldom seen by the villagers. They live in deep holes, and are reported to do much damage to the caroub trees. They are not known in towns.

It happened, curiously enough, that the four specimens in the Gardens and all those obtained by Mr. Michell were devoid of tails. This corroborates the remarks of Miss Bate on the brittleness of the vertebrae in these animals. The mice bred while in captivity, producing two at a birth. The young had normal tails, but lost them in a very short time.

6. On the Muscles of the Ungulata. By BERTRAM C. A. WINDLE, Sc.D., M.D., M.A., F.R.S., Professor of Anatomy in the University of Birmingham, and F. G. PARSONS, F.R.C.S., F.Z.S., F.L.S., Lecturer on Human and Comparative Anatomy at St. Thomas's Hospital, late Hunterian Professor in the Royal College of Surgeons, England.

PART II.—MUSCLES OF THE HIND-LIMB AND TRUNK.

[Received September 8, 1903.]

(Text-figures 24–27.)

The first part of this paper, which dealt with the muscles of the head, neck, and fore-limb, was read before the Society on December 17, 1901, and published in the 'Proceedings' in April 1902 (see P. Z. S. 1901, vol. ii. pp. 656–704), and we now wish to give an account of the muscles of the hind-limb and trunk, together with some general observations on the Order.

* Ann. & Mag. Nat. Hist. (7) xi. p. 565 (1903).

*List of Animals.*Division A. *UNGULATA VERA*.

Suborder ARTIODACTYLA.

Family HIPPOPOTAMIDÆ.

1. *Hippopotamus amphibius*. Gratiolet et Alix (III.).
2. " " Humphry (IV.).
3. " " Cuvier et Laurillard (I.).

Family SUIDÆ.

4. *Sus scrofa* (Domestic Pig). Lesbres (V.).
5. " " " Chauveau (II.).
6. " " " Bronn (VI.).
7. " " " Cuvier et Laurillard (I.).
8. " " " Macalister (unpublished).
9. " " " Meckel (VII.).
10. " " (Wild Boar). Cuvier et Laurillard (I.).
11. " *porcus* (Red River-Hog).
12. *Babirusa*. Vrolik (VIII.).
13. *Dicotyles* (Peccary). Cuvier et Laurillard (I.).
14. " " "

Family CAMELIDÆ.

15. *Camelus dromedarius*. Chauveau (II.).
16. " " Lesbres (V.).
17. " " Walton (IX.).
18. " " Meckel (VII.).
19. " " P. Thompson.

Family TRAGULIDÆ.

20. *Tragulius javanicus* (Chevrotain). Kinberg (X.).
21. " " "
22. " *kanchil*.
23. " *stanleyanus*. Macalister (unpublished).
24. *Dorcatherium* (Water-Chevrotain). Chatin (XI.).

Family CERVIDÆ.

25. *Cervus axis*. Macalister (unpublished).
26. " *manchuricus*.
27. *Cervulus muntjac*.
28. *Cariacus rufus* (Brocket).
29. " *mexicanus* (Brocket).
30. *Alces machlis* (Elk). Watson & Young (XXX. & XXXI.).
31. *Moschus moschiferus* * (Musk-Deer). Bell (XIV.).

* By a regrettable error this animal was described as the Musk-Ox (*Ovibos moschatus*) in the first part of this paper (P. Z. S. 1901, vol. ii, p. 657).

Family GIRAFFIDÆ.

32. *Camelopardus giraffa*. Joly et Lavocat (XII.).
 33. " " Murie (XXXII.).
 34. " " Owen (XIII.).

Family BOVIDÆ.

35. *Bos taurus*. Chauveau (II.).
 36. " " Lesbres (V.).
 37. " " Meckel (VII.).
 38. " " Bronn (VI.).
 39. " " R.C.S. Museum (C. 216).
 40. " " " (C. 220).
 41. *Ovis aries*. Lesbres (V.).
 42. " " Chauveau (II.).
 43. " " Bronn (VI.).
 44. " " Meckel (VII.).
 45. " " R.C.S. Museum.
 46. " "
 47. " " *steatopyga* (Fat-tailed Sheep).
 48. " " (Syrian Sheep).
 49. " *musimon* (Mouflon).
 50. *Capra hircus*. Lesbres (V.).
 51. " " Chauveau (II.).
 52. " " Haughton (XV.).
 53. " " R.C.S. Museum.
 54. *Cephalophus grimmii* (Duiker-bok).
 55. *Tragelaphus scriptus* (Harnessed Antelope).

Suborder PERISSODACTYLA.

Family TAPIRIDÆ.

56. *Tapirus americanus*. Turner (XVI.).
 57. " " De Longchamps (XVIII.).
 58. " " Cuvier et Laurillard (I.).
 59. " " Vrolik (VIII.).
 60. " " Lesbres (V.).
 61. " "
 62. " *indicus*. Murie (XVII.).

Family EQUIDÆ.

63. *Equus caballus*. Chauveau (II.).
 64. " " Bronn (VI.).
 65. " " Lesbres (V.).
 66. " " Cuvier et Laurillard (I.).
 67. " " Meckel (VII.).
 68. " *asinus*. Cuvier et Laurillard (I.).
 69. " " Steel (XIX.).

Family RHINOCEROTIDÆ.

- | | | |
|-----|---------------------------------|-------------------------|
| 70. | <i>Rhinoceros sumatrensis</i> . | Beddard & Treves (XX.). |
| 71. | " ? sp. | Haughton (XXI.). |
| 72. | " " | Owen (XXII.). |
| 73. | " " | Macalister (XXIII.). |

Division B. SUBUNGULATA.

Family PROCAVIIDÆ.

- | | | |
|-----|-----------------------------------|-------------------------|
| 74. | <i>Procapia dorsalis</i> (Hyrax). | Mivart & Murie (XXIV.). |
| 75. | " <i>capensis</i> . | |
| 76. | " ? sp. | Brandt (XXV.). |
| 77. | " " | George (XXVI.). |
| 78. | " " | Meckel (VII.). |

Family ELEPHANTIDÆ.

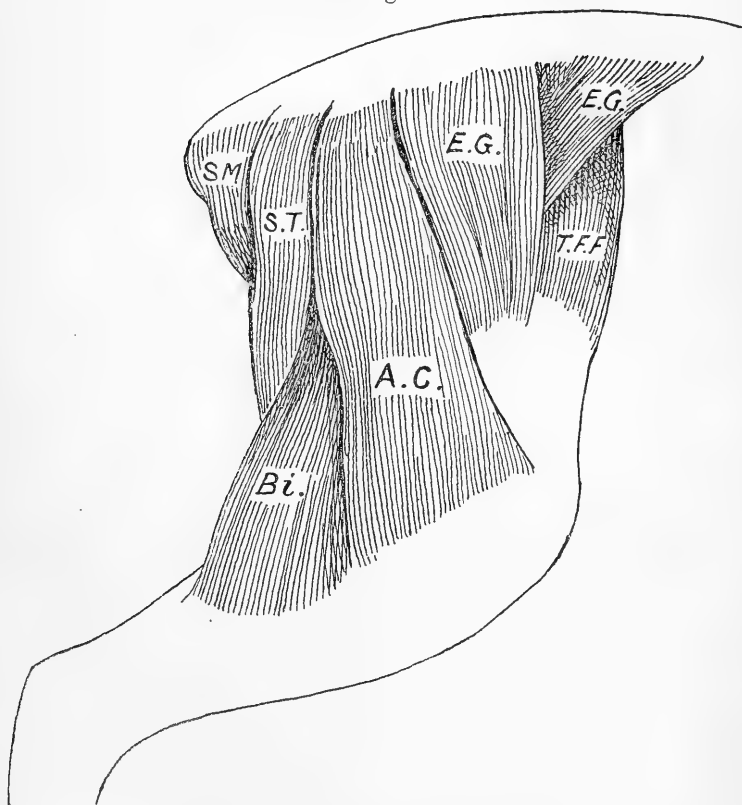
- | | | |
|-----|--------------------------|-------------------------------|
| 79. | <i>Elephas indicus</i> . | Anderson (XXVII.). |
| 80. | " " | Mayer (XXVIII.). |
| 81. | " " | Miall & Greenwood (XXIX.). |
| 82. | " " | Watson (XXX.). |
| 83. | " " | Young (XXXI.). |
| 84. | " " | Cuvier et Laurillard (I.). |
| 85. | " " | Paterson & Dun (unpublished). |
| 86. | " <i>africanus</i> . | R.C.S. Museum. |

Muscles of the Gluteal Region.

Ectogluteus (*Gluteus maximus*).—In the Ungulata the muscular sheet formed by the ectogluteus, femoro-coccygeus, and biceps is less separable than in any other order we know, and the difficulty of deciding how much of it is to be called ectogluteus is added to by the fact that the femoro-coccygeus or agitator caudæ has quite lately been recognised as a separate muscle, and so appears only in papers of recent date. The origin of the muscle is in all cases from the spines of the sacral and anterior caudal vertebrae, and sometimes from the iliac crest; the most interesting thing about its insertion is that among the Artiodactyla, in which there is no third trochanter, it ends entirely in the fascia of the outer side of the thigh and has no bony insertion into the femur. This is the case in the Hippopotamidæ (1, 3), Suidæ (4, 5, 8, 11, 13, 14), Camelidæ (15), Tragulidæ (22), Cervidæ (26, 27, 29, 30), and Bovidæ (35, 36, 38, 39, 41, 42, 43, 47, 50, 51, 52, 54, 55). In the Perissodactyla, in which a large third trochanter is present, the ectogluteus is inserted into it, though it did not seem to us that the muscle in the odd-toed Ungulates was usually better developed than in those with an even number of toes. This insertion into the third trochanter is recorded in the Tapiridæ (58, 61, 62), Equidæ (63, 65), and Rhinocerotidæ (71). Among the Subungulata the muscle was certainly inserted entirely into the fascia in

our specimen of Hyrax (75) (see text-fig. 24), and in that of George (77), but we think that the other authors have included the femoro-coccygeus in their descriptions. In the Elephantidæ, Miall and Greenwood (XXIX.) notice a strong attachment to the middle fifth of the femur, and this is confirmed by Paterson and Dun. We are therefore able to generalise by saying that

Text-fig. 24.



Muscles of outer side of Thigh of Hyrax.

T.F.F. Tensor fasciæ femoris.
 E.G. Ectogluteus.
 A.C. Agitator caudæ (femoro-
 coccygeus).

Bi. Biceps.
 S.T. Semitendinosus.
 S.M. Semimembranosus.

in the Artiodactyla and the Procaviidæ the ectogluteus is inserted into fascia only, while in the Perissodactyla and the Elephantidæ there is a definite femoral insertion. The nerve-supply in the Antelope, Sheep, and Pig is from a definite inferior gluteal nerve

which comes off the sciatic outside the pelvis and below the point of origin of the superior gluteal.

Femoro-coccygeus (*Agilator caudæ*).—This muscle can be made out readily enough in most Ungulates by anyone who is familiar with it and who appreciates the fact that it is the part of the great muscular sheet which lies between the ectogluteus and biceps. The origin is from the posterior sacral and anterior caudal spines, and the insertion chiefly into the outer side of the patella; above and below this it blends with the fascia (see text-fig. 24). As this muscle was not known by most of the older writers on myology, its description is often included with that of the ectogluteus or biceps. We believe that it is present in every Ungulate, and that its attachments are very constant. It is supplied by the same nerve as the ectogluteus.

Tensor fasciæ femoris.—As the femoro-coccygeus connects the ectogluteus and biceps, so the muscle under consideration lies between the ectogluteus and sartorius though it is often separated by a good interval from the former. It rises from the iliac crest, which of course is a short structure, and spreads out into a fan-shaped muscular mass which usually becomes lost in the fascia lata about the middle of the thigh. In the Elephant (79, 81, 84), however, it runs two-thirds of the way down, while in the Tapir (61, 62) it is fleshy as low as the outer side of the patella. Pater-son and Dun have noticed in the Elephant (85), and Murie in the Giraffe (33), that the fascia lata on the outer side of the thigh is elastic. Its nerve-supply is the superior gluteal.

Mesogluteus (*Gluteus medius*).—This muscle, as is usual in mammals, is generally larger than the ectogluteus; it rises from the greater part of the gluteal surface of the ilium as far as the margin of the great sciatic notch, as well as from the fascia covering the muscle. At its origin it is probably inseparably blended with the pyriformis, at all events the latter can never be traced to its human origin from the ventral side of the sacrum. The insertion of the mesogluteus is into the great trochanter on its outer and often also on its posterior surface. It is supplied by the superior gluteal nerve in the Pig, Sheep, Antelope, and Horse, but in the Harnessed Antelope (55) we also found a small twig passing to it from the inferior gluteal. In the *Perissodactyla* the muscle seems specially large, and its origin creeps along the fascia lata covering it to the sheath of the erector spinæ and the sacro-iliac and sacro-sciatic ligaments. Meckel (VII.) says that in the Horse it is twelve times as large as the ectogluteus, and it is also very large in the Tapir. In the Pig and Hyrax it is relatively much smaller, and Meckel describes it in the latter animal as being absolutely smaller than the ectogluteus. In our specimen of Hyrax (75) we do not feel justified in going as far as this, but the muscle was certainly very thin in the middle.

Entogluteus (*Gluteus minimus*).—This is also a large muscle, but its exact attachments are difficult to define owing to the fact that it is often closely connected with the gluteus ventralis. We

believe that these two muscles are always present in Ungulates, and that the line of separation can be determined, if carefully looked for, by the branch from the superior gluteal nerve to the tensor fasciæ femoris passing through it. The origin is from the ventral part of the gluteal surface of the ilium near that portion of the bone usually described by veterinary anatomists as the neck, while its insertion is into the front and outer side of the great trochanter. In the Horse, Lesbres (V.) says that the ento- and meso-glutei can only be distinguished from one another at their insertions. The nerve-supply seems always to be the superior gluteal.

Gluteus ventralis (*Gluteus quartus* ; *Scansorius*).—This muscle, when it is distinct, as it generally is in the families of Camelidæ, Giraffidæ, and Bovidæ, rises from the ventral border of the ilium and is concealed by the overlapping entogluteus, and is inserted into the anterior surface of the great trochanter. In Ungulates belonging to other families than those just mentioned, it is often difficult to separate the muscle from the entogluteus unless the nerve to the tensor fasciæ femoris is looked for. The nerve-supply is the superior gluteal.

Gluteus profundus (*Gluteus quintus* ; *Ilio-capsularis*).—It is quite certain that this is not a constant and well-defined muscle in Ungulates, though it is occasionally found. Lesbres (V.) describes the “abductor trochitereen” in the Horse as very distinct, and says that it lies over the superior surface of the capsule of the hip, rises from the supracotyloid crest, and is inserted into the anterior part of the internal surface of the great trochanter which is known to veterinary anatomists as the convexity of the trochanter. He regards it as the serial homologue of the infraspinatus secundus (see Part I. of this paper, P. Z. S. 1901, vol. ii. p. 687), but it answers very well to our idea of the *gluteus profundus*. In addition to this, he describes another muscle in the Horse, rising from the ilium close to the origin of the rectus and inserted into the anterior surface of the femur close to the head; this he considers is the homologue of the *ilio-capsularis* of the Carnivora. For practical purposes it does not seem to us that these two muscles require separate names; they are probably two slips of the deepest delamination of the gluteal mass lying in contact with the capsule of the hip. In the Harnessed Antelope (55) we found a *gluteus profundus*, and Kinberg (X.) describes it in the Chevrotain under the name of *M. tenuis femoris*. In the other Ungulates the muscle is not as a rule delaminated from the entogluteal sheet. The nerve-supply in the Harnessed Antelope is from the sacral plexus just below the origin of the superior gluteal nerve.

Pyriiformis.—We have already stated that the mesogluteus is usually fused more or less completely with the pyriiformis, but in some cases, *e. g.* the Duiker-bok (54) and Harnessed Antelope (55), the entogluteus is more closely blended with it than is the mesogluteus; it must, however, be remembered that in the Ungulates

the delamination of the gluteal mass is not nearly so complete as it is in Man. In the Pig (4, 5, 8, 9, 11, 14), Ox (35, 36, 38), and Sheep (41, 42, 43, 46, 47) the pyriformis is so completely fused with the meso- or entogluteus that no trace of it can be found. In no case does it come out of the great sciatic foramen, for this is closed by a membrane, and when the muscle is distinct it rises from the surface of this. The nerve-supply in the Duiker-bok and Harnessed Antelope is the superior gluteal.

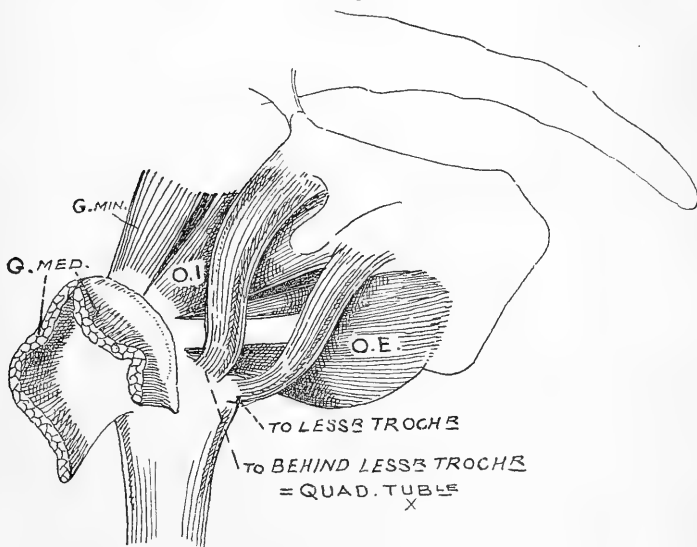
Obturator internus.—This muscle in the Suidæ (4, 8, 11, 14), Tragulidæ (20, 21), Giraffidæ (32–34), Bovidæ (36, 39, 41, 46, 48, 50, 53, 54, 55), and Procaviidæ (74, 75) is small, and more nearly resembles a gemellus than the usual mammalian obturator internus: the reason for this is that the obturator tertius usurps the normal origin of the muscle, and the internus has to arise from the body of the ischium at the lesser sciatic notch, thus reverting to what is probably the original and generalised origin. Of its arrangement in the Cervidæ we are not sure, but Watson and Young describe it in the Elk (XXX. & XXXI.) as having the usual origin from the inner side of the obturator membrane. In the Perissodactyla and Elephantidæ the muscle rises from the inner side of the true pelvis as usual. In all cases it is inserted into the bottom of the trochanteric (digital) fossa, and it is supplied by a branch of the sacral plexus.

Gemelli.—In those animals just mentioned in which the obturator internus rises at the lesser sacro-sciatic notch, the gemelli are fused with it; in the others only an inferior gemellus is as a rule present. In the Horse, however (63, 65), three gemelli are often met with, the third rising a little ventral and caudal to the inferior, between it and the obturator externus. In the Elk (30) the two gemelli are joined.

Obturator externus and *Obturator tertius* (see text-figs. 25 & 26).—Mivart and Murie nearly forty years ago described a muscle in Hyrax (74) passing through the obturator foramen and being inserted into the trochanteric fossa with the obturator externus; this they named the obturator tertius. Later Murie found the same muscle in the Giraffe (33), and Lesbres (V.) has evidently noticed the same thing, for he says that, in the Horse, Pig, and Ruminants, part of the obturator internus rises from the pelvis above the obturator vessels as high up as the ilium, while the other part passes through the obturator foramen. We have carefully studied this muscle in the Chevrotain, Ox, Sheep, Goat, Pig, Duiker-bok, Harnessed Antelope, and Hyrax, and are convinced that the following is the explanation of it. The obturator tertius is really a part of the obturator externus, which has made its way through the obturator foramen from outside, pushing the obturator membrane in front of it. In doing this it has stolen a good deal of the usual origin of the obturator internus and pushed that muscle out of the pelvis, so that it rises, as we have shown, from the margin of the lesser sciatic notch. There is, therefore, the curious paradox of the obturator externus rising inside the pelvis, while the internus

risks outside. Our reasons for coming to this conclusion are, firstly, that in dissecting away the obturator externus to expose, as we thought, the obturator tertius we found that the two muscles were practically one, and that no division was possible between them; secondly, that the obturator membrane can be clearly seen on the pelvic surface of the so-called obturator tertius; and, thirdly, that the part of the muscle which passes through the obturator foramen is supplied by the obturator nerve, and not by a branch from the sacral plexus. This last fact is perhaps the one on which we are inclined to lay most stress. We regret that in many of the animals which passed through our hands we did not pay enough attention to this muscle, and it was only when

Text-fig. 25.



Hip-region of Sheep, showing double Quadratus femoris muscle.

G.MED. Gluteus medius.	O.I. Obturator internus.
G.MIN. Gluteus minimus.	O.E. Obturator externus.

working through Hyrax with the aid of Mivart and Murie's paper that we first noticed it. We have seen enough, however, to feel sure that it is present in the Suidæ, Tragulidæ, Giraffidæ, Bovidæ, and Procaviidæ. We expect, from what we know of other muscles, that it will also be found in the Hippopotamidæ, Camelidæ, and Cervidæ, if carefully and specially looked for, but the various writers on these families were, like ourselves, evidently ignorant of its existence. With regard to the Perissodactyla, we have satisfied ourselves, through the kindness of the authorities at the Royal Veterinary College, that no muscle passes through the

obturator foramen in the Horse, and this in spite of Lesbres's assertion to the contrary. In the Tapiridae, too (61), we failed to find it, and so did Murie (XVII.), who certainly would have been on the look out for it since he was the original describer. It is not described by any author in the Rhinocerotidae, but further observation is necessary here. In the Elephant no mention is made of it, though Miall and Greenwood (XXIX.) and Paterson and Dun describe the obturators somewhat carefully. With further opportunity for research we believe that it will be found that the obturator externus passes through the foramen in the Artiodactyla and Procaviidae, but that it does not do so in the Perissodactyla and Elephantidae.

Quadratus femoris.—This muscle varies a good deal in size in different Ungulates, but it is usually present. Owing to the horizontal position of the pelvis, it passes obliquely from the tuber ischii to the back of the upper part of the shaft of the femur so as to form an X with the tendon of the obturator externus; it is usually somewhat constricted at its insertion, so that the name quadratus femoris used in human anatomy does not very aptly describe it. It is especially large in the Hyrax (74, 75), and in one Sheep (46) (see text-fig. 25) it was found to be double, but this does not seem to be always the case. Among the Perissodactyla it is not well developed; in the Horse (63) it is quite small, and Meckel (VII.) says absent altogether. In the Tapir (61, 62) it is also small, while in the Rhinoceros (71) Houghton failed to find it*. In all the other animals on our list the muscle was present, and in the Duiker-bok, Sheep, and Harnessed Antelope was supplied by a branch from the sacral plexus as in Man.

Muscles of the Posterior Femoral Region.

Semimembranosus and *Presemimembranosus*.—These muscles have the usual mammalian attachments; they are always fused at their origin from the tuber ischii; and it is characteristic of ungulates that this fusion continues much lower down the thigh than it usually does in other mammals. This is the case in the Hippopotamus (1), Pig (4, 11, 14), Chevrotain (21, 22), Deer (26, 29, 30), Ox (36, 40), Sheep (41, 46, 47), Goat (50, 52), Antelope (54, 55), Tapir (58, 61), Rhinoceros (71), Hyrax (74, 75), and Elephant (81, 84, 85). Meckel (VII.) and Lesbres (V.) point out that in the ruminants the origin is entirely ischial, while the Horse has a caudal origin besides; we think that we are justified in broadening this generalisation and in saying that in the Artiodactyla there is only an ischial head, while in the Perissodactyla and Subungulata ischial and caudal heads are found (see text-figs. 24 & 26, S.M.).

The semimembranosus has the usual mammalian insertion by a rounded tendon deep to the internal lateral ligament: in the

* The dissection of this animal seems to have been carried out under great difficulties, so that the muscle may have been overlooked.

Elephant (81, 85), however, an expansion from this insertion is found running down to the inner side of the ankle. According to some authors the semimembranosus may occasionally be absent altogether: this was the case in Kinberg's Chevrotain (20), Chatin's Water-Chevrotain (24)*, and Lesbre's Horse (65). The presemimembranosus is usually larger than the semimembranosus, and is inserted by fleshy fibres into the lower part of the femur just above the internal condyle; besides its fusion with the semimembranosus it is very intimately connected with the adductor mass and so has escaped notice by some observers. The nerve-supply in the Pig, Antelope, Sheep, and Hyrax is from the nerve to the hamstrings, a large branch which comes off the internal popliteal element of the great sciatic.

Semitendinosus.—This muscle, like the last, may rise by one or two heads, of which the one from the tuber ischii is always present. A caudal head is rarely found in the Artiodactyla, Chatin's Water-Chevrotain (24) and the Pig (4, 6) are the only exceptions we know. In the other suborders, the Horse (63, 64, 65), Tapir (58, 62), and Hyrax (74, 75, 78) have two heads (see text-figs. 24 & 26, S.T.). The insertion is into the second quarter of the internal surface of the shaft of the tibia as a rule, and from this a small expansion is sent off to help the biceps and gracilis in reinforcing and providing a sheath for the tendo Achillis, and so acting on the calcaneal tuberosity. These expansions from the inner and outer hamstrings are seen at their best in the Ungulata; but they are so common among the Mammalia generally†, that they probably have a phylogenetic history to account for their presence, as well as a physiological advantage to account for their special development in Ungulates. In all probability their past history is that they are remnants of the longitudinal muscle-fibres passing uninterruptedly from the pelvic girdle to the foot, such as are found among the Reptilia, while the explanation of the fact that they are so well developed in Ungulates must be looked for in the mode of life of these animals. Among all the orders of mammals there is not one which is more distinctly cursorial in the habits of its species; with the exception of the Tree-Hyrax there are no arboreal types; the Hippopotamus and Water-Chevrotain are the only ones which are partially aquatic, while there is no example of a fossorial Ungulate. For these reasons, any modification which we meet with in the limb-muscles of Ungulates as a group, will probably be explained by its being an advantage to them in running. The expansions of the hamstrings to the calcaneum act as plantar flexors of the ankle-joint, while the hamstrings themselves are flexors of the knee. In watching the sequence of movements of

* In our specimens of Chevrotain (21, 22) the muscle was undoubtedly present, though so closely connected with the presemimembranosus that it might easily be overlooked without careful dissection of the insertion.

† The fascial expansions from the semitendinosus and gracilis in Man will at once occur to the human anatomist.

the hind-limb in walking, one notices that the knee is extended and the ankle plantar flexed in order to lengthen the limb and so pull and push the body of the animal over the spot on which the foot is planted, while at the same time the knee is slightly flexed. It is probable that the expansions from the hamstrings effect the plantar flexion of the ankle by pulling up the calcaneal tuberosity, at the same time that they are causing slight flexion of the knee. An interesting and, so far as we know, unaccounted for structure in the semitendinosus of Man, is the fibrous streak running across the muscular belly; this is seldom seen in the lower mammals, and we have not noticed it in any Ungulate, although we have carefully looked for it. Macalister, however, found it distinctly in the Muntjac (27). The nerve-supply of the semitendinosus is the special nerve to the hamstrings from the internal popliteal element of the great sciatic (see text-fig. 26, p. 274).

Biceps (Flexor cruris lateralis).—It has already been pointed out how closely the biceps is connected with the femoro-coccygeus in the Ungulata, and how constantly the latter muscle is inserted into the side of the patella; we shall therefore describe as biceps only that part of the superficial lateral plane of muscle which is inserted below the patella. As the muscle is so inseparable from its neighbour the femoro-coccygeus (agitator caudæ), it is very difficult to say whether any of its fibres really rise from the caudal vertebræ; we are, however, inclined to agree with Lesbres that in the Ungulates the biceps has only an origin from the tuber ischii (see text-fig. 24, Bi.). Its insertion is into the fascia of the upper half or more of the outer side of the leg, while from its lower border a strong fibrous process passes down to the calcaneal tuberosity, helping the gracilis and semitendinosus to ensheath the tendo Achillis. With the exception of relative size, there is hardly any variety in the biceps of different Ungulates; it perhaps reaches its greatest development in the Tapir (58, 61, 62).

Bicipiti accessorius (Tenuissimus).—This in most Ungulates is either suppressed or completely blended with the biceps. The only record we can find of it is that it is figured in Cuvier and Laurillard's Elephant (84), and may possibly be the deep part of the biceps of the Tapir described by Murie (XVII.).

Muscles of the Internal Femoral Region.

Pectineus.—This muscle is often difficult to distinguish from the adductor longus, especially as the latter may or may not be delaminated from the adductor mass. The origin is fairly constant, coming from some part of the ilio-pectineal line, while the insertion seems to range all over the shaft of the femur. In the Hippopotamus (1) Gratiolet describes three parts, pubic, symphyseal, and ischial; of these the latter two are evidently adductor longus and quadratus femoris. In the Suidæ (6, 7, 11, 14) the muscle rises from the whole ilio-pectineal line and is inserted into the middle or distal part of the femur; it is comparatively small in this

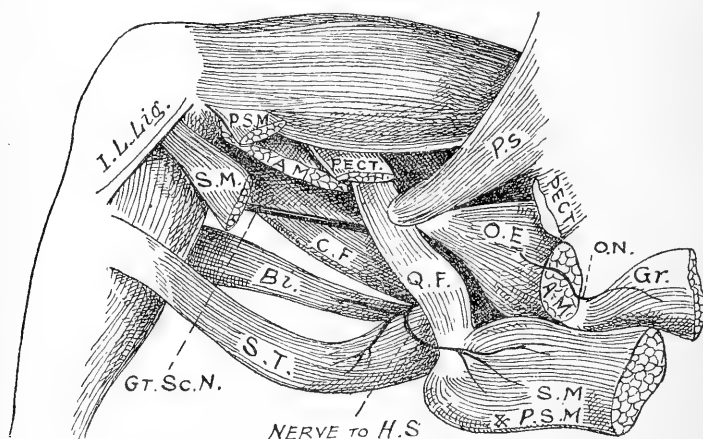
family. In the Chevrotain, Kinberg (X.) says that it is inserted into the trochanteric fossa, but the origin is the same as in the Suidæ. Among the Cervidæ we have records of it in *Cervus* (26), *Caracus* (28), and *Alces* (30), and in these it passes to the middle third of the femur. Of the Giraffidæ we have no definite records. Among the Bovidæ it seems to be variable. In the Ox, Chauveau (II.) notices that it is in two bundles, and so it is in the College of Surgeons' specimen (39); Lesbres (V.) says that this is true for all ruminants, and we are not surprised to meet with this description since we have found it double in other orders of mammals; still in our specimens of Sheep (46, 47, 49), Duiker-bok (54), and Harnessed Antelope (55) we looked in vain for a division. In these three animals the origin was instructive: in the Sheep (46) it rose from the whole of the ilio-pectineal line and was inserted into the upper two-thirds of the femur; in the Fat-tailed Sheep (47) and Duiker-bok (54) it rose only from the angle of the pubis and went to the upper half of the femur; while in the Harnessed Antelope (55) it rose from the outer end of the ilio-pectineal line close to the psoas and was inserted into the femur just below the lesser trochanter. In the Tapiridæ (61, 62) the origin is from the pelvic brim as usual, but the insertion is very high up behind the lesser trochanter or even, according to Murie, into the trochanteric fossa. In the Equidæ (63, 65, 67) the muscle is well marked and rises either from the ligamentum teres, which in this animal comes out of the cotyloid notch and runs forward to the hypogastric region, or splits to allow that ligament to pass through its origin; it is inserted into the middle third of the femur. In the Rhinoceros (71) it is inserted into the junction of the middle and lower thirds of the femur by a rounded tendon. Among the Subungulata, in the Hyrax (see text-fig. 26, p. 274) (74, 75, 78) and Elephant (81, 84) it has the usual origin from the anterior ramus of the pubis, while the insertion is into the middle third of the femur.

The nerve-supply may, as in Man, be anterior crural, obturator, or both. In the Duiker-bok, Sheep, and Hyrax it was supplied by the obturator alone, in the Harnessed Antelope by the anterior crural alone, while in the Peccary it received twigs from both nerves.

Adductor mass.—Many of the dissectors of Ungulates in the past have, we believe, been stimulated by their knowledge of human anatomy to artificially divide up this mass in an unnecessary manner. In the animals which we have dissected we have noticed that the nerve to the gracilis from the obturator forms a convenient indication of the interval between the adductor longus and the rest of the mass. When this interval is clearly marked an adductor longus may fairly be described, but unless this is the case there seems to us little object in separating one part of the mass from the rest. Among the Artiodactyla there seems more difficulty in distinguishing an adductor longus from the rest of the mass than there is in the Perissodactyla or Subungulata, though it is

always an arbitrary proceeding to settle whether a muscle is divisible or not. In the following animals no natural division was made out:—Hippopotamus (1), Pig (4, 11), Peccary (14), Chevrotain (20, 21, 22), Deer (25, 26), Elk (30), Ox (35), Sheep (42, 46), and Duiker-bok (54). A fairly distinct adductor longus, on the other hand, was found in the Giraffe (33), Harnessed Antelope (55), Tapir (62), Horse (63, 65, 67), Rhinoceros (70), Hyrax (74, 75, 78) (see text-fig. 26), and Elephant (81, 85). We have not been able to satisfy ourselves of a single instance of the presence of an adductor brevis, for the muscle which is called by this name in the veterinary books is clearly the homologue of the human adductor longus. The adductor longus, when it is distinct, rises close to the anterior part of the symphysis, while the insertion is into the shaft of the femur, usually in its middle third. The rest of the adductor mass rises from the whole length of the subpubic ramus and is inserted into the lower half or two-thirds of the femur. The whole of the adductor mass is always supplied by the obturator nerve.

Text-fig. 26.



Muscles of inner side of Thigh of Hyrax.

P.s. Psoas.
 PECT. Pectineus.
 O.E. Obturator externus.
 A.M. Adductor mass.
 O.N. Obturator nerve.
 Gr. Gracilis.
 Gt.Sc.N. Great sciatic nerve.
 S.M. Semimembranosus.

P.S.M. Preseminembranosus.
 Q.F. Quadratus femoris.
 C.F. Femoro-coccygeus.
 Bi. Biceps.
 S.T. Semitendinosus.
 I.L.Lig. Internal lateral ligament.
 H.S. Ham-string.

Gracilis (*Adductor cruris*).—This is a very constant muscle among the Ungulata; it rises as usual from the whole length of the symphysis and runs down as a single broad sheet to the usual insertion at the upper part of the inner surface of the tibia. Its tendon of insertion is generally more or less directly fused with

that of the sartorius, while from its lower margin it gives off an expansion to the inner side of the tendo Achillis which blends with similar expansions of the biceps and semitendinosus to form the sheath for that tendon. This sheath has already been discussed under the head of the semitendinosus. The muscle seems so constant in the various families that it is needless to repeat each individual record, especially as there are thirty-four of them fairly evenly distributed over the order; it will be sufficient to point out that according to Murie (XXXII.) the muscle is absent in the Giraffe, while Chauveau (II.) says that in the Camel its origin is bifid, the anterior branch being the smaller. Meckel (VII.), on the other hand, says that there are four heads to the gracilis in the Camel, so that it is clear that further knowledge is needed on this point. The nerve-supply in every animal we dissected was the obturator.

Muscles of the Anterior Femoral Region.

Sartorius (Ilio-tibialis).—The origin of this muscle is usually not so high as the anterior superior spine of the ilium, more often it comes from the iliac fascia covering the insertion of the psoas parvus as well as from Poupart's ligament close by. In the Ox (35, 36, 37), Sheep (41, 42, 46, 48), and Goat (50) it has another origin from the pubis just internal to the femoral vessels, but the two origins soon join so that the vessels pierce the conjoined origin. The insertion is into the upper part of the tibia by means of the fascia of the thigh; sometimes the fleshy fibres reach as far as, or even beyond, the knee, but more often they are lost in the fascia lata or join the tendon of the gracilis before the knee is reached. In the Perissodactyla the sartorius seems rather better developed than in the rest of the Ungulata, at all events it remains fleshy below the knee in the Horse (63), Tapir (58, 59, 60, 61), and Rhinoceros (71). Sometimes the muscle is absent, this was the case in Hyrax (74, 75); and we have no doubt that what Meckel describes in this animal (78) as sartorius is really tensor fasciæ femoris. It was also absent in Anderson's Elephant (79), and Cuvier and Laurillard (84) do not figure it, though it is definitely described by Miall and Greenwood (81) as well as by Paterson and Dun (85). On comparing this muscle in the Ungulata with its condition in other orders, it will be seen that it is better developed than in many of them, and may cover in the femoral vessels, making a definite Hunter's canal. Its nerve-supply in the Pig, Sheep, Duiker-bok, Harnessed Antelope, and Elephant is the anterior crural, the special branch to it passing over (superficial to) the femoral vessels a little below Poupart's ligament.

The *Quadriceps extensor cruris* has only a few points of special interest so far as our observations go. The rectus, as is usual in mammals, always has a reflected head, and often a straight head too, though the two may be continuous and so only one is described. We have so far not met with a single ungulate in

which by cutting the rectus and turning its origin up, evidence of the two heads could not be found. Lesbres (V.) says that in the Pig, Sheep, and Goat the reflected head is absent; we have, however, paid special attention to the point in the Pig (11, 14) and Sheep (46, 47), and are convinced that both heads are really there. With regard to the crureus in Ungulates, we have often noticed that it is more distinct than in many other orders of mammals, and it rises from all three surfaces of the femur. Sometimes, as in the Ox (40) and Sheep (41), it is divided more or less completely into an inner and an outer portion. The vastus externus is usually larger than the internus, but in the Tapir (61, 62) both Murie and ourselves were struck by the enormous size of the vastus internus. The nerve-supply of the quadriceps is always the anterior crural.

Anterior Tibial Region.

Tibialis anticus.—This muscle usually has a femoral origin from the front of the external condyle, rising with the extensor longus digitorum, as well as a tibial origin from a small part of the upper and front portion of the tibia.

In the Hippopotamus (3) the two parts are quite separate, the tibial portion being inserted into the base of the second (index) metatarsal, while the condylar part forms an arch in front of the ankle which binds down the extensor tendons, the two horns of the arch being attached to the bases of the index and minimus metatarsals. In the Suidæ (4, 5, 11, 14) the two parts are also distinct, but the fibrous arch is not present, and they are both inserted into the index metatarsal and middle cuneiform bones. In all the other Artiodactyla, viz. Chevrotain (22, also the "Napu Deer" described by Haughton XV., which is the Javan Chevrotain), Virginian Deer, Nyghau, Elk (30), Brocket Deer (29), Sheep (47, 48), Ox (35, 40), Goat (50, 52), and Antelope (54, 55), the arrangement is practically identical with that of the Duiker-bok (54), the variations being very slight. In this animal (54) the femoral head is the larger, and opposite the ankle is pierced by the tibial tendon, it is then inserted into the inner side of the dorsum of the base of the large metatarsal bone, which is common to the medius and annularis digits. The tibial tendon, which pierces the one just described, runs to the ventral part of the inner side of the base of the same metatarsal bone. In the Perissodactyla the same femoral and tibial origins are found in the Tapiridæ (61, 62) and Equidæ (63, 64, 65), and the same perforation occurs in the Horse, though we did not notice it in the Tapir (61). As to the Rhinoceros we have not sufficient data to form an opinion. In the Subungulata the femoral origin is absent; this is the case in both the Hyrax (74, 75) and the Elephant (80, 81, 84, 85). In the Hyrax its insertion is into the second metatarsal, while in the Elephant it is usually inserted into the first as well. It is always supplied by the anterior tibial nerve.

Extensor proprius hallucis.—This muscle is often described in Ungulates, but, we think, without any real reason. As the hallux and often the fibula are suppressed, the muscle called extensor proprius hallucis is a slip of the extensor longus digitorum passing to the index or medius digit. Unless the authors who use the name have good grounds for thinking that this is really a displaced muscle of the hallux, it seems a needless complication to retain the name in the Ungulata.

Extensor longus digitorum.—In the Hippopotamidæ (1, 3) and Suidæ (4, 7, 10, 11, 12, 13, 14) this muscle is inserted into all four toes, and its origin is from the front of the external condyle of the femur with the tibialis anticus. Meckel (VII.) denies that it has a femoral origin in the Pig, but his was clearly an exceptional case. In the other Artiodactyla the origin is always femoral and the insertion into both toes. An interesting point about this muscle in the Ox (40), Sheep (46), Duiker-bok (54), Harnessed Antelope (55), Chevrotain (20), and Camel (17) is that there is an insertion into the middle phalanx of the medius digit as well as into the terminal of the medius and annularis. A more careful examination of the muscle in the other Artiodactyles would possibly show that this is a constant arrangement. In the Tapiridæ (59, 61, 62) and Rhinocerotidæ the origin is femoral and the insertion into all three toes. In the Equidæ (63, 65) the origin is also femoral and the insertion into the middle and terminal phalanges of the single digit (medius). Among the Subungulata the origin is femoral in Hyrax (74, 75), though Meckel (VII.) says that it is tibial; its insertion is into all the digits. In the Elephant (81, 84, 85) the origin is certainly tibial and the insertion into the 2nd, 3rd, 4th and 5th digits. Both Paterson and Dun (85) and Miall and Greenwood (81) notice that insertions are given to some of the proximal as well as the distal phalanges, though which digits have slips to these phalanges varies in different individuals as well as on opposite sides of the same individual. The nerve-supply is the anterior crural. Summing up, it may be said that the origin of this muscle in the Ungulata is always femoral except in the Elephant.

Extensor brevis digitorum.—This muscle is always present and has the usual origin from the front of the upper surface of the calcaneum. In the Hippopotamus (1, 3) it is inserted into the index, medius, and annularis digits. In the Suidæ (4, 5, 10, 11, 14) it usually goes to the medius and annularis only, but it may send a slip which joins the tendon of the extensor longus digitorum on the dorsum of the foot.

In the Tapiridæ (61, 62) the muscle is very large and is inserted into all three toes. Murie (XVII.) notices that the slip to the medius is inserted into the proximal phalanx. In the Equidæ (63, 65) there is only one insertion into the extensor longus as in the Ruminants. In the Rhinoceros, Haughton (XXI.) only found a tendon for the medius toe. Among the Subungulata, Hyrax may have three tendons for the proximal phalanges

according to Mivart and Murie (74), or only two for the hallux and index (Meckel, VII.). In our specimen (74) we found tendons for the hallux and index, but they were inserted into the proximal phalanges. In the Elephant (85), Paterson and Dun notice that the muscle rises not only from the calcaneum but from the navicular, base of the metatarsal of the medius, and the dorsal ligaments of the tarsus; it is inserted into all three phalanges of the medius, the slip to the terminal phalanx joining the extensor longus to that digit; on the right side it is inserted into the annularis as well. In Miall and Greenwood's (81) and Cuvier and Laurillard's (84) specimens details are wanting, but the muscle only goes to the medius in the former and to the medius and annularis in the latter. Like the extensor longus this muscle is remarkable for often having an insertion into the proximal or middle phalanges. It is always supplied by the anterior tibial nerve.

Peroneal Region.

Peroneus longus.—This muscle in the Hippopotamidæ (1, 3) and Suidæ (4, 6, 8, 11, 13, 14) rises from the external tuberosity of the tibia and the head of the fibula, though sometimes the latter origin may be absent; it passes behind the external malleolus and across the sole as usual to be inserted into the innermost cuneiform. In the other Artiodactyla its apparent origin is always from the external tuberosity of the tibia, but in our Harnessed Antelope (55) we found that some of its fibres could easily be traced upward to the condyle of the femur, forming an oblique band of fibrous tissue on the outer side of the long external lateral ligament of the knee. In a former paper ("Joints of Mammals," Journ. of Anat. vol. xxxiv. p. 307) one of us has drawn attention to the constant twisting of the fibres of this ligament, and we have now very little doubt that its superficial layer which runs downward and forward is really the remains of the origin of the peroneus longus from the femur. Although the Harnessed Antelope shows this in the most marked way, it can be made out by careful dissection in most Ungulates. The insertion in these Artiodactyla is chiefly into the under side of the base of the great cannon-bone.

Among the Perissodactyla the muscle is present in the Tapiridæ (58, 61) and Rhinocerotidæ, and its femoral origin can easily be traced. In the Equidæ (63, 64, 65) there is no peroneus longus. In the Subungulata it rises entirely from the head of the fibula in Hyrax (74, 75) and is inserted into the base of the index metatarsal. In the Elephant, Paterson and Dun made out a distinct femoral and tibial origin (85), while the same is clearly figured by Cuvier and Laurillard (84). Miall and Greenwood, however, failed to notice any femoral origin (XXIX.). The insertion, according to Paterson and Dun, whose account is by far the most exact and detailed of any we have yet seen

on Elephant's muscles, is into the bases of all the metatarsal bones from the fifth to the first. The nerve-supply is from the external popliteal in the Duiker-bok, Chevrotain, Sheep, and Elephant.

Peroneus brevis.—In animals such as the Lemur and many of the Rodents, where a complete set of peroneals is found, the peroneus brevis runs from the fibula to the base of the fifth metatarsal bone, while the peronei quarti et quinti digitorum pass on to the dorsum of the phalanges. Judging by this standard, we have no hesitation in saying that we have as yet seen no reason to believe that a peroneus brevis is ever present in Ungulates, except, perhaps, in the Elephant. It is described by a great many authors, but in every case we have found that what they call peroneus brevis is continued on to the dorsum of the fourth (annularis) digit, and does not even end in the fourth metatarsal bone. When one realises how commonly the fibula and the fifth metatarsal are suppressed in this order, one is prepared to expect a similar suppression of the peroneus brevis. In Paterson and Dun's Elephant a muscle was found which they call peroneus minimus, which rose from the fibula and was inserted into the calcaneum and base of the fifth metatarsal; this we believe is a peroneus brevis, and the only example of it found in the Ungulata. The authors call it peroneus minimus because they have fallen into the common mistake of calling the peroneus quarti digiti the peroneus brevis.

Peroneus quarti digiti.—This muscle is always present in Ungulates. When the fibula is well developed, as in Hyrax and the Elephant, it rises from the middle third of that bone, but when, as in most Ungulates, there is only the head of the bone present, the muscle rises from that and often from the adjacent part of the tibia. The tendon usually runs in a groove on the outer side of, not behind, the external malleolus, and is inserted into the extensor longus digitorum tendon of the annularis. In the Horse, however, with the suppression of the annularis, the peroneus quarti digiti, which is the only peroneal present, shifts its insertion on to the dorsum of the medius. We have records of the peroneus quarti digiti under various names in the following representative series of animals:—Hippopotamus (1, 3), Pig (4, 6, 7, 11), Peccary (13, 14), Camel (17), Chevrotain (20, 22, 24), Deer (25, 26, 27, 29), Elk (30), Musk-Deer (31), Ox (35, 36, 38, 40) (in the last-named animal, 40, the tendon was inserted into the middle phalanx of the annularis toe), Sheep (41, 42, 43, 47, 48), Goat (50, 51), Antelope (54, 55), Tapir (58, 62), Horse (63, 64, 65), Rhinoceros (71), Hyrax (74, 75), and Elephant (81, 85). The nerve-supply is always the musculo-cutaneous.

Peroneus quinti digiti.—This muscle is present in the Hippopotamus (1, 3) and sometimes in the Pig (4), Musk-Deer (31), and Elephant (81, 85). It rises from the upper part of the fibula and is inserted into the extensor tendon of the fifth digit. Its nerve-supply is the musculo-cutaneous.

Posterior Tibial Region.

Gastrocnemius.—The two heads of this muscle rise, as usual, from just above the condyles of the femur; the inner is generally more extensive in its origin than the external and often extends over a considerable portion of the popliteal surface of the femur. One of the most notable points in this muscle in the Ungulata is the absence of fabellæ in its origins. The only member of the order in which we have found fabellæ is the Hyrax, and in it only the outer one was present. The tendo Achillis shows the characteristic rope-like twisting previously described by one of us (Journ. Anat. vol. xxviii. p. 414) very well, and in some animals, *e. g.* the Elephant (79) and Musk-Deer (31), the tendons remain separate as far as the calcaneum. In the Chevrotain, Kinberg (X.) describes the outer head as having an anterior and posterior origin. In the Hippopotamus, Gratiolet and Alix (III.) say that the origins are continued down to the tibia. The expansions from the thigh-muscles forming a sheath for the gastrocnemius tendon have already been described. The nerve-supply is always the internal popliteal.

Soleus.—In the Hippopotamidæ (1, 3) and Suidæ (4, 6, 9, 11, 12, 14) this is either wanting or, more probably, has shifted its origin upward to the external condyle of the femur and is fused with the external head of the gastrocnemius. In Cuvier and Laurillard's Peccary (13), however, its origin is drawn rising from the surface of the peroneus quarti digiti. In the Tragulidæ (20, 22) the muscle is distinct, and in our specimen (22) rose from the middle third of the fibula. In the Cervidæ (29, 30) it rises from the external condyle, but is a distinct, though small, muscle. In the Bovidæ (40, 48, 54, 55) it usually rises from the rudimentary head of the fibula and joins the outer head of the gastrocnemius. In the Tapiridæ (61, 62) it is condylar and very small. Turner (XVI.) failed to find it at all. In the Equidæ (63, 64, 65) it rises from the external tuberosity of the tibia. We have no record of it in the Rhinocerotidæ.

In the Procaviidæ (74, 75) it comes from the head of the fibula and is fairly well developed. In the Elephantidæ (74, 77, 79) it is also well developed, rises from the head of the fibula and is inserted separately into the calcaneum.

From the foregoing it will be seen that this muscle in the Ungulata is subject to a good deal of variation, but in all except the Subungulata is feebly developed. In the Hippopotamidæ, Suidæ, Cervidæ, and Tapiridæ its origin is usually shifted up to the external condyle, while in the other families it rises either from the fibula or from the adjacent external tuberosity of the tibia. Its nerve-supply is the internal popliteal.

Plantaris.—This muscle is always present in the Ungulata. In the Hippopotamus (1) it has a very large muscular belly rising from above the external condyle of the femur; this tendon in the sole has a few fleshy fibres on its deep surface and is the only

instance, with the exception of Hyrax, we have met with in the whole order of any trace of a fleshy flexor brevis digitorum. Slips are given off which act as flexores perforati to all four digits. In the Suidæ (4, 7, 11, 12, 13, 14) the fleshy belly in the calf is also fairly large and is wrapped up in the outer head of the gastrocnemius; passing round the tuber calcis its tendon gains the sole and usually divides into three slips for the index, medius, and annularis digits, though occasionally (12) it goes to all four digits. In the rest of the Artiodactyla its fleshy belly is much smaller, and its tendon, after passing round the pulley-like surface on the back of the tuberosity of the calcaneum, enters the sole and gives off a loop from its deep surface which surrounds the flexores tibialis et fibularis, then the tendon divides for the medius and annularis digits, and each slip acts as a flexor perforatus before being inserted into the middle phalanx. In the Ox especially the perforation of the tendon takes up a good deal of its length, and a section through the perforans and perforatus tendons shows the former enclosed by a complete ring of the latter.

In *Dorcatherium* (23) Chatin describes tendons to all four digits. In the Perissodactyla the muscle rises from the supra-condylar fossa and passes to the middle phalanges of all the toes, *i. e.* one in the Horse and three in the Rhinoceros and Tapir. In the Subungulata, Hyrax (74, 75) has a fleshy flexor brevis developed in the sole. The nerve-supply is always the internal popliteal.

Popliteus.—There is but little of special interest about this muscle in the Ungulata; it rises as usual from the outer surface of the external condyle and is inserted into the upper quarter or third of the posterior surface of the tibia. As a rule no sesamoid is developed in its tendon, though we found one in our Tapir. The anterior tibial artery apparently always passes in front of the muscle. With regard to the nerve-supply the Duiker-bok (54) and Harnessed Antelope (55) have a branch from the internal popliteal entering the muscle at its lower border but not curving round that border as in Man, in addition there are two or three smaller branches entering the posterior surface.

Flexor fibularis (*Flexor longus hallucis* of human anatomy).—This, except in the Camel and Elephant, is much larger than the flexor tibialis, and rises from the posterior surface of the tibia a little lower than the latter; it winds round the internal malleolus and is soon afterwards joined by the flexor tibialis; it then divides into a variable number of tendons which pierce those of the flexor brevis digitorum or continuation of the plantaris, and are inserted into the terminal phalanges. In the Hippopotamidæ, Suidæ, and *Dorcatherium* there are four tendons, in the other Artiodactyla only two; in the Rhinoceros, Tapir, and Hyrax three, in the Horse one; and in the Elephant the combined flexores tibialis et fibularis give tendons to all five digits, though the chief contribution is from the tibialis. It is always supplied by the posterior tibial nerve.

Flexor tibialis (*Flexor longus digitorum* of human anatomy).—This rises from the upper part of the posterior surface of the tibia, and from the back of the head of the fibula just below the popliteus. In every case of which we have records it joins the flexor fibularis in the upper part of the tarsus. As a rule it only sends fibres to the tibial digits, while the flexor fibularis supplies them all. In the Elephant and Camel, however, the flexor tibialis is the larger tendon of the two. Like the flexor fibularis it is supplied by the posterior tibial nerve.

Lumbricales.—Speaking generally, the Ungulates are not well provided with these muscles. In the Hippopotamidæ, Gratiolet (III.) found one for the medius digit. In the Suidæ they are apparently absent, at least they were so in our specimens (11, 14), and we find no mention of them by other writers, nor are they drawn in Cuvier and Laurillard's plates (I.). In the rest of the Artiodactyla they are, we believe, always absent. In the Perissodactyla they are more constant. Chauveau (II.) describes two in the Horse, one from each side of the flexor perforans tendon. In the Tapir (61, 62) there are three, the outermost being much the largest. Among the Subungulata, Hyrax (74, 75) has two, which pass round the tibial sides of the medius and annularis digits; in our specimen (75) they were both supplied by the external plantar nerve. In the Elephant, Paterson and Dun found only one small lumbrical, which was on the tibial side of the medius digit and was supplied by the internal plantar nerve. Miall and Greenwood (XXIX.), however, describe some more superficial ones rising from the plantaris and being inserted into the plantar sheaths.

Tibialis posticus.—This muscle, when it is present, rises from the upper part of the back of the tibia and joins the flexor fibularis in the upper part of the tarsus before that tendon unites with the flexor tibialis. We have records of it in the following animals: Hippopotamus (3), Suidæ (4, 7, 12, 13, 14), Camel (15)—here it is said to form the chief working part of the flexor perforans,—Chevrotain (20), Water-Chevrotain (24), Axis Deer (25), Ox (35, 36, 40), Sheep (41, 42), Goat (50, 51), Horse (63, 65). In the Elephant, according to Paterson and Dun, it rises from the tibia, fibula, and interosseous membrane, and is inserted into the dorsum of the bases of the second and third metatarsal bones as well as slightly into the first. Miall and Greenwood (XXIX.) and Anderson (XXVII.) agree with this, though neither of them found any insertion into the first metatarsal, but in Anderson's specimen it went to the fourth in addition to the second and third. It is certainly absent or quite fused with the flexor fibularis in many ungulates; thus Bronn (VI.), Meckel (VII.), and Cuvier say that it is absent in the order, and in the following animals it could not be made out:—Chevrotain (22), Brocket Deer (29), Gazelle, Sheep (47), Duiker-bok (54), Harnessed Antelope (55), Tapir (56, 61, 62), and Hyrax (74, 75). Its nerve-supply is the posterior tibial.

Plantar Region.

Flexor brevis digitorum pedis.—This rudimentary structure has already been described with the plantaris, of which it is the continuation into the sole.

The *Accessorius* is always absent, the only approach to it is a small fleshy bundle seen by Mivart and Murie in Hyrax and by ourselves in the Ox (40).

Deep Plantar Muscles.—In the Hippopotamus (1, 3) there is an abductor indicis, an abductor minimi digiti, and double-headed flexores breves for each toe.

In the Suidæ there is a greater suppression and evidently considerable individual variation. Lesbres (V.) describes only a few fleshy fibres on the outer and inner side of the foot, while Chauveau (II.) says that four interossei are present. In our specimen of Red River-Hog (11) we found one interosseus going to the tibial side of the medius, one to the fibular side of the annularis, and one to each side of the minimus, in addition to a feeble abductor minimi digiti. In the Peccary (14), on the other hand, there were only three muscles, that to the tibial side of the minimus being absent. In the rest of the Artiodactyla it is usual to find only two double-headed flexores breves, each head having a sesamoid bone developed in it; there are, however, no fleshy fibres in these structures. An exception is the Water-Chevrotaia, in which Chatin (XI.) describes four interossei, and from his figure there appears to be a double-headed fleshy flexor brevis to each toe. The increased development is not surprising when one remembers how large the lateral digits are in this animal. In the Tapir (61) we found a double flexor brevis to each toe, and Murie (XVII.) agrees with this but describes in addition two superficial muscles to the medius. In the Horse two interossei (*sic*) are described by Chauveau (II.) and Cunningham.

Among the Subungulata the sole-muscles are more numerous; Hyrax (75) has an adductor indicis and annularis on a superficial plane and deep to them three double flexores breves, while in addition to these there is an abductor indicis and quarti digiti. In Mivart and Murie's specimen all these were present as well as an adductor medii on the superficial plane.

In the Elephant (85), Paterson and Dun found an abductor hallucis rising from the calcaneum, and a "flexor brevis digiti secundi," which comes from the tuber calcis and covers the long tendons entering the sole. There is some reason to think that this represents the flexor brevis digitorum of Man, save that its insertion is into the metatarso-phalangeal capsule instead of into the middle phalanx. The minimus has an abductor and a double-headed flexor brevis. The four interosseous spaces are well supplied with muscles which do not seem to be arranged as double-headed flexores breves. Without an accurate diagram it is difficult to say whether any of these belong to the more superficial adductor series of the mammalian foot, or whether they are

flexores breves dislocated into plantar and dorsal interossei as in Man. The other authorities on the Elephant give us little help, and we must reserve the question for future investigation.

Muscles of the Trunk.

Serrati dorsales.—The anterior and posterior muscles can usually, though not always, be distinguished, and it is probably owing to the great difficulty in deciding how much was anterior and how much posterior that the great discrepancies in different authors' accounts have occurred. The origins of the two muscles are from the thoracic and anterior lumbar spines. The following are some of the recorded insertions of the anterior muscle:—

Hippopotamus (1)	3	ribs.
Pig (4)	3-8	„
Chevrotain (20)	2-9	„
„ (22)	3-12	„
Ox (35)	5-9	„
Sheep (42)	5-9	„
Antelope (55)	4-7	„
Horse (63, 65)	5-14	„
Hyrax (74, 75, 78)	4-20	„
Elephant (84)	5-8	„

The following are those of the posterior muscle:—

Hippopotamus (1)	4-15	ribs.
Pig (4)	8-14	„
Chevrotain (20)	9-12	„
Ox (35)	10-13	„
Sheep (42)	10-13	„
Antelope (55)	10-13	„
Elephant (84)	9-22	„

In the Chevrotain (22) and Hyrax (74, 75, 78) the muscle formed one single sheet and it was impossible to distinguish anterior and posterior parts.

The nerve-supply is from the posterior primary divisions of the thoracic nerves.

Splenius capitis.—This muscle varies a good deal in different animals; it rises from several of the anterior thoracic spines, but never seems to reach farther back than the 6th. In the Giraffe it is entirely absent according to Murie (XXXII.), while in the Camel (15, 18) it is so small as easily to escape notice. In the Ox (36) and Sheep (44) it is also very small. In the Hippopotamus (1) and Pig (4) it is fairly well marked, and in the latter animal Lesbres (V.) found it divided into two portions, one being inserted into the occipital crest, the other into the mastoid portion of the temporal. In the Elephant, Miall and Greenwood describe it (XXIX.) as bilaminar, while in the Horse (63, 65) and Hyrax (74, 75) it is well developed.

Splenius colli.—In the Artiodactyla this muscle, when present,

is small and is usually only inserted into the atlas, though in the Ox (36) it reaches the axis as well. It is absent in the Camel (15, 18) and Giraffe (33), though present in the Chevrotain (20).

In the Perissodactyla, judging from the Horse (63, 65, 67) and Tapir (62), it is specially strong, and in the latter animal is inserted into the six anterior cervical transverse processes. Among the Subungulata it is present in Hyrax (74, 75), but absent in the Elephant (81).

Erector spinæ.—The outer portion of this muscle, which in Man is composed of the sacro-lumbalis, accessorius, and cervicalis ascendens, is not well developed in Ungulates except the Subungulata (Hyrax and Elephant); the sacral origin is very feeble and is represented only by a delicate fibrous band rising from the common origin on the dorsal surface of the sacrum. The accessorius is the best developed part, and rises from the hinder ribs near their angles to be inserted into the same place on the anterior ribs. The cervicalis ascendens is represented only by one slip going to the transverse process of the 7th cervical vertebra. Although these muscles are feeble they are usually quite clearly marked off from the longissimus dorsi. In the Horse the accessorius and sacro-lumbalis are less well developed than in the Artiodactyla, and, according to Chauveau (II.), are inseparable from the longissimus, though other authors were easily able to distinguish the two.

The *Longissimus dorsi* is always well developed and has an external series of attachments just internal to the angles of the ribs, and an internal to the thoracic transverse processes; this internal series of attachments is continued up into the neck as the transversalis colli, trachelo-mastoid, and complexus.

While the *spinalis colli* is very strong, the *spinalis dorsi* is less well developed but still quite distinguishable. The semispinalis is well developed, especially in the neck.

The *Transversalis colli* is always present, and is inserted by a series of slips into the first five cervical vertebrae.

The *Trachelo-mastoid* (transversalis capitis) is, as usual, a continuation upward of the longissimus dorsi and is inserted into the paramastoid process of the temporal bone; it is closely connected with the transversalis colli. Lesbres (V.) says that it divides at its insertion, one part being attached to the skull and the other into the transverse process of the atlas. From our own dissections we feel sure that Lesbres has included a slip of the transversalis colli in his description. In the Chevrotain, Kinberg (X.) says the muscle is absent, but we found it in our specimen (21). In the Hyrax (75) we noticed that the muscle continued to rise in the neck from the articular processes of the cervical vertebrae.

Complexus.—This muscle rises from the transverse processes of the anterior thoracic vertebrae, varying from the 3rd to the 10th, as well as from the articular processes of the posterior cervical vertebrae; it is inserted into the skull just below the occipital

crest. In the Hippopotamus (1) and Pig (4) it is very large, and in the former reaches back as far as the 10th thoracic vertebra; in the Pig it is divided into a central and lateral bundle, the former of which corresponds to the biventer cervicis of other mammals although no central tendon is present. In the Camel (18), Giraffe (33), and Chevrotain (20) the biventer forms the greater part of the muscle and is really a biventer. In the Ox (36, 37), Sheep (41, 44), and Antelope (55) the two bundles are present, but the inner or biventer does not deserve its name as it has no central tendon. In the Horse (63, 67) the two parts are present, and four oblique myocommata are found intersecting one or both. In the Tapir (55) Murie makes no mention of a biventer, though he certainly knew of the existence of such a muscle. In our own Tapir unfortunately the deep neck-muscles could not be examined. In our specimen of Hyrax (75) the muscle was composed of three distinct parallel bundles; of these the innermost was continuous with the longissimus dorsi, the middle rose from the anterior thoracic transverse processes, while the external came from the articular processes of the hinder cervical vertebræ. All three were inserted together into the occipital bone, and a single myocomma was present in each of the external and internal bundles though not opposite one another. This description differs a good deal from that of Mivart and and Murie (XXIV.) in the Hyrax; the arrangement they found differs so much from that of any other ungulate that we fancy it must have been abnormal.

The *Multifidus spinæ*, *Interspinales*, and *Intertransversales* show nothing of special importance. The description in Man applies to them very well.

Suboccipital Muscles.—These have the usual mammalian arrangement: the posterior (inferior) oblique is very massive, and the rectus capitis dorsalis (posticus) major, as is so frequently the case, is a double muscle consisting of an external and an internal part; the latter Lesbres (V.) calls rectus capitis posticus medius, and he says it is always present in Ungulates. Meckel (VII.), however, says that in the Sheep only a single muscle is present, and we are so far inclined to agree with him that in our specimen (46) we found the separation a very arbitrary one.

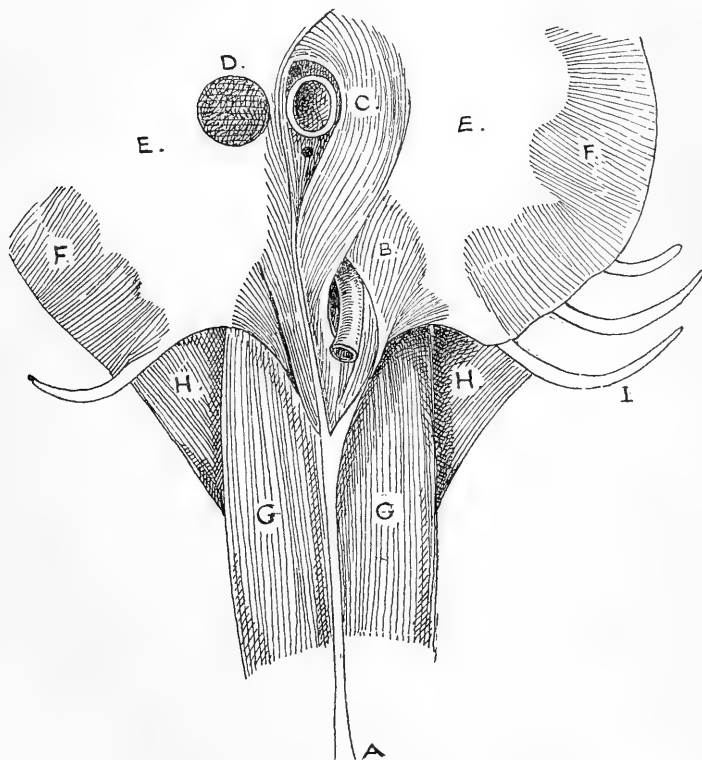
The *Rectus capitis dorsalis (posticus) minor* and *lateralis* are of fair size and have the attachments as in Man.

Triangularis sterni.—This muscle, as Lesbres (V.) remarks, is better developed in the Ungulates than in Man. Its origin is, as usual, from the caudal portion of the dorsal surface of the sternum. In the Chevrotain (20), Duiker-bok (54), and Horse (63) it is inserted from the 2nd to the 8th rib, in the Harnessed Antelope from the 2nd to the 9th.

Diaphragm.—This muscle in Ungulates differs in a good many respects from that of Man. The costal origins usually come from about half the total number of ribs, and where they are inserted into the central tendon each digitation can still be distinguished,

so that the junction between the flesh and the tendon has a scalloped appearance. There is only one crus, which rises far back in the lumbar region; in the Harnessed Antelope (55) it comes from the last lumbar, it runs forward as a long narrow tendinous band and becomes fleshy just before the aortic opening; here the main part passes to the right of the aorta and later on divides to form the œsophageal sphincter; the part which passes

Text-fig. 27.



Diaphragm of Harnessed Antelope. (Abdominal surface.)

- | | |
|------------------------|----------------------------|
| A. Crus. | F. Costal origin. |
| B. Aortic opening. | G. Psoas. |
| C. Œsophageal opening. | H. Retractor ultimæ costæ. |
| D. Caval opening. | I. Last (13th) rib. |
| E. Central tendon. | |

on the left side of the aorta is much smaller, and in some animals, *e.g.* the Chevrotain (21), is practically absent. There is only one arcuate ligament on each side, since the quadratus lumborum is quite concealed by the psoas. The caval opening is on the right side of the central tendon as usual. In the Horse, Chauveau (II.)

says that the costal origins do not interdigitate with the transversalis.

Obliquus abdominis externus.—This muscle usually rises from a large number of ribs, as the following list shows:—

Hippotamus (1)	4-15
Pig (11)	7-13
Chevrotain (20, 22)	6-13
Sheep (43)	6-13
Harnessed Antelope (55)	5-12
Duiker-bok (54)	6-14
Tapir (62)	4-18
Horse (63)	4-18
Hyrax (75)	5-22
Elephant (81)	3-19
Elephant (72)	3-20

The insertion into the crest of the ilium is very slight, so that Poupart's ligament is not a well-defined structure as in Man. In the Horse the external abdominal ring is a large oval structure, but in the Ruminants it is a mere slit, the two pillars joining at the pubic attachment. The muscle is largely supported by the tunica elastica which lies superficial to it and is specially well-developed in the Solipeds, Ruminants, and Elephant.

The *Supracostalis* is the forward continuation of the external oblique; we have little doubt that it is always present in Ungulates, although it is so thin and transparent that it requires careful looking for, and many authors make no mention of it. It rises from the sternum opposite the second and third ribs and passes forward and outward, covering the anterior part of the rectus to be inserted into the first near the junction of the bone and cartilage.

Obliquus abdominis internus.—This has a definite origin from the iliac crest and lumbar aponeurosis; it is much more fleshy in the hinder than in the fore part of the abdomen and is inserted into the cartilages of the hinder ribs. Myocommata are frequently found extending into it.

Retractor ultimæ costæ.—Chauveau (II.) describes in the Horse a small oblique muscle lying dorsal to the quadratus lumborum, rising from the anterior lumbar costal processes and being inserted into the posterior border of the last rib; he regards this as part of the internal oblique sheet, and we have little doubt that he is right since it is entirely in series with the internal intercostals. We have found the muscle in the Cervidæ, Bovidæ, and Tragulidæ, and believe that it is present in all Ungulates (see text-fig. 27, H., p. 287).

The *Transversalis abdominis* requires some little care to separate from the internal oblique, but, unlike that muscle, it is more fleshy in the anterior part of the abdomen, and is usually attached to the deep surfaces of about half the ribs—in the Chevrotain and Harnessed Antelope to the last six, in the Tapir and Horse to the last eleven.

Rectus ventralis (*R. abdominis*).—This, as usual, rises from the ventral aspect of the pubis near the symphysis and is continued forward to the first rib. Ventral to the anterior two or three ribs it lies deep to the supracostalis, and here its fleshy fibres usually cease and it is continued to the first rib by a thin aponeurosis. Many authors describe it as ending at the third, fourth, or fifth ribs, but wherever we have been able to repeat their dissections we have always been able to make out a delicate continuation of the muscle to the first rib. The number of lineæ transversæ varies from five to ten but eight or nine is the commonest number; they are, however, not well marked, and Steel (XIX.) has pointed out that in the Ass their number varies in individual specimens.

Pyramidalis.—We have never seen this muscle in Ungulates, and our experience agrees with that of Lesbres (V.) and Meckel (VII.). Mivart and Murie (XXIV.) were certain of its presence in Hyrax, but in our specimen it was undoubtedly absent.

All the preceding ventro-lateral muscles of the belly-wall are supplied by the intercostal nerves.

Quadratus lumborum.—This is a much narrower muscle in the Ungulata than in Man, and is attached posteriorly, by a narrow tendon, to the sacro-iliac joint or to a tubercle on the ilium close by. Anteriorly it is inserted into the lumbar transverse processes, and usually into the heads of several of the last ribs. In the Hyrax (74) it goes to the posterior twelve ribs, in the Chevrotain (20) into five, in the Horse (64, 65), Pig (4), and Elephant (81) into two, while in the Bovidæ its costal insertion seldom extends beyond the last rib.

Psoas magnus.—This rises from the transverse processes of all the lumbar vertebræ as well as from the sides of the bodies, it often also rises from a few of the lower thoracic bodies; its insertion is as usual into the lesser trochanter. In the Hippopotamus (1) it comes from the last two thoracic as well as the lumbar vertebræ. In the Pig (9, 11) it is not well developed and only comes from the lumbar region. In the Elephant (81) its attachment seems to be the most extensive, as in that animal it rises as far forward as the last four thoracic vertebræ as well as the last four ribs near their heads.

The *Psoas parvus* was present in every animal of which we have records except the Red River-Hog (11), and we have no doubt of its being a very constant muscle in Ungulates; it rises from the bodies of the last three or four thoracic, and several of the lumbar vertebræ; it is inserted by a ribbon-like tendon into the ilio-pectineal eminence.

The *Iliacus* is a small muscle and is laterally compressed; it rises from the iliac fossa, the ventral sacro-iliac ligament, and the margin of the sacrum. Before its insertion it blends with the psoas. Murie, in the Giraffe (XXXII.), noticed that the iliac and sacral origins remained separate for some time, and we found the same in the Harnessed Antelope (55), though it certainly is not always the case in Ungulates.

Perineal and Caudal Regions.

Sphincter ani.—This muscle has the human attachments in male animals, but in females it is continuous with the sphincter vaginae, forming the sphincter cloacæ. This is certainly the case in the Mare, the Sheep, the Chevrotain, and the Hyrax.

Transversus perinei.—Thompson (XXXVI.) says that this muscle is absent in Ungulates; it is described, however, by Kinberg in the Chevrotain (X.) and by Chauveau in the Horse and Bull (II.) We have seen it in the Sheep, but we agree with Thompson that it is not well marked.

Bulbo-cavernosus.—As the bulb is a bifid structure in Ungulates, the two halves of the muscle are separated by a wide raphe and do not unite in the middle line.

Ischio-cavernosus.—This is always well developed and rises from the inner side of the tuber ischii, it then turns forward, wrapping round the crus penis or clitoridis. Thompson gives a good illustration of it in the Camel (XXXVI.).

The *Compressor urethræ* surrounds the membranous portion of the urethra and consists, as in Man, of an upper and lower bundle; it differs from the human muscle in not being definitely attached to the pelvic wall.

Levator ani.—Thompson (XXXVI.) has shown that the levator ani of Man is a compound muscle consisting of two modified tail-muscles—the ilio- and pubo-coccygeus supplied by the sacral plexus, and an ischio-anal muscle which is a derivative of the sphincter cloacæ and, like that muscle, supplied by the pudic nerve. He points out that in the Ungulates only the ischio-anal muscle is present, and in this we can agree with him, though Gratiolet (III.) describes an ilio-coccygeus in the Hippopotamus and says that it is inserted into the anterior three caudal transverse processes.

Ischio-coccygeus (Coccygeus).—This is well developed in the Artiodactyla, and rises from the pelvic surface of the ischial spine or the region where that structure would be, as well as from the sacro-sciatic ligament. It is inserted into the anterior caudal transverse processes. Lesbres (V.) points out that in the Equidæ it is not well developed, and Chauveau (II.) agrees with this. Joly and Lavocat (XII.) deny its presence in the Giraffe, but Murie definitely found it in that animal. It is supplied by the sacral plexus.

Sacro-coccygeus superior (Levator caudæ; Extensor caudæ).—This rises from the sacral spines, and is inserted into the dorsal surfaces of the caudal vertebrae by a series of separate tendons. In those Ungulates in which the tail is well developed, a division into external and internal layers may be made out as in other mammals.

Sacro-coccygeus lateralis is the continuation backwards of the semispinalis layer of the erector spinæ.

Sacro-coccygeus inferior (Depressor caudæ; Curvator coccygis).—As Lesbres points out (V.), there are external and internal parts of this muscle, the latter being slightly developed and reaching only

to the 6th or 7th caudal vertebra, while the former runs to the tip of the tail.

The *Interspinales* and *Intertransversales caudæ* are feebly developed and diminish as the bones decrease in size.

ADDENDUM.

Orbital Muscles.—In addition to the recti and obliqui of human anatomy, there is a retractor bulbi or posterior rectus which surrounds the optic nerve and is inserted into the posterior part of the eyeball. This in the Chevrotain (20, 21) is divided into an upper and lower part, while in the Horse (63) and Ass (69) the division is more complete, for it is divided into four slips corresponding to the four recti. In the Horse (63) and Ass (69) there is also a middle oblique muscle which rises from the inner wall of the orbit below the pulley and later on joins the superior oblique; it is apparently a part of this muscle which does not pass through the pulley. We have looked for this muscle in the Artiodactyla but have never seen it, nor do we know whether it occurs in the Rhinoceros and Tapir among the Perissodactyla.

GENERAL SUMMARY.

We now propose to consider whether a study of these muscles is of any value from a classificatory point of view, and it will perhaps be best to collect first those myological points which are common to all Ungulates though not common to all mammals.

Myological Characteristics of the Ungulata.

1. Almost constant presence of masto-styloideus.
2. Absence of epitrochleo-anconeus.
3. Rudimentary condition of pronator radii teres.
4. Absence of pronator quadratus (except in Tapir).
5. Position and function of extensor carpi ulnaris as a flexor of the carpus.
6. Absence of supinator brevis.
7. Insertion of caudo-femoralis into patella.
8. Semi- and presemimembranosus fused almost to insertion.
9. Marked expansions from hamstrings to calcaneum forming a sheath for the tendo Achillis.
10. Only an ischial origin for the biceps femoris.
11. Usual absence of bicipiti accessorius.
12. Constant presence of straight and reflected heads to rectus femoris.
13. Usual presence of femoral origin of tibialis anticus (Subungulata the exception).
14. Usual presence of femoral origin of extensor longus digitorum (Elephant the exception).
15. Peroneus longus can be traced up to femur with external lateral ligament.

16. Almost constant absence of peroneus brevis.
17. Absence of accessorius pedis.
18. Constant presence of trachelo-mastoid.
19. Absence of pyramidalis.

We will next consider whether the division of Subungulata (comprising the Hyrax and Elephant) has any special points distinguishing it from the Ungulata vera.

Myological Characteristics of Subungulata.

1. Semimembranosus and presemimembranosus have ischial and caudal heads, but these are also found in the Perissodactyla.
2. Sartorius always absent in Hyrax and often in Elephant.
3. Tibialis anticus has no femoral origin.
4. Lumbricales are fairly well developed, but so they are in the Tapir.
5. Abdomino-humeralis well developed.
6. Palmaris longus present.
7. Flexor brevis digitorum manus present.

It will be seen, therefore, that there are not many points common to the Hyrax and Elephant, but nos. 3 and 7 are certainly significant so far as they go.

Between the Artio- and Perissodactyla there are a good many rather striking points of difference.

Myological Characteristics of the Artiodactyla.

1. Ectogluteus is inserted into the fascia of the thigh.
2. Obturator internus rises outside the pelvis.
3. Obturator tertius (so-called) is present.
4. Semi- and presemimembranosus have only an ischial head.
5. Semitendinosus has usually only an ischial head.
6. Lumbricales are absent except in the Hippopotamus.
7. Splenius colli is feeble or absent.

Myological Characteristics of the Perissodactyla.

1. Ectogluteus is inserted into the third trochanter.
2. Obturator internus rises inside the pelvis.
3. Obturator tertius absent.
4. Semi- and presemimembranosus have ischial and caudal heads.
5. Semitendinosus has ischial and caudal heads.
6. Lumbricales usually present.
7. Splenius colli strongly developed.

Speaking, therefore, from a myological point of view, there is good reason for dividing the Ungulata vera into two sharply defined groups, but there is little reason for placing the Hyrax and Elephant together in a separate division, for, excepting the absence of the femoral origin of the tibialis anticus and the

presence of the flexor brevis digitorum manûs, they have little in common.

The following are some of the myological characteristics of the different families of Ungulata, but they will be better appreciated by referring to the table :—

HIPPOPOTAMIDÆ.

1. Posterior belly of digastric often wanting.
2. Sterno-masseteric absent or very feeble.
3. Well-developed rhomboideus capitis.
4. Well-developed sterno-scapularis.
5. Coraco-brachialis entirely absent or only the longus present.
6. Supinator longus sometimes present.
7. Peroneus quinti digiti present.
8. Soleus absent.
9. Flexor brevis digitorum pedis fleshy.
10. One lumbrical present.
11. Tibialis posticus present.

SUIDÆ.

1. Sterno-facialis is superficial to platysma.
2. Posterior belly of digastric often absent.
3. Hyoideus transversus absent.
4. Sterno-thyroid often double.
5. Omo-hyoid may or may not have a posterior belly.
6. Sterno-masseteric absent.
7. Dorso-epitrochlearis from axillary border of scapula.
8. Rhomboideus capitis present.
9. Sterno-scapularis present.
10. Subglenoid muscle occasionally present.
11. Coraco-brachialis medius present.
12. Palmaris longus absent.
13. Supinator longus absent.
14. Extensor profundus digitorum sometimes present.
15. Obturator internus rises outside pelvis.
16. Obturator tertius present.
17. Peroneus quinti digiti present.
18. Soleus absent.
19. Tibialis posticus present.

CAMELIDÆ.

1. Sterno-mastoid has an insertion into the angle of the jaw.
2. Rhomboideus capitis absent.
3. Coraco-brachialis medius apparently present.
4. Palmaris longus absent.
5. Supinator longus absent.
6. Peroneus quinti digiti absent.
7. Tibialis posticus very large.
8. Splenius colli absent.

TRAGULIDÆ.

1. Omo-hyoid has no posterior belly.
2. Sterno-mastoid has an insertion into fascia over masseter.
3. Dorso-epitrochlearis from latissimus dorsi or fascia over infra-spinatus.
4. Rhomboideus capitis absent.
5. Sterno-scapularis small, sometimes absent.
6. Coraco-brachialis medius.
7. Palmaris longus absent.
8. Supinator longus absent.
9. Obturator internus rises outside pelvis.
10. Obturator tertius present.
11. Peroneus quinti digiti absent.
12. Tibialis posticus may be present or absent.

CERVIDÆ.

1. Omo-hyoid has no posterior belly.
2. Sterno-masseteric (mastoid) into anterior border of masseter.
3. Omo-trachelian absent apparently.
4. Dorso-epitrochlearis from latissimus dorsi or panniculus.
5. Rhomboideus capitis absent.
6. Sterno-scapularis small, sometimes absent.
7. Coraco-brachialis medius or medius and longus.
8. Palmaris longus absent.
9. Lumbricales absent.
10. Obturator internus and tertius doubtful, probably as in Tragulidæ, Giraffidæ, and Bovidæ.
11. Peroneus quinti digiti absent except in the Musk-Deer.
12. Tibialis posticus present or absent.

GIRAFFIDÆ.

1. Two or more tendinous intersections in the sterno-hyoid.
2. Omo-hyoid has no posterior belly.
3. Sterno-masseteric (mastoid) into anterior border of masseter.
4. Omo-trachelian rises from 6th and 7th cervical vertebræ instead of from atlas.
5. Rhomboideus capitis absent.
6. Sterno-scapularis probably absent.
7. Coraco-brachialis medius and longus.
8. Palmaris longus absent.
9. Supinator longus absent.
10. Obturator internus rises outside pelvis.
11. Obturator tertius present.
12. Peroneus quinti digiti absent.
13. Splenius capitis absent.
14. Splenius colli absent.

BOVIDÆ.

1. Omo-hyoid has no posterior belly.

2. Sterno-masseteric into anterior border of masseter except in Sheep.
3. Dorso-epitrochlearis small or absent.
4. Infrapinatus secundus sometimes, though rarely, present.
5. Rhomboideus capitis absent.
6. Sterno-scapularis small, often absent.
7. Coraco-brachialis medius or medius and longus.
8. Palmaris longus absent.
9. Lumbricales absent.
10. Supinator longus absent.
11. Obturator internus rises outside pelvis.
12. Obturator tertius present.
13. Peroneus quinti digiti absent.
14. Tibialis posticus present or absent.

TAPIRIDÆ.

1. Central tendon of digastric absent.
2. Omo-hyoid well developed.
3. Sterno-masseteric into angle of jaw.
4. Dorso-epitrochlearis from latissimus dorsi.
5. Rhomboideus capitis absent.
6. Sterno-scapularis comes from three costal cartilages.
7. Infrapinatus secundus present.
8. Coraco-brachialis medius and longus.
9. Palmaris longus absent.
10. Flexor brevis digitorum manûs sometimes present.
11. Supinator longus present.
12. Pronator quadratus present.
13. Obturator internus rises inside pelvis.
14. Obturator tertius absent.
15. Peroneus quinti digiti absent.
16. Tibialis posticus absent.
17. Splenius colli very strong.

EQUIDÆ.

1. Vertical slip of panniculus over shoulder.
2. Slip of digastric to ramus of mandible.
3. Sterno-hyoid has a central tendon.
4. Omo-hyoid well developed.
5. Sterno-masseteric into angle of jaw.
6. Dorso-epitrochlearis from axillary border of scapula.
7. Rhomboideus capitis absent.
8. Sterno-scapularis from three costal cartilages.
9. Subglenoid muscle occasionally present.
10. Infrapinatus secundus present.
11. Coraco-brachialis brevis and medius.
12. Palmaris longus absent.
13. Supinator longus absent.
14. Obturator internus rises inside pelvis.

15. Obturator tertius absent.
16. A third gemellus is often present.
17. Peroneus quinti digiti absent.
18. Peroneus longus absent.
19. Tibialis posticus present.
20. Splenius colli strongly developed.

RHINOCEROTIDÆ.

(Further details of this family are badly needed.)

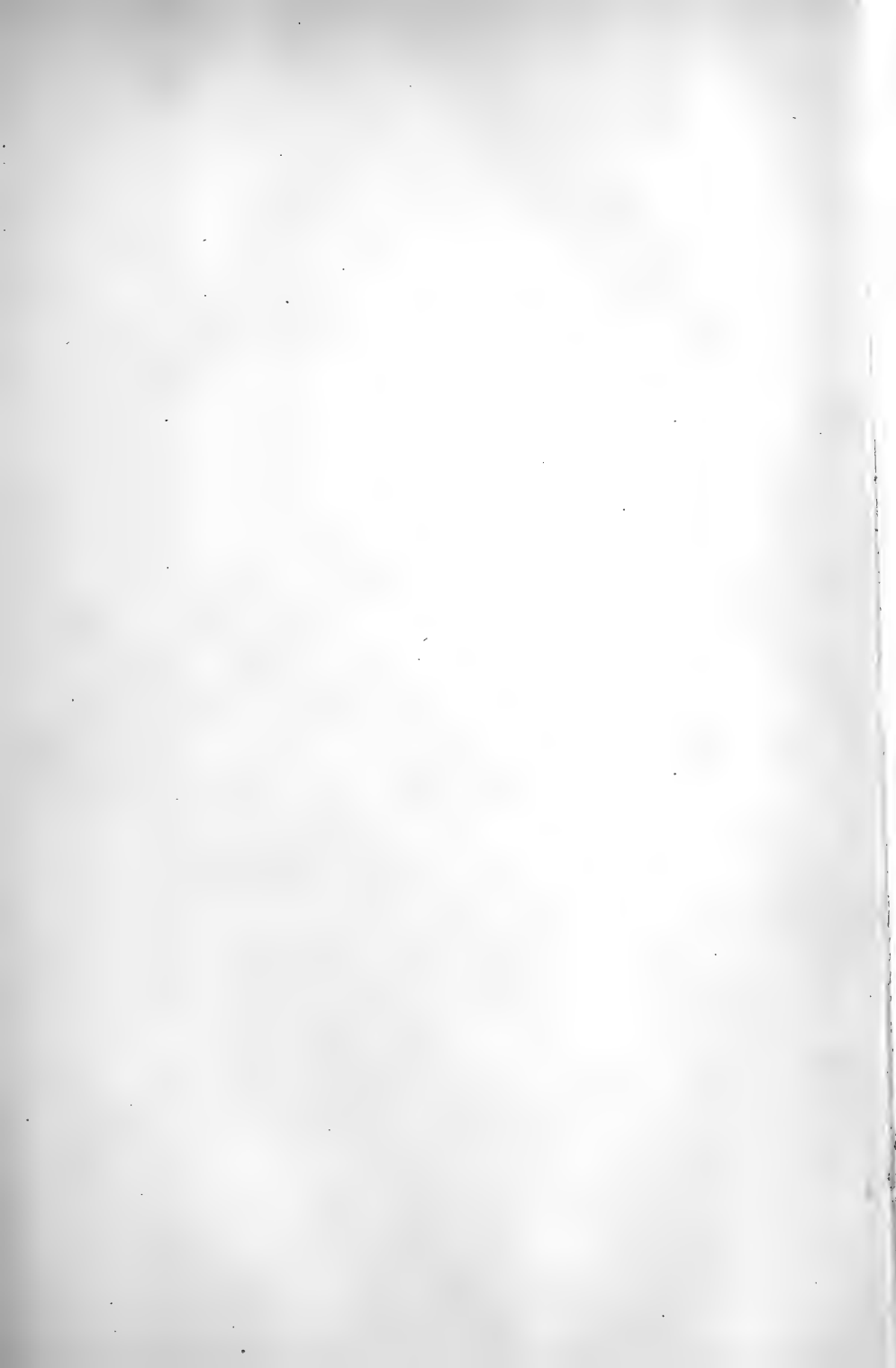
1. Sterno-scapularis present (no details).
2. Coraco-brachialis medius or longus.
3. Palmaris longus absent.
4. Supinator longus present.
5. Obturator internus apparently rises inside the pelvis.
6. Obturator tertius apparently absent.
7. Peroneus quinti digiti absent.

PROCAVIDÆ.

1. Abdomino-humeralis well developed.
2. Sterno-facialis absent.
3. Zygomaticus absent.
4. Masto-styloideus absent.
5. Omo-hyoid absent.
6. Sterno-masseteric enormous.
7. Dorsal-epitrochlearis from latissimus dorsi and fascia over infraspinatus.
8. Rhomboideus capitis present.
9. Sterno-scapularis from three costal cartilages.
10. Coraco-brachialis medius, sometimes longus.
11. Palmaris longus present.
12. Flexor brevis digitorum manus present.
13. Olecranal head of flexor carpi ulnaris well developed.
14. Supinator longus absent.
15. No femoral insertion of ectogluteus.
16. Obturator internus rises outside pelvis.
17. Obturator tertius present.
18. Tibialis anticus has no femoral origin.
19. Peroneus quinti digiti absent.
20. Fabella in outer head of gastrocnemius.
21. Flexor brevis digitorum pedis fleshy.
22. Tibialis posticus absent.

ELEPHANTIDÆ.

1. Abdomino-humeralis well developed.
2. Sterno-facialis absent.
3. Sterno-hyoid absent.
4. Omo-hyoid absent.
5. Two sterno-masseteric attachments.



	HIPPOPOTAMIDÆ.	ST	TAPIRIDÆ.	PERIS
1. Abdomino-humeralis.	?			
2. Sterno-facialis.	?	S		
3. Zygomaticus.				
4. Digastric.	Posterior belly often		No central tendon.	Two b
5. Masto-styloideus. ....	||			
6. Sterno-hyoid.	Prolonged to jaw.		Strong.	O
7. Sterno-thyroid.	Single.	O		
8. Omo-hyoid.	No scapular attachment.	Some a	Scapular attachm	
9. Hyoideus transversus.	Present.		?	
10. Sterno-masseteric.	To post. border of ramus.		To angle of jaw.	Ne
11. Rhomboideus capitis.	Present.			
12. Sterno-scapularis.	Present.			
13. Dorso-epitrochlearis.	?	From sqg; from lats. dorsi.		F
14. Subglenoid muscle.	Absent.	Somed.		
15. Coraco-brachialis.	Absent or longus only.	M	Medius and longus.	Br
16. Palmaris longus.				
17. Olecranal head of Flexor } carpi ulnaris. }	Separate muscle.		Feeble.	F
18. Supinator longus.	Present or absent.		Present.	
19. Flexor brevis digitorum manûs			sometimes present.	
20. Sartorius.				
21. Ectogluteus.				Inserted
22. Obturator tertius.	?			Absent.
23. Origin of Semi- and Presemi- } membranosus. .... }				||
24. Lumbricales.	One.			Present.
25. Soleus (origin).		Femoral.	Femoral.	||
26. Tibialis posticus.			Absent.	
27. Flexor brevis digitorum pedis.	Fleshy.			
28. Tibialis anticus.				
29. Extensor longus digitorum } (origin). }				
30. Peroneus quinti digiti.	Present.	Of		Absent.
31. Splenius colli.	Present.			Very strong

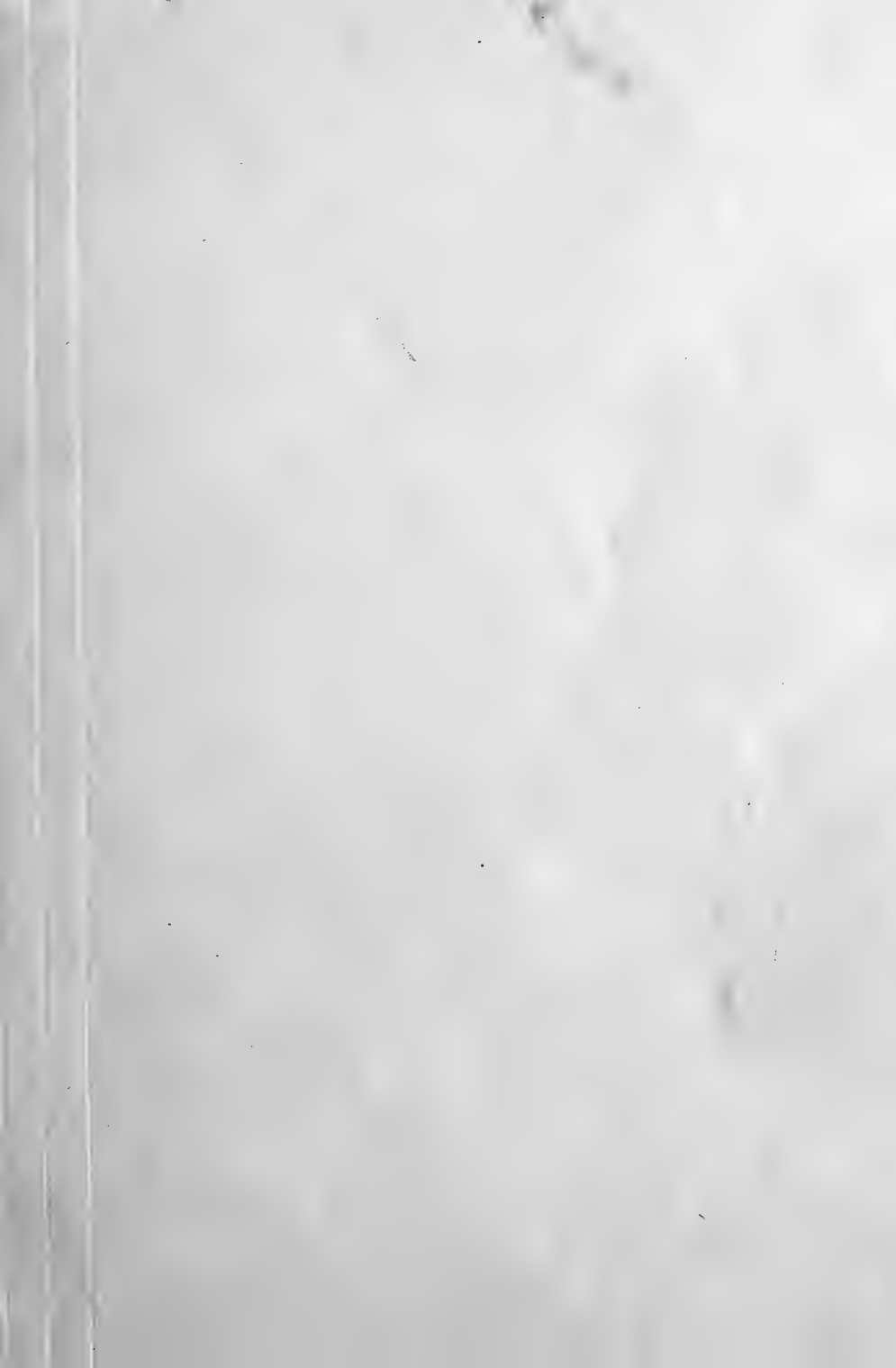
6. Dorso-epitrochlearis from latissimus dorsi and axillary border of scapula.
7. Rhomboideus capitis absent.
8. Sterno-scapularis present.
9. Subglenoid muscle occasionally present.
10. Coraco-brachialis medius and longus.
11. Palmaris longus present.
12. Flexor sublimis digitorum absent.
13. Flexor brevis digitorum manûs present.
14. Olecranal head of flexor carpi ulnaris well developed.
15. Supinator longus present.
16. Extensor profundus digitorum present to index.
17. Ectogluteus has a femoral insertion.
18. Obturator internus rises inside pelvis.
19. Obturator tertius absent.
20. Extensor longus digitorum has no femoral origin.
21. Tibialis anticus has no femoral origin.
22. Peroneus quinti digiti present.
23. Tibialis posticus present.
24. Splenius colli absent.

The Table facing this page will, we hope, be useful to future investigators. It shows at a glance the arrangement of 31 of the most interesting muscles in the bodies of Ungulates. So far as we know, the muscles which are not included have either the generalised mammalian arrangement, or else are specially characteristic of all Ungulates, in which case they have already been given on p. 291. Another point in which this Table may be valuable is that it draws special attention to the gaps in our knowledge, and this is often the first step towards filling them up.

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	ARTIODACTYLA.										PERISSODACTYLA.		SUBUNGULATA.		
	HIPPOTAMIDÆ.	SUIDÆ.	CAMELIDÆ.	TRAGULIDÆ.	CERVIDÆ.	GIRAFFIDÆ.	BOVIDÆ.	TAPIRIDÆ.	EQUIDÆ.	RHINOCEROTIDÆ.	PROCAVIDÆ.	ELEPHANTIDÆ.			
1. Abdomino-humeralis	?					Feeble.							Strong.		1.
2. Sterno-facialis	?	Strong.					Feeble if present.						Absent.		2.
3. Zygomaticus						Present.							Absent.	Present.	3.
4. Digastric	Posterior belly often wanting.			Two bellies.			?	Two bellies.	No central tendon.	Two bellies and an extra slip.	?		Fan-like.	Central tendon may be present.	4.
5. Masto-styloideus						Present.							Absent.	Present.	5.
6. Sterno-hyoid	Prolonged to jaw.	Strong.	?	Fused posteriorly.	Slight.	Many tendinous inter-sections.	Slight or absent.	Strong.	Central tendon.	?			Strong.	Absent.	6.
7. Sterno-thyroid	Single.	Often double.						Single.							7.
8. Omo-hyoid	No scapular attachment.	Sometimes a scapular attachment.			No scapular attachment.			Scapular attachment.					No omo-hyoid.		8.
9. Hyoides transversus	Present.	Absent.	?	Present.		?	Present.	?	Present.	?	?	?	?	?	9.
10. Sterno-masseteric	To post. border of ramus.	Absent.	To angle of jaw.	To fascia over masseter.	To anterior border of masseter.	To angle of jaw and surface of masseter.	Usually to anterior border of masseter.	To angle of jaw.	Near angle of jaw.	?			Very large; to surface of masseter.	Two mandibular insertions.	10.
11. Rhomboideus capitis	Present.					Absent.				?			Present.	Absent.	11.
12. Sterno-scapularis	Present.		Probably absent.	Present but feeble.		Probably absent.	Present or absent.			Present.					12.
13. Dorsio-epitrochlearis	?	From scap. or lats. dors.	?	From infraspinatus or lats. dors.	From pinniculus or lats. dors.	?	Feeble; origin very variable.	Strong; from lats. dors.	From scapula.	?			From infraspinatus and lats. dors.	From scapula or lats. dors.	13.
14. Subglenoid muscle	Absent.	Sometimes present.					Not recorded.							Sometimes present.	14.
15. Coraco-brachialis	Absent or longus only.	Medius only.	Apparently medius only.	Medius only.	Medius always, longus sometimes.	?	Medius always, longus sometimes.	Medius and longus.	Brevis and medius.	Medius or longus.	Medius always, longus sometimes.	Medius and longus.			15.
16. Palmaris longus						Absent.							Present.		16.
17. Olecranal head of Flexor carpi ulnaris	Separate muscle.	Absent.	?	Feeble or absent.	Present.	Apparently absent.	Feeble or absent.	Feeble.	Feeble or absent.		Present.				17.
18. Supinator longus	Present or absent.			Absent.				Present.	Absent.	Present.	Absent?	Present.			18.
19. Flexor brevis digitorum manus				Absent.				Sometimes present.	Absent.			Present.			19.
20. Sartorius					Present.								Absent.	Usually absent.	20.
21. Ectoglossus			Inserted into fascia.			?	Inserted into fascia.		Inserted into third trochanter.		Inserted into fascia.	Inserted into femur.			21.
22. Obturator tertius	?	Present.	?	Present.	?	Present.	Present.		Absent.	Probably absent.	Present.	Absent.			22.
23. Origin of Semi- and Presemi-membranosus				Only ischial origin.						Ischial and caudal origin.					23.
24. Lumbricales	One.			Absent.					Present.	?		Present.			24.
25. Soleus (origin)	Femoral.	?	Fibular.	Femoral.	?	Fibular.	Femoral.	Tibial.	?		Fibular.				25.
26. Tibialis posticus		Present.		Present or absent.	?	Present or absent.	Absent.	Present.	?		Absent.	Present.			26.
27. Flexor brevis digitorum pedis	Fleshy.					Fibrous.					Fleshy.	Fibrous.			27.
28. Tibialis anticus					Femoral origin present.					?	No femoral origin.				28.
29. Extensor longus digitorum (origin)						Femoral.						Tibial.			29.
30. Peroneus quinti digiti	Present.	Often present.	Absent.	Present in Musk-deer.				Absent.				Present.			30.
31. Splenius colli	Present.		Absent.		Present.			Very strong.	?		Present.	Absent.			31.



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7. On some Points in the Anatomy, chiefly of the Heart and Vascular System, of the Japanese Salamander, *Megalobatrachus japonicus*. By FRANK E. BEDDARD, M.A., F.R.S., F.R.S.E., Prosector to the Society.

[Received September 29, 1903.]

(Text-figures 28–34.)

The anatomy of the Japanese Salamander has formed the subject of more than one memoir of late years, and has been furthermore treated of incidentally in a number of papers dealing with the anatomy of organs and systems of organs in the Amphibia generally*. The dissection of two examples of this

* Osawa (Mith. Medicin. Facult. k. Japan. Univ. Bd. v. no. 4, 1902) gives a copious bibliography.

great Amphibian which died in the Society's Gardens enables me, however, to add a few new facts to what is already known of its structure. The larger example measures 39 inches, the smaller 20 inches. The large *Megalobatrachus* was injected, and though the injection did not run with equal regularity through all the branches of the arterial system, certain regions were filled with the gelatine, and allow of the description of quite minute arteries, some of which are of importance and apparently have not been described.

§ *On certain of the Abdominal Viscera.*

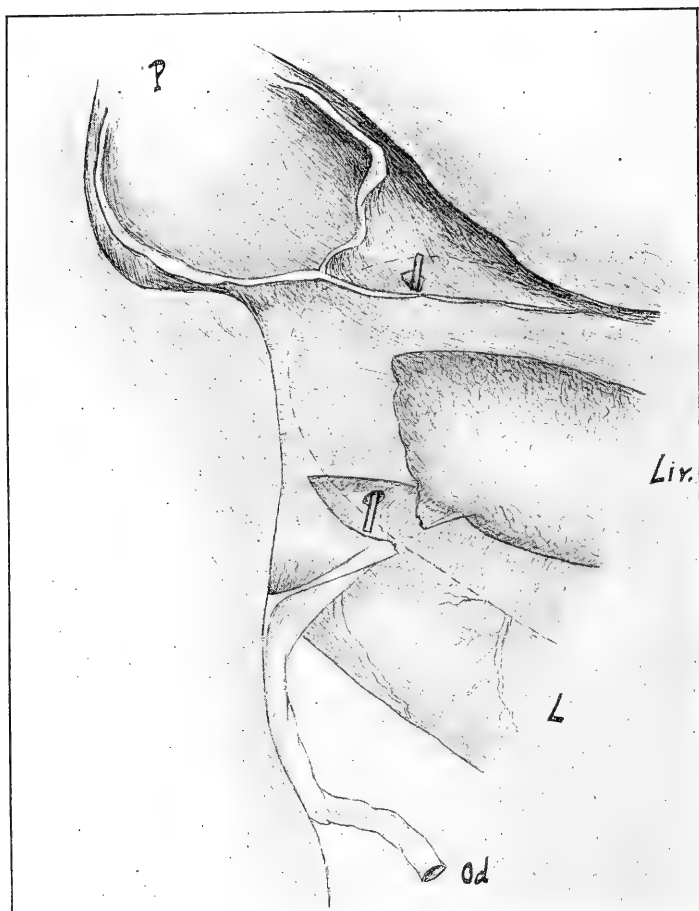
About one-third of the length of the right lung is free from any mesenteric attachments, and lies freely over the abdominal viscera. The rest of this organ, nearly up to the root, depends by two mesenteries which are inserted along the internal edge of the lung where the pulmonary artery runs. One of these mesenteries attaches the lung to the liver, the other to the aorta posteriorly, and to the œsophagus anteriorly after the origin of the gastric artery. Anteriorly the two mesenteries arise separately from the lung; posteriorly they arise in common and ultimately become fused into one membrane, which at the end of the liver is continuous with the mesoarium.

The tip of the left lung is also free from mesentery, but for a shorter space than that of the right lung. One membrane only is attached to it, which passes to the œsophagus and stomach anteriorly, and posteriorly joins the mesogastrium. Posteriorly the spleen is suspended in the mesogastrium, and between the spleen and the lung is a funnel-shaped depression of the mesentery up which passes the gastro-splenic artery. Posteriorly, the mesentery attaching the stomach to the aorta passes into the mesoarium, as has been described on the right side of the body. The liver is furthermore attached to the œsophagus and stomach by a membrane which corresponds dorsally to the falciform ligament ventrally. The spleen is borne upon the outside of the hepatocœsophageal mesentery.

The liver therefore underlies a considerable cavity which is largely separate from the rest of the abdominal cavity, the walls of which are formed by the various mesenteries attached to the liver. Anteriorly this cavity extends beyond the liver, and reaches up to the wall of the pericardium; its boundaries are shown by the dotted line in the accompanying drawing (text-fig. 28, p. 300). Its wall is very strong and tough. Posteriorly the mesenteries supporting the ovaries and the oviducts are not attached separately to the body-wall. The arrangement is as follows:—In the middle line is the mesentery supporting the gut, which is low in the rectal region where the gut is straight, and is higher anteriorly where the gut has a more sinuous course. It ends anteriorly upon the ventral surface of the liver on the right side of the gall-bladder, beyond which it does not extend. It is parallel to the falciform ligament, which is attached on the

left side of the gall-bladder. It is also attached on the left side to the hepato-oesophageal mesentery, and on the right to the pulmono-hepatic. Externally to the intestinal mesentery is the mesoarium, and externally to this again the sheet supporting the oviduct, which is much more pigmented than the other mesenteries.

Text-fig. 28.



Dissection of the base of the liver and lung of *Megalobatrachus* on the right side of the body, to show arrangement of divisions of Coelom.

L, right lung; Liv., liver; Od., oviduct; P, pericardial cavity.

The mesenteries of all the abdominally situated viscera, therefore, converge upon the vena cava and aorta. Quite anteriorly,

however, the oviducal mesentery leaves the common dorsal mesentery, and goes to the right and to the left to follow the oviduct to its internal aperture. The aorta itself is removed by quite a long distance from the dorsal median line, from which the dorsal mesentery, over an inch wide in parts, suspends it. It should be observed that this membrane is continuous and not fenestrated as it is in the frog, where the aorta also does not lie close to the backbone. Within this mesentery are suspended the intercostal arteries and certain portal veins, both of which are described elsewhere (see p. 312). The halves of this mesentery are so loosely attached to each other that the slightest pull brings them apart. I am disposed to think that this ready separation argues a lymph-space or spaces of considerable extent within the cavity of this dorsal mesentery.

The above description of the mesenteries has been given partly to serve for a comparison with *Menopoma*. The differences between the two forms are not, however, great. In the first place, the left lung is very much shorter than the right in *Menopoma*. In *Megalobatrachus* it is slightly longer. Nevertheless, in *Menopoma* the free tip of the lung to which no mesentery is attached is proportionately much longer than in *Megalobatrachus*. Finally, the left lung of *Menopoma* is connected only with the œsophagus. This membrane, however, runs for a little distance over the mesentery attaching the stomach to the aorta, and is a trace of the former greater extension of the lung. The gastro-hepatic ligament bears, of course, the gastric and œsophageal branches of the portal, which show differences in the two animals. In both, the œsophageal portal is quite distinct from the gastric, and enters the liver at about the middle of its length. In *Menopoma* this trunk is formed by the union of two equally sized vessels. In *Megalobatrachus* there is but one. In the larger specimen of this genus, moreover, the condition was still more specialised; there was no separate œsophageal trunk at all. Furthermore, in *Menopoma* the gastric trunk consisted of two main trunks meeting near to their entrance into the liver posteriorly; the anterior of these has two branches, the posterior three. In *Megalobatrachus* this vessel is more obviously one trunk with many branches. These and other reasons (such as the at least general persistence of a pair of gill-slits) lead me to dissent from those who would unite the American and Japanese Salamanders into one genus, *Cryptobranchus*.

A sheet of membrane, quite tough in character, extends from the right lobe of the liver to the parietes, and arches over a section of the body-cavity. Into the pocket formed at the corner of this next to the lateral parietes opens the oviduct. The general relations of these various parts are shown in the accompanying sketch (text-fig. 28). This cavity is entirely floored by the lung, and its boundary near the middle line of the body is the mesentery connecting the liver with the lung. On the right side, and below the shelter afforded by the transverse and horizontal

sheet of membrane just referred to, is a foramen in the hepatopulmonary membrane, which, whether normal or abnormal, is certainly natural. It is a foramen with a perfectly clear margin as seen with a lens, and four to five millimetres across. In the drawing a probe is represented inserted in this foramen. On the left side of the body the membrane which bears the orifice of the oviduct arises also from the edge of the liver anteriorly.

This state of affairs, which has been described by others, is not apparent in the smaller, male, individual. In this Salamander the base of the lung is closely attached to the lateral parietes on both sides of the body by a tough and very short membrane. There is no trace whatever of a fold of membrane arching over this and bearing the mouth of the oviduct. Evidently, therefore, the existence of this fold is associated with the oviduct, for the smaller animal was fully mature.

The sperm-duct could be traced forward to below the shelter of the lung, *i. e.* where the latter fills up the space between the liver and the parietes. Here the membrane supporting it curves round in a semicircle to the right as in the larger individual, but there was no trace of the oviduct along the semicircular curve. On the other hand, what I take to be the end of the sperm-duct lay in the same straight line with the rest of the duct*. I may remark, furthermore, that the extent and depth, as shown by passing a probe above it, of the semicircular membrane is greater proportionately in this male individual. A bristle tipped with sealing-wax could be passed forwards as far as to a point beneath the pericardium. This extension forwards of the body-cavity then comes to be obliterated in the female, or indeed possibly in course of growth, perhaps owing to the pressure of the lung.

On the left-hand side of the body I found precisely the same state of affairs.

§ *The Heart.*

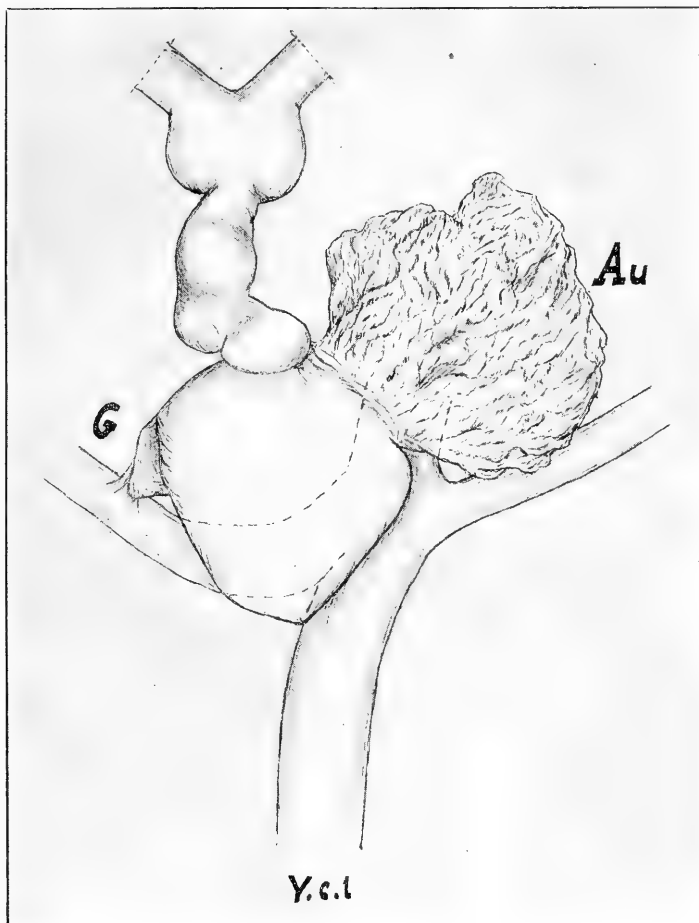
The heart, which has been described by Osawa † more accurately than by others, lies in a spacious pericardium which is roughly of a circular form, and proved to have the following dimensions: greatest diameter 65 mm., greatest length 6.5 mm. The heart does not by any means completely fill this pericardium. As to the general shape of the heart, the ventricle is rhomboidal, the posterior angle of the rhomboid lying a little to the right of the entrance of the vena cava inferior. The right-hand angle of the rhomboid is tied down by a gubernaculum (text-fig. 29, G), not figured by Osawa, which is attached partly to the wall of the pericardium, and partly to the right vena cava superior. The gubernaculum is broad and can be seen, by passing a probe beneath it and then

* The sperm-ducts end anteriorly in a small flattened projecting body only attached by one end to the membrane which supports it. I find a precisely similar body in the large female, but entirely unconnected with any further rudiment of the male-duct. This is referred to on p. 315, in connection with the termination of the *Arteriae comites aortae*.

† "Beiträge zur Anatomie des Japanischen Riesensalamanders," Mitth. Medicin. Facult. k. Japan. Univ. v. p. 221 (1902).

raising it, to pass over (literally, of course, under) the *ductus Cuvieri* before becoming attached to its posterior wall and to the posterior wall of the pericardium. In *Menopoma*, on the other hand, I observe that the gubernaculum is smaller and less band-like and

Text-fig. 29.

Ventral view of Heart of *Megalobatrachus*.

Au., auricle; G, gubernaculum cordis; V.c.i., vena cava inferior.

(For this drawing and text-fig. 28 I am indebted to the kindness of Mr. R. Crawshay.)

is attached at once to the vein without passing beyond it. Moreover, in the latter Amphibian as contrasted with *Megalobatrachus*,

the vein has a much shorter course within the pericardium, and leaves that cavity at its posterior corner on each side, instead of passing forward and running for some space within the pericardium at an angle with its former course. Hyrtl figures veins in the place of the gubernaculum which he describes as ramifying over the heart; but he describes no coronary artery. On the contrary, I find a very distinct coronary artery (see p. 308), but have seen no coronary veins. In the interior of the ventricle I could find no traces of a subdivision into two cavities. The demarcation between the pylangium and the synangium is quite visible externally, and plainly to be seen in the accompanying drawing (text-fig. 29, p. 303). The entire truncus arteriosus measures 43 mm. as against 34 mm., which is the extreme length of the ventricle. Of this 43 mm., 28 mm. belong to the pylangium. The pylangium is rather plainly divisible into three divisions, which are subequal. The first division, that nearest to the ventricle, seems on a dissection to belong partly to the ventricle and partly to the truncus arteriosus. Externally, however, as the drawing shows, it appears to be clearly a part of the truncus; its smooth walls and sharp demarcation from the ventricle mark it out as a portion of the truncus. The synangium does not abut upon the anterior wall of the pericardium as in *Menobranthus**. It divides while within the pericardium into right and left halves, which separately perforate the pericardium. The diameter of the synangium is very much greater than that of the pylangium, about twice as great, and it has an almost square outline.

The auricle is attached to the ventricle for the greater part of the anterior left-hand border.

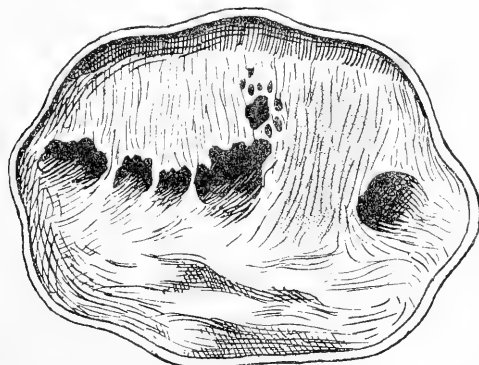
It is naturally, on account of its thin walls, of somewhat irregular outline. It is a little difficult to compare the sizes of the auricle and the ventricle on account of their different shape; but it appeared to me that the auricle is slightly, but not very distinctly, the larger. Whether the auricle does during life I do not know, but it *can* lie entirely on the left hand of the ventricle owing to the large pericardium. The sinus venosus is spacious and opens into the auricle not far from the opening of the latter into the ventricle. It receives below and approximately in the middle line the vena cava inferior. On each side opens into the sinus venosus a transverse trunk which is, I presume, partly *ductus Cuvieri* and partly superior cardinal. Each transverse trunk runs along the whole of the transverse diameter of the pericardium and in contact with its posterior wall.

The auricle is very distinctly divided into two cavities (text-fig. 30). The larger, which I presume to be the equivalent of the right auricle, lies nearest to the ventricle into which it opens. The sinus venosus opens into this, and its orifice is shielded on the side remote from the ventricle by a flap, which so far completely partitions the auricle, since it extends from roof to floor, and has

* Huxley, "On the Structure of the Skull and of the Heart of *Menobranthus lateralis*," P. Z. S. 1874, p. 186.

no fenestræ—at least visible fenestræ. This flap appears to be purely membranous. Anteriorly it is continuous with the rest of the interauricular septum, which, on the contrary, is entirely muscular. It is much fenestrated, and consists below of vertical pillars passing from the dorsal to the ventral wall of the auricle. There is also, particularly on the side adjoining the fibrous part of the septum, a mesh-like disposition of the muscular strands such as Huxley has figured in *Menobranchus**. The completeness of the separation of two auricles, not indicated externally, I may repeat, is furthermore shown by the fact that they debouch quite independently of each other into the ventricle. The septum between the two auricles is almost suggestive of a heart-valve in being partly muscular and partly membranous. And it may possibly be the case that the septum is physiologically something more than a mere partition-wall—and incomplete at that—between two neighbouring cavities. It may possibly by its own

Text-fig. 30.



Auricular septum of *Megalobatrachus*, viewed from in front.
The membranous part is dotted.

contraction, by the contractions of the muscular part playing upon the tendinous sheet, do something to stop or facilitate at different periods of the heart's beat the admixture of arterial and venous blood before it reaches the ventricle. I greatly regret that, having only one large heart at my disposal, I am unable to push this matter any further.

I do not find myself absolutely in accord with the account of the interauricular septum given by Hyrtl or with his figure of the same. Hyrtl describes the septum as extremely delicate but imperforate, and as arching over the atrio-ventricular orifice. It is clear that this is only that part of the septum which I have described as thin and imperforate. Hyrtl does not refer to the muscular pillars which tie down the rest of the thin, and in parts

* *Loc. cit.* pl. 32, fig. 5.

fenestrated, interauricular partition. Nor is there an indication of these structures in his figure. Nevertheless, an inspection of the drawing which I herewith submit (text-fig. 30, p. 305) will, I think, prove that the septum is not so simple as illustrated by Hyrtl*. On the other hand, Dr. Chapman† writes:—"It is needless to add that the author found the delicate septum separating the auricles incomplete." But there is no detailed description, nor does Osawa figure a perforate septum, though he states that it is "vielfach durchlöcherter."

The advantage of a large-sized specimen for investigation is clearly brought out in the examination of the structure of the heart in this Amphibian. I have been able to compare the large individual with a much smaller one, not more than a sixth of its size. In this Salamander the ventricle did not show any marked traces of the characteristic rhomboidal form which is so apparent in the large Amphibian; its contour was indeed of a general oval form, much like the heart as figured by Osawa. Furthermore, the pylangium only appeared divisible externally into two divisions, of which one, that nearest to the ventricle, was not more than half the length of the larger distal portion. It became naturally a question of interest to determine which of the three divisions so plainly visible in the larger specimen were fused together to form the single larger barrel-shaped section. I found by an examination of the internal structure of the proximal shorter part of the pylangium, that this is to be looked upon as the first and ventricle-like portion of the pylangium.

Pylangium.—The proximal division of this section has for the most part such strongly muscular walls that it might be regarded as a portion of the ventricle, were it not for the fact of its marked constriction from the ventricle and the smooth character of a portion of its internal surface. At the end of this smooth portion is situated the first row of watch-pocket valves, which appear to me to be accurately transverse in direction, but not symmetrical with reference to the dorsal and ventral lines of the pylangium or in their distances from each other. Furthermore two are equisized and larger than the third. There is also a fourth‡ in the specimen dissected by myself. In comparing the pylangium of this large Salamander with that of the smaller example, a fact which appears to me to be of some little physiological importance comes out. The proportions between the conus arteriosus and the ventricle are the same in both individuals, but the heart as a whole is of course larger in the larger specimen. The valves, apparently, are nearly of the same size in the two specimens, and thus do not grow, or grow but slightly. Furthermore, in the smaller specimen the valves are so nearly in contact, that at the requisite times they must occlude the pylangium and thus

* *Cryptobranchus japonicus*: Vindobonæ, mdccclxv. p. 93, pl. xii. fig. 3.

† "Observations on the Japanese Salamander, *Cryptobranchus maximus* (Schlegel)," Proc. Acad. Nat. Sci. Philad. 1893, p. 227.

‡ According to Hyrtl and Osawa there may be a fifth.

perform their function perfectly. On the other hand, this could hardly be the case with the big Salamander; and it may be that the unequal growth of the various parts of the heart is a direct cause of death*.

Concerning the second row of valves I have nothing to add to the account given by Osawa, who corrects previous errors†.

Synangium.—A transverse section through the synangium at about its middle point shows that the term "synangium" is especially applicable to *Megalobatrachus*. In *Menobranchus* this region of the heart as figured by Huxley‡ is divided into four cavities only, the subsequent subdivisions of which form the several aortic trunks. In *Megalobatrachus* all the arteries may be said to arise separately from the pylangium. The transverse section, in fact, shows the cavity of the bulky synangium to be primarily divisible into a right and left half. Each half is again divided by septa into cavities, which are those of the four arterial trunks. These are placed one above the other in a series of stories, and increase in size from below upwards, the lowest and smallest being, of course, the Carotid and the largest and most dorsal the Pulmonary. The vertically-disposed origin of the arteries contrasts with their nearly horizontal position on emergence from the common sheath§.

§ Aortic Arches.

I do not find that my dissections of the arteries arising from the conus arteriosus agree altogether with the figures or the descriptions of Hyrtl and Osawa, even in important details. As will be seen from the drawing submitted herewith (text-fig. 33, p. 311), there are four branches, as is correctly shown by Schmidt, Goddard, and Van der Hoeven in their memoir||, and by Dr. Chapman¶ and Prof. Osawa**. Nor are the views which Hyrtl gives of sections through the conus arteriosus correct according to my own observations. When the conus is cut through just before the arteries diverge, the four trunks are seen to lie close together in the relations shown in the accompanying drawing (text-fig. 31, p. 308). The largest cavity is that of the pulmonary trunk; the two next largest are subequal and belong respectively to the two aortic trunks. The smallest is that of the carotid. I need say nothing of the exact position which each holds in the complex, inasmuch as the facts are accurately shown in that drawing. If the drawing be compared with the two figures given by Hyrtl and with those of Osawa which illustrate

* See note in 'Nature,' vol. lxxviii. p. 497 (1903).

† *Loc. cit.*

‡ *Loc. cit.* pl. xxxii. fig. 6 a.

§ It will be seen that my drawing does not agree with that of Osawa (*loc. cit.* pl. xxxviii., B and C).

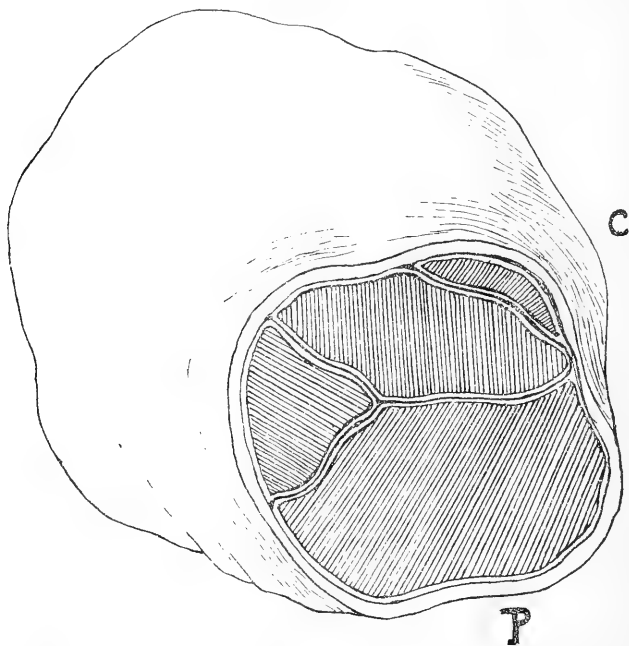
|| "Aanteekeningen over de Anatomie van den *Cryptobranchus japonicus*," Nat. Verh. Maatsch. Wetensch. Haarlem, deel 19, 1864. It is curious that this error should have been perpetuated in Bronn's 'Thierreich' by the reproduction of Hyrtl's figures.

¶ Proc. Acad. Nat. Sci. Philad. 1893, p. 227.

** *Loc. cit.* pl. xii. figs. 1 & 4.

the point, it will be seen that in any case the conditions obtaining in the example dissected by those anatomists differ from those which characterise the example dissected by myself. Moreover, Hyrtl shows the pulmonary artery as arising from the third aortic arch.

Text-fig. 31.



Transverse section through right branch of Synangium of *Megalobatrachus*.

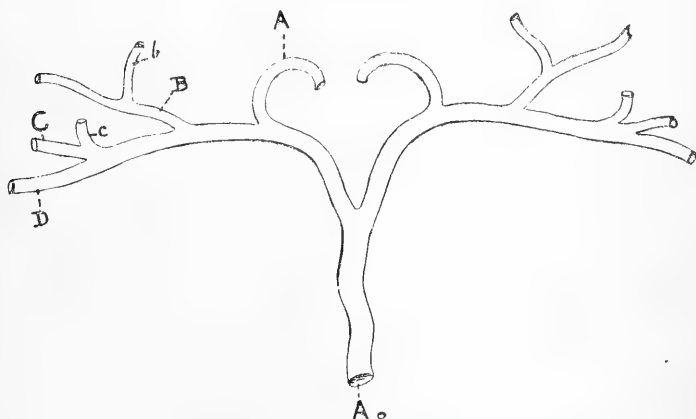
P, pulmonary; C, carotid. Between them the two aortic trunks.

Coronary Artery.—Before leaving this region of the heart it is necessary to call attention to the coronary artery, which has not been studied by Osawa. The artery in question lies upon the dorsal surface of the conus arteriosus, to which region it is limited so far as a naked-eye inspection enables me to judge. It is much contorted in its course, a state of affairs which, of course, allows of the expansion of the conus without unduly distending the artery. The coronary artery is exactly median in position, corresponding to the internal septum which divides the synangium into two halves. At its origin, however, which is from the externally undivided region of the synangium, it is deflected to the right, and is seen to communicate with one (the second) of the two aortic arches; its orifice is guarded by a strong valvular flap. I could not trace the coronary artery with certainty farther

than the posterior end of the conus arteriosus. It seemed to me to pass from it to the surface of the auricle near to the opening of the latter into the ventricle.

In the heart of *Menobranchus*, as Huxley has shown and as I have observed myself, the synangium ends in a single (that is, of course, apparently single) trunk, which leaves the pericardium in the anterior middle line. In *Megalobatrachus*, on the other hand, as I have already pointed out, the synangium gives rise to two aortic trunks, which leave the pericardium separately one on each side. There is not, however, by reason of this a vacant space left between the anterior end of the synangium and the anterior wall of the pericardium. On the contrary, a rounded piece of tissue of a different colour and appearance to the synangium fastens it to the anterior wall of the pericardium. This piece of tissue was dissected, and the dissection reveals that the mass of tissue contains a cavity, which runs for a very short way beneath the synangium. Physiologically, I imagine this structure acts as a kind of buffer to prevent impacts during contraction of the heart against the anterior wall of the pericardium, and the fact that the "buffer" is hollow would aid its efficiency in that capacity.

Text-fig. 32.



Junction of vascular arches of *Megalobatrachus* to form dorsal aorta.

A, vertebral artery; Ao, dorsal aorta; B, carotid arch; b, deep carotid;
C, first aortic arch; c, muscular branch; D, second aortic arch.

The *Dorsal Aorta* is formed by the union of three of the "branchial" arches. Hyrtl, however, figures* only two of these arches as taking part in its formation, viz. the second and third. I shall presently deal more minutely with the course and branches of the various arteries which issue from the synangium. But the broad outlines of their course will be apparent from the drawing

* *Loc. cit.* pl. xi, fig. 4 i.

(text-fig. 32, p. 309). It will be seen from that drawing that three arches actually unite to form the median dorsal aorta, and that all of these trunks are pervious where they join; there is not a question of an imperforate Ductus Botalli. The injection has enabled me to ascertain this matter, and, moreover, the arteries are so large that a dissection allows of the orifices of the several tubes being seen with ease. The second and the third of the vascular arches are the first to join each other. The common aorta thus formed gives off a thickish branch to the muscles dorsally shortly after this junction. A little beyond this, *i. e.* nearer to the middle line, the first, or Carotid, arch unites with the common trunk. The aorta of each side of the body then gives off a branch which perforates the musculature, and is that vessel figured by Hyrtl* as running backwards through the transverse processes of the vertebræ. I have not, however, followed it farther than into the first vertebra which it approaches. A little after this the two aortæ meet and become the single dorsal aorta. This junction takes place at about the level of the anterior end of the pericardium. The junction of the several aortic arches does not seem to be accurately represented by Osawa. For a considerable distance the aorta is closely adherent to the middle line of the parietes, and indeed has even the appearance of being sunk a little below it. It is covered with a sheet of fibrous tissue, which has to be dissected away to expose the artery. This sheet is apt to be a good deal pigmented. The aorta leaves its close contact with the muscular parietes just before the transverse membranes which tie down the two oviducts to the parietes, which membranes come into contact in the middle line. At this point, then, the aorta ascends on to a sheet of mesentery, and the ascent increases as the abdominal region is entered, until finally the distance of the aorta from the actual middle line of the parietes is more than an inch.

The four aortic arches increase gradually in size, as might be inferred from the sections through the median part of the synangium and its two branches. The Carotid is the smallest and the Pulmonary the largest.

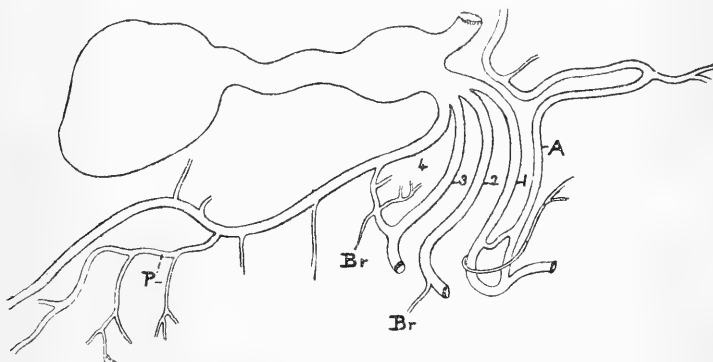
The course of the *Carotid arch* is shown in the accompanying drawing (text-fig. 33), which does not entirely agree with the figure of Osawa†. When it has freed itself from the synangium, it passes along more or less parallel to the next arch. It lies anteriorly to the first of the branchial muscles and ultimately joins, as has been already stated, the common aortic trunk. At the point where it is most curved in its course it gives off a strong lingual branch (text-fig. 33, A) which runs forward. This branch is also attached to the carotid trunk by a pervious connection situated nearer to the root of the carotid, and thus allowing of a

* Osawa (*loc. cit.* pl. xxxix., *vert.*, & pl. xlii. fig. A, *vert.*) represents this artery as arising from the afferent carotid arch in one figure and from the efferent second arch in the other.

† *Loc. cit.* pl. xxxix.

"short circuiting" of the blood-stream *. On the opposite side of the carotid, just where this transverse connection occurs, a small artery is given off which also runs forward. It is not shown by Osawa. The lingual branch just referred to runs forward and ends in two slender branches; before this termination it gives off a backwardly-running branch, which lies parallel to itself, and then, bending to the middle line of the body, runs parallel to the trunk of the carotid at its origin. It gives off an equally strong branch running forwards. The deep carotid artery (text-fig. 32, p. 309) arises from the carotid arch just before the junction of the former with the common aortic trunk. Close to the lower bend of the carotid, just where it gives off the lingual artery, is a small reddish body, served by an artery from the carotid (not shown in text-fig. 33), which I take to be a part of the thymus. Another body of a similar form lies further back in the neck.

Text-fig. 33.

Heart and Arterial Trunks of *Megalobatrachus* from the side.

1-4, vascular arches; A, anteriorly running branch of carotid;
Br, branchial twigs; P, main branch of pulmonary.

The *second arch* is partly protected by a branchial muscle, and a smaller muscle arches over the third branchial trunk. The second arch gives off a small branch running upwards, which appears to me to correspond with the small branch supplying the thymus in the case of the carotid. This is not figured by Osawa, who does figure such a twig arising from a connecting branch between this and the next arch.

The *third vascular arch* again gives off a similar branch; but this joins a twig from the pulmonary, which will be described immediately.

The *fourth or pulmonary artery* runs a course which is by no means so simple as is figured by Hyrtl or Osawa. It bends back, and follows almost exactly the edge of the pericardium. The

* I found this only upon one side of the body.

artery gives off several branches of varying importance as to size. The first of these is one of the smallest in size but greatest in morphological importance; it arises from where the artery has begun very definitely to bend backwards, and is directed upwards towards the dorsal side of the body. It is, in fact, the *Ductus Botalli*, the link between this aortic arch and the preceding one. The principal branch in point of size arises from the same side and a little further on. This closely accompanies the pulmonary artery, so closely that it is bound up in the same sheath and had to be carefully dissected away. It gives off two branches on the dorsal side and one on the ventral side. At the base of the lung this vessel abandons its close companionship with the main pulmonary trunk, and runs along a different face of the lung. This branch is not figured by Osawa.

The *Ductus Botalli*, as has been already mentioned, joins a branch from the third vascular arch, and the conjoined vessels give off a number of twigs to the adjacent musculature, which are illustrated in the drawing submitted herewith (text-fig. 33, p. 311)*. I take it that this series of small vessels, which have been referred to as existing in all of the vascular arches, are the arteries which originally supplied the branchia. There is a final fact about the pulmonary artery, to which I desire to refer. The right pulmonary artery gives off a branch which supplies the œsophagus. I could find no corresponding branch on the left side, and indeed I do not think that one exists. I imagine that the various small branches of the pulmonary arch and of its large branch collectively represent the cutaneous trunk of the Amphibia generally.

The *Pulmonary vein* might easily escape attention, as it is not at all apparent on a dissection. It lies in fact directly above the vena cava inferior, and being of much smaller dimensions, it is completely covered by that vein when the animal is dissected from the ventral surface. The two pulmonary veins join each other just within the pericardium, where they form a tolerably wide trunk. The common pulmonary vein increases in diameter as it passes along the sinus venosus, and finally opens into the smaller division of the auricle. There is thus at least a partial separation of arterial and venous blood in the heart.

Intercostal Arteries and Veins.—The very deep fold of peritoneum which ties down the aorta to the dorsal parietes enables me to see clearly the course of the intercostal arteries and of certain intercostal veins, which are presumably branches of the portal system in the abdominal region. Of the arteries I counted seven, four of which are arranged in pairs, while the three remaining arteries are not so disposed. They arise from the aorta, however, definitely on one side or the other; they are not median in origin. Furthermore, the points of entrance into the thickness of the parietes are not median; they are on one side or the other, and in the case of the paired arteries they enter the

* Prof. Osawa represents nothing more than a simple transverse *Ductus Botalli* uniting the arteries in question.

parietes side by side in a symmetrically paired fashion. It will be seen that this account does not exactly agree with that of Osawa. I saw only four intercostal veins, which are disposed singly. Two of them lie at intervals from each other in front of the first of the intercostal arteries; then follow two arteries; after this the third vein; then a pair of arteries, and finally the last of the intercostal veins.

*Arteria comites aortæ**.—The unpaired dorsal aorta for some little distance before and after the origin of the subclavians is accompanied, as shown in the drawing (text-fig. 34, p. 314), by a slender aorta on each side, not distant more than 2 or 3 millimetres from the aortic trunk. At the origin of the subclavians these vessels each give off a branch which accompanies in the same way its own subclavian. These two vessels arise from the aortic trunk between the union of the two aortæ to form the dorsal aorta and the origin of the subclavians, but much nearer to the latter. Each of these vessels, immediately after its origin, gives off a forwardly-running trunk which accompanies the aorta on each side for a little distance, and is lost among the muscles of the back. The main branches run posteriorly and end upon the transverse membrane which ties the transversely-running portion of the oviduct to the parietes. Osawa does not appear to have studied these arteries.

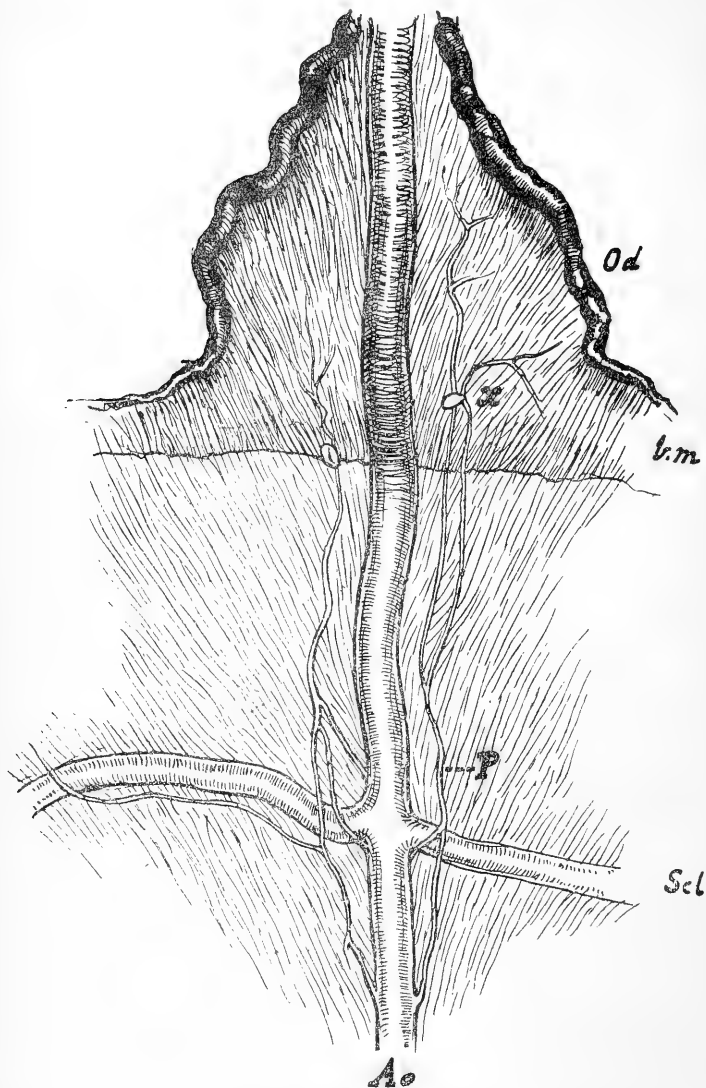
Each *arteria comes aortæ* is reinforced during its course by other branches arising from the aorta. That of the left side has two such supplementary roots. One springs from the aorta just in front of the origin of the subclavian; it crosses over (really, of course, below) the subclavian, and runs for a considerable distance alongside of the first branch before joining it. A second branch springs from the aorta on the posterior side of the subclavian. This also runs alongside of the two above-mentioned vessels for a considerable distance before joining them. The left-hand vessel has only the first of the two accessory branches, which arises actually from the posterior margin of the subclavian. About halfway between this point and the oviducal mesentery the artery divides into two branches, of which the inner spreads out over that mesentery, while the outer ends in a projecting reddish body which is dealt with later (p. 315).

The anatomy of this region of the body in *Megalobatrachus* is in several respects by no means unsuggestive of the mammalian diaphragm, or, to be more accurate, a portion of the diaphragm, which is itself a complex structure. The transverse position of the membrane supporting the end of the oviduct (found, it must be remembered, in both sexes) is the first notable fact to be pointed out. Secondly, the heart and a great part of the lungs lie in front of this transverse septum, which from its position delimits a "chest" not incomparable with the mammalian thorax. The arteries, which have just been described as ramifying upon the

* These arteries must not be confused with the deep-running vertebral arteries figured by Hyrtl and just referred to by myself (p. 310).

surface of this membrane, call to mind the superior phrenic artery of mammals. Finally, its relations to the oviduct are not

Text-fig. 34.



Dissection illustrating relation of arteriæ comites aortæ of *Megalobatrachus* to "diaphragm."

Ao, aorta; Od, oviduct; P, arteria comites aortæ; Scl, subelavian; V.m, vertical membrane ("diaphragm"); x, problematic body.

so fatal to the hypothesis here dealt with as might at first appear. In some mammals, for instance in *Galictis barbara*, the broad ligament continuous with the suspensory ligaments of the gonads and their ducts is continued forwards very nearly as far as the diaphragm. Furthermore, in some birds the oviduct is in actual contact with the oblique septum, which is a structure also to be compared with these septa that we are now considering. It must not be lost sight of that the transversely-running membrane in *Megalobatrachus* is not a characteristic of the female animal only, and serving merely for the support of the oviduct: it is equally developed in the male.

In the figure that I have just referred to a projecting body (text-fig. 34) lettered "x" will be noticed. This is brownish in colour, more or less oval in form, and depends from the anterior side of the oviducal membrane. From its position I take it to represent a somewhat similar body which I have already referred to as existing in the male *Megalobatrachus*. I have investigated both by means of serial sections.

In the case of the female the oval body consists of an outer muscular layer which is thickened at the solid "neck" and continuous with the membrane, from which it freely depends into the body-cavity. Through the "neck" passes a large blood-vessel, a branch of the arteria comes aortæ. The interior of the body consists of largish nucleated cells of which I could detect no regular arrangement. In the male the structure seems to be the same, with more muscular fibres interspersed in the core. I imagine that this body is the persistent rudiment of the pronephros, but the structural indications are quite inconclusive. If so, it is plain that the oviducal funnel of the female can have nothing to do with the pronephros.

November 17, 1903.

H.G. THE DUKE OF BEDFORD, K.G., President, in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of October 1903:—

The registered additions to the Society's Menagerie during the month of October were 180 in number. Of these 83 were acquired by presentation and 3 by purchase, 15 were born in the Gardens, 78 were received on deposit and 1 in exchange. The total number of departures during the same period, by death and removals, was 139.

Amongst the additions attention may be called to:—

1. A fine male Chimpanzee (*Anthropopithecus troglodytes*), from the Albert Nyanza, presented by Lt.-Col. David Bruce, F.R.S., Oct. 4th. This animal, so far as is known, is the first living example received by the Society from Eastern Africa.

2. Two Scoresby's Gulls (*Leucophaeus scoresbii*), deposited by the Hon. Walter Rothschild, M.P., Oct. 17th.

3. Two Wharton's Fruit-Pigeons (*Carpophaga whartoni*) and a

Christmas-Island Dove (*Chalcophaps natalis*), from Christmas Island, in the Indian Ocean, presented by Capt. A. W. Cole, Oct. 27th.

Mr. Henry Scherren, F.Z.S., exhibited the front horn of a Burchell's Rhinoceros (*Rhinoceros simus*), the largest yet received in England from the Soudan. It was the property of Col. B. T. Mahon, C.B., D.S.O. (for whom it had been mounted by Mr. Rowland Ward), and measured along the anterior curve $36\frac{1}{4}$ in., with a circumference at the base of $19\frac{3}{4}$ in. This is only three-fifths of the length of the record horn obtained in South Africa by Roualeyn Gordon Cumming, which has a length of $62\frac{1}{2}$ in. In addition to the horn exhibited and that belonging to Capt. Hawker (*cf.* above, p. 194), other horns from the same region were in the possession of Major-Gen. Sir F. R. Wingate, Hon. Capt. McNaughten, Major Sanders, and Capt. J. G. A. Massey. Mr. Scherren stated that this Rhinoceros was reported as being fairly numerous on the northern boundary of the Congo Free State and in the adjacent parts of the Soudan, and that Mr. Rowland Ward had known of these horns coming from that district for many years before Major Gibbons secured his specimen (*cf.* P. Z. S. 1900, p. 949).

Mr. R. I. Pocock, F.Z.S., exhibited a piece of basalt picked up between tide-marks on the coast of Victoria, Australia, by Mrs. Kenyon, which contained a specimen of the web of the Marine Spider *Desis kenyonæ*, described in the 'Proceedings' of last year (*cf.* 1902, ii. p. 102). Although broken, the web served to illustrate the habit of these marine spiders of spinning a closely-woven sheet of silk over a crevice in the rock as a protection against the rising tide.

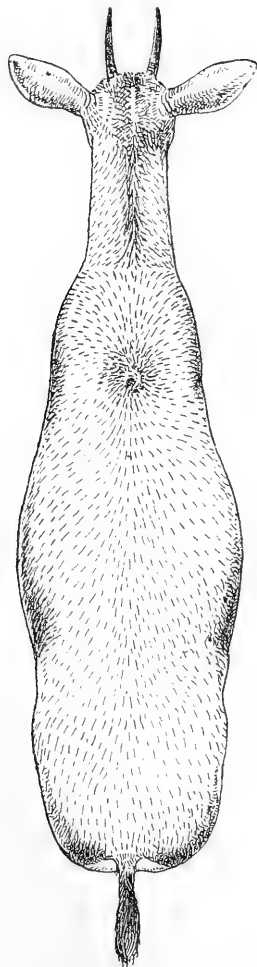
Mr. Pocock also gave an exposition, illustrated by drawings, of a new suggestion as to the white rump-patches of Ungulata, with special reference to the races of Burchell's Zebra.

Mr. E. E. Austen exhibited specimens, with pupæ, of *Glossina palpalis* Rob.-Desv., the species of Tsetse-fly which is the active agent in the transmission of sleeping-sickness in Uganda, by conveying *Trypanosoma castellanii* Kruse, the parasite which is the cause of the disease, from man to man. Examples of four other species of Tsetse-flies were also shown for the sake of comparison, and the general characteristics of the genus *Glossina*, which is confined to Africa, were pointed out. Attention was drawn to the remarkable mode of reproduction in the genus, which renders it impossible to attack the insects in their breeding-places, as has been successfully accomplished in many places in the case of mosquitos; for, instead of laying eggs, Tsetse-flies produce but a single larva at a birth, which forthwith crawls away and assumes the pupal condition on reaching some sheltered spot. Seven species of Tsetse-flies are at present known, and of these at least two, *Glossina morsitans* Westw. and *Gl. pallidipes* Austen, are probably concerned in the dissemination of "Nagana," or Tsetse-

fly disease, caused by *Trypanosoma brucei*, among domestic animals. The demonstration of the connection between *Glossina palpalis* and sleeping-sickness in Uganda is due to the recent researches of Lieut.-Colonel Bruce, R.A.M.C., of which a detailed report is shortly to be presented to the Royal Society.

Mr. Oldfield Thomas, F.R.S., exhibited on behalf of Mr. de Winton a drawing of a female Gazelle (*Gazella muscatensis* (?)),

Text-fig. 35.



Diagrammatic sketch of skin of Gazelle to show hair-whorl on withers.

obtained at Sheik Oman near Aden, and presented to the Society

by the Officers of H.M.S. 'Cossack,' which showed a complete and perfect whorl of the hair on the withers (text-fig. 35, p. 317). A male of the same species obtained at the same time exhibited no sign of this whorl, but the hair lay in the direction of the tail from the base of the neck.

Mr. C. Tate Regan read a paper entitled "A Revision of the Fishes of the Family *Loricariidae*," in which nearly 200 species were recognised as valid, 35 being described as new to science. The types of the species described by Cuvier and Valenciennes and by Castlenau, in the Museum at Paris, had been examined. The genera were grouped into five subfamilies—*Plecotominae*, *Hypoptopominae*, *Loricariinae*, *Neoplecostominae*, and *Argiinae*, the last two being regarded as closely related on anatomical grounds, although differing in external characters.

This paper will be published entire in the Society's 'Transactions.'

The following papers were read :—

1. On Early Sanskrit References to the Tiger.

By V. V. RAMANAN, M.A., F.Z.S.

[Received September 14, 1903.]

In his paper "On the Original Home of the Tiger" (P. Z. S. 1903, vol. i. p. 109), Col. C. E. Stewart made some statements that I am able to correct. He said that, after enquiry, he could find no Sanskrit word for the Tiger. The word *Vyāghra* is the Sanskrit term for the tiger, and is common in juvenile books. The modern Hindustani word to which Col. Stewart referred is a corrupt derivative of the Sanskrit original.

I have also to note that references to the tiger are frequent in Sanskrit literature. Col. Stewart stated that he could find no mention of the tiger in Sanskrit works treating of the fighting between Rāma and Rāvana. The *Ramāyan* of Valmiki is the most ancient of the many Sanskrit works that deal with the famous "Lanka" war. In Ramayana there are numerous allusions to tigers, especially in the chapter where the primeval forest, *Dandaka*, is described. I pass over many similar references in other works dealing with the same war, as these are of later date.

In the *Mahabhārata*, a poem which is of the same age as, if not more ancient than, the *Ramāyan*, there are numerous references to the tiger. The legend of the *Vyāghra-pāda*, the "tiger-footed" Rishi, is familiar.

In the 'Vedas,' the most archaic documents in Hindu literature, there are references to the tiger. One quotation, from the *Taittiriya Brahmana* section, is enough for my purpose:—
"Vyāghrōyam Agnau charati pravṛshthah."

There is not an Indian vernacular, ancient or modern, Dravidian or Aryan, without its own name for the tiger. It is interesting to note that in South India there are vernaculars of quite indigenous origin that owe no part of their vocabulary to Sanskrit, and which, on that account, are supposed to be more ancient than Sanskrit. In these there are many synonyms for the tiger, and these enter frequently into the composition of the names of South-Indian villages. Villages bearing the names "Tiger-town," "Tiger-village," "Small Tiger-town," and so forth are quite common.

I shall add no more, as the discussion, if pursued further in this direction, would lose its zoological interest and become purely etymological. But I shall be pleased to give any zoologist more detailed information. I am not competent to say if the question of the original home of the tiger, which is one of zoogeography and palæozoology, can be made to rest on a foundation of philology. I should like, however, to elicit the opinions of Mr. Lydekker and Dr. Blanford, whose labours have made them competent judges.

2. On the Trachea, Lungs, and other Points in the Anatomy of the Hamadryad Snake (*Ophiophagus bungarus*). By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received November 3, 1903.]

(Text-figures 36-40.)

Although some recent systematists* include the Hamadryad within the same genus (*Naja*) as the Hooded Cobra and its immediate allies, there are nevertheless a number of anatomical features in which the Hamadryad differs from *Naja tripudians*, and which, therefore, tend to justify its earlier separation as a distinct generic type. It differs, for example, in the form of the liver. In *Ophiophagus*, as in other Snakes, the liver has two distinct though closely-adjacent lobes, which are divided by the vena cava posterior, and of which each is lodged in a separate cœlomic compartment†. These lobes are, however, quite unequal in size. The left-hand lobe measures 16 inches in length, the larger right-hand lobe 19 inches. The latter, however, extends for $7\frac{1}{2}$ inches beyond the termination of the former, but it begins $4\frac{1}{2}$ inches after it. The inequality in size between the lobes is thus accentuated by their position with reference to each other. In the Cobra (*Naja tripudians*) precisely the reverse conditions obtain. The left lobe (that nearest to the stomach, when the animal is opened and viewed from the ventral surface) is

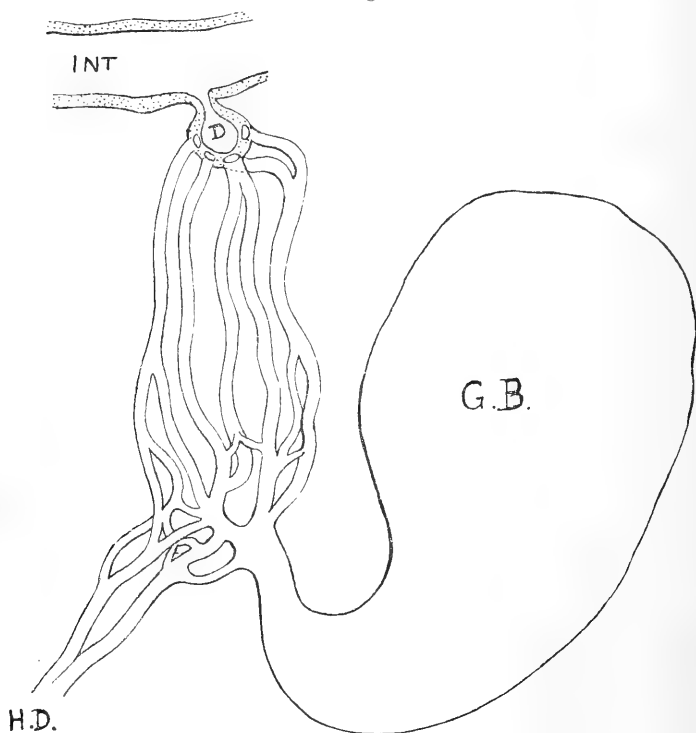
* *E. g.* Boulenger, Cat. Snakes B. M. vol. iii. 1896, p. 386.

† Butler, "On the Subdivision of the Body-cavity in Snakes," P. Z. S. 1892, p. 477.

considerably the longer; it measures 11 inches; it commences 3 inches before the right lobe and ends $\frac{1}{4}$ inch behind it. The right lobe, therefore, measures $7\frac{3}{4}$ inches. It is clear, therefore, that the proportionate difference also varies in the two species.

Gall-bladder.—As I have been at some pains to make a careful dissection of the complicated series of anastomosing tubes by which the bile enters the gut, I venture to include in the present communication a description of the same, which is illustrated by the drawing (text-fig. 36)*. The two specimens which I have examined differ slightly in the exact relations of the tubes of

Text-fig. 36.

Gall-bladder of *Ophiophagus bungarus*.

D., diverticulum; G.B., gall-bladder; H.D., hepatic duct of intestine;
INT., intestine.

the rete, but not so materially as to interfere with the general truth of the figure. The actual plexus is not very complex, but the hepatic duct, as will be seen, enters into it. Ultimately five

* The drawing was made from the injected gall-bladder, which I caused to be filled with coloured gelatine.

bile-ducts emerge from the rete and pursue a long course (long as compared with the plexus region) through the pancreas to the intestine. Arrived at the intestine they do not debouch directly into its lumen by five orifices, but open separately, or nearly so, into a thick-walled diverticulum of the gut, which itself communicates with the gut by an orifice not wider than one of the separate bile-ducts. I have noticed a similar diverticulum, which receives both cystic and hepatic ducts, in Westerman's Cassowary. As compared with the Cobra*, which I have also examined, the bile-ducts of *Ophiophagus* are more numerous and more complex in their intercommunications. The hepatic duct, for example, is single, though it communicates with more than one of the cystic ducts. The gall-bladder itself has not so long a common cystic duct as that which characterises *Ophiophagus*. I do not think that a more minute description of the cystic network in the two types is useful at present; but I may observe that sketches of the gall-bladder published by other anatomists, and a few made by myself, indicate that the general plan of the cystic rete is not without use in distinguishing and comparing various genera of serpents.

Again, the Cobra has a testis proportionately longer than that of the Hamadryad and differently situated. The anterior testis is $2\frac{1}{2}$ inches long and its anterior border is 11 inches from the liver; its posterior border is a long way in front of the kidney.

In *Ophiophagus bungarus* the anterior testis abuts so closely upon the anterior kidney that the two organs are only just disconnected; while the spermatic artery, influenced, so to speak, by this near approximation, sends a branch to the kidney before entering the testis. The anterior end of the testis is, moreover, 22 inches away from the end of the liver, and it measures only $1\frac{3}{4}$ inches in length though very much plumper than the corresponding testis of the Cobra. In estimating these facts it must be borne in mind that the Hamadryad measured 93 inches from tip of snout to vent, and the Cobra 51 inches.

More possibly, but still to my mind not certainly, associated with difference of size is the fact that the Hamadryad possesses six gastric arteries as against three in the case of the Cobra. I recognise—it may be explained—as gastric arteries those vessels which arise from the aorta *after* the posterior end of the liver and supply the stomach only.

In the Ophidia generally there are two Carotid arteries, both of which spring near together from the right aortic arch. The left-hand artery is, I believe, always the largest, and extends right up the neck as far as the head, giving off branches along its course to the gullet and windpipe. The second and smaller of the two Carotids is, as a rule, of much smaller calibre, and in the distribution of its twigs is hardly more than a thyroidean artery. In *Ophiophagus bungarus* these conditions obtain, and the artery in question does not extend up the neck very much beyond the

* Bronn's 'Thierreich,' Rept., Bd. vi. pt. iii. pl. cxxx. fig. 2.

thyroid gland. On the other hand, in the Cobra the conditions are quite different. The right Carotid, although perhaps not more than one-half of the diameter of the left, is quite as fully developed as regards the length of its course, and runs right up to the head and lies closely side by side with its fellow artery. It is rather curious that both arteries plunge into the thickness of the tissues of the head, not on opposite sides as might be expected, but close together on the same (left) side.

Another difference in the *situs viscerum* is indicated by the following measurements:—In *Ophiophagus* the origin of the superior mesenteric artery is 73 inches from the mandibular symphysis and $21\frac{1}{2}$ from the cloacal aperture. The corresponding measurements in the Cobra which I examined were 35 and 15 inches respectively. There is thus in the Hamadryad a shortening of the “abdominal” region of the body as compared with the Cobra, and a consequent crowding of the viscera therein contained. This is also expressed by the nearness of the kidney to the testis already referred to. In spite of this the lung of the Hamadryad has a longer vascular, and therefore respiratory, region than the Cobra. The measurements are as follows:—In the Cobra the lung ceases to be vascular 18 inches from the snout, in the Hamadryad 38 inches. Were the proportions the same, the length of the Hamadryad from snout to vent would be $107\frac{1}{2}$ inches; it is, as a matter of fact, 93 inches. It follows, therefore, that the vascular part of the lung in this snake is proportionately longer than in the Cobra.

It seems to me to be plain that these various characters are, at least, more striking as a means of separating the two snakes than those used by the original describer of “*Hamadryas hannah*” * or by those who have succeeded him.

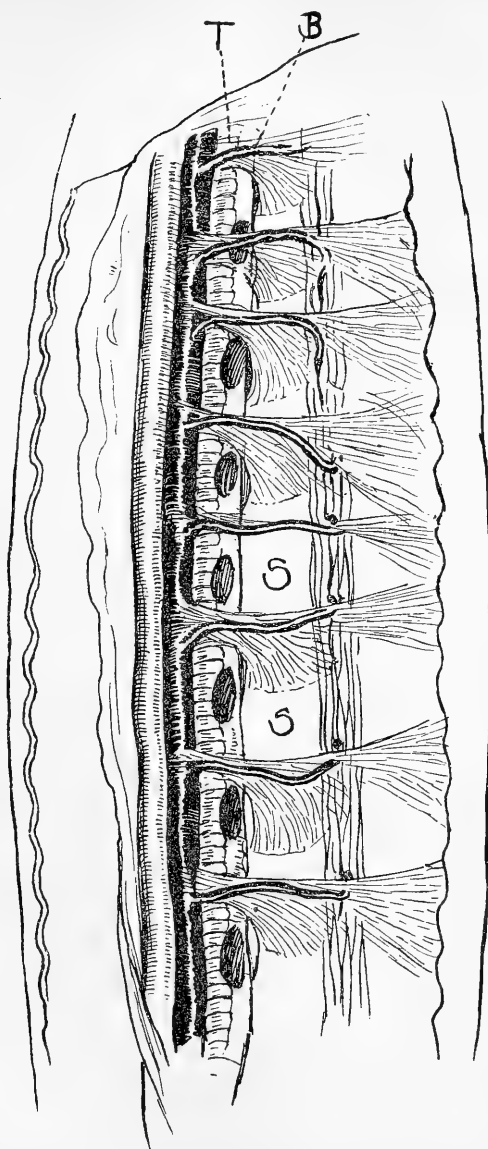
But a more remarkable character still distinguishes this snake from its ally, the Indian Cobra. In the latter snake, as is well and has been long known †, the tracheal rings are incomplete dorsally as cartilaginous rings, the interspaces being merely membranous. The membrane, however, except at the beginning of the trachea, has a diameter fully as great as that of the cartilaginous tract; it is, moreover, tough, longitudinally creased, and obviously dilatable.

In *Ophiophagus* the tracheal rings are similarly incomplete from the very first, but the membranous interval is less tough and strong (though the snake is considerably larger), and very much less in relative and even in actual diameter. So far, therefore, the differences are but slight. A very remarkable difference is illustrated in the accompanying drawings (text-figs. 37, 38, pp. 323, 324). At intervals this dorsal tracheal membrane is

* Cantor, “Sketch of an undescribed Hooded Serpent, &c.” *Asiat. Researches*, vol. xix. 1836, p. 87, and also P. Z. S. 1838, p. 73, where it is described as “*Hamadryas ophiophagus*,” a reference omitted by Mr. Boulenger in his Catalogue, who quotes only, though so far correctly, P. Z. S. 1839, p. 32.

† Cuvier, ‘Leçons d’Anatomie Comparée réd. par Duvernoy,’ ed. 2, Paris, vol. vii. 1840, p. 93.

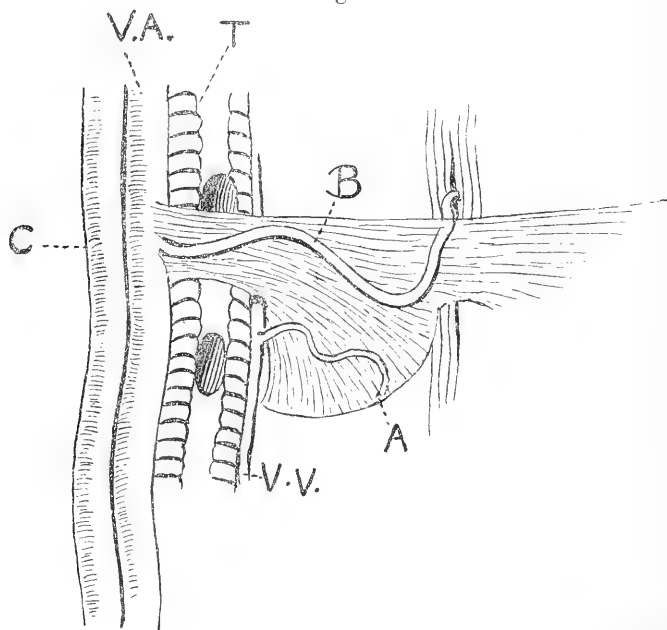
Text-fig. 37.

Dissection of neck of *Ophiophagus*.

B, intercostal artery; S, air-sacs; T, trachea.

perforated by regular oval foramina, which commence two and a half inches from the larynx and continue to within half an inch of the lung. These apertures vary somewhat in size, 8 mm. being one extreme and 3 or 4 mm. the other. They may be really divided into two series. Twenty-six or twenty-seven (and it should be said that this series comprises the largest foramina) lie at approximately equidistant intervals, corresponding either exactly or very nearly exactly to the middle of a large membranous sac, which is plainly to be regarded as a hernia-like outpushing of the lining membrane of the trachea. This series

Text-fig. 38.



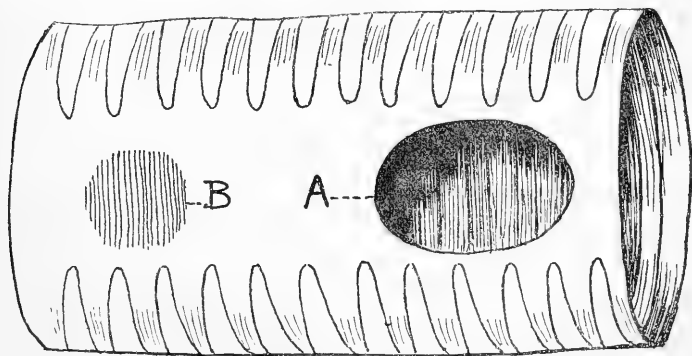
A more detailed view of two air-sacs and dividing septum in *Ophiophagus*.

A, intercostal vein; B, intercostal artery (both resting upon septum which divides two adjacent air-sacs); C, carotid; T, trachea, with two perforations; V.A., vertebral artery; V.V., vertebral vein.

of sacs surrounds the organs of the neck and practically obliterates the cœlum. The sacs are of about the same dimensions, an inch or so in antero-posterior diameter. So closely are adjacent sacs pressed together that the bounding walls anteriorly and posteriorly run straight across the neck. The appearance thus produced, when the parietes of the neck are cut through deeply enough to include the ventral wall of the sacs, would lead naturally, on a superficial view, to the inference that we had here to do with a

cœlom divided by metamerically arranged transverse septa like that of a typical Annelid. This, however, is obviously not the case unless we are to adopt the totally improbable view that the trachea communicates directly with the cœlom. These 26 or 27 chambers, extending from the chin to the lung, do not, so far as I have been able to ascertain, communicate with each other. They correspond fairly, though not accurately, with the intercostal branches of the anterior vertebral artery, and in the following way:—Those arteries arise at approximately equidistant intervals and bury themselves in the thickness of the parietes in the dorsal middle line. Along their course they are supported by the membranous partitions in question, which adhere to them from their origin to their disappearance in the parietes. Only four of the total series of over thirty of these arteries were not so supported, and only two “septa” were devoid of an arterial companion. On the opposite side of the body the vertebral veins have a similar relation to the “septa.” In addition to the

Text-fig. 39.



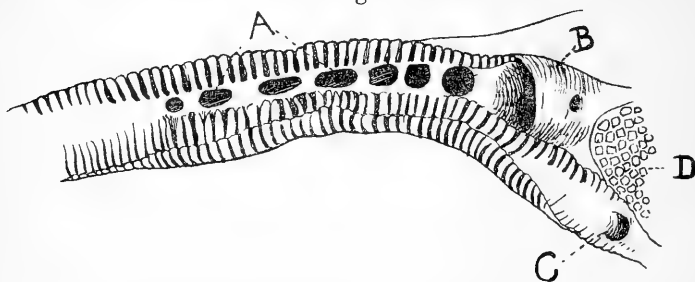
A portion of trachea from dorsal surface of *Ophiophagus*, showing, A, perforation leading into air-sac, and, B, circular thinning of tracheal membrane.

principal tracheal foramina there are smaller ones which lie between the larger and just between two adjacent air-sacs. The arrangement of these, however, is not regular. I could only count four or five of them. I imagine that they correspond to smaller intercalary sacs, of which there was distinct evidence, lying between the larger ones. Finally here and there, and also lying between the primary sacs, were regularly rounded thinnings of the tracheal membrane (text-fig. 39, B) which may be looked upon as—if the expression be allowed—imperforate foramina. I could detect no evidence of intercalary sacs in connection with them; but they are ready, as it were, to form such sacs.

In a second example of this Snake, also a male, I examined the air-sacs of the neck, which I found to agree in all essentials with those of the first specimen. There are, however, rather fewer

of the compartments (about 22), which fact, coupled with the smaller dimensions of the snake, bears out, to a certain extent, my belief that the smaller intercalary sacs grow with the increase in size of the snake.

Text-fig. 40.



Ending of trachea in lung of *Ophiophagus*. A, foramina leading into air-sacs; B, terminal air-sac; C, entrance to rudimentary lung; D, lung.

The accompanying sketch (text-fig. 40) shows the relation of the last of these air-sacs to the lung. It will be observed that in *Ophiophagus* as in *Naja* there is a rudimentary lung as well as the fully developed one, and that the bronchus enters the fully developed lung about half an inch posteriorly to the commencement of the latter. The rings of the bronchus do not extend down the lung beyond the origin of the bronchus to the rudimentary lung, but a narrow white seam is to be observed which is developed for some distance along the lung. The median thin fibrous wall of the trachea, of course, is in contact with the lung-tissue; but there is no transitional area between the two. The dark red vascular lung begins abruptly. The last orifice from the trachea is shown in the figure, and beyond it will be seen a flap with a crescentic edge which covers over a short sac which is the last of the series of neck-sacs and in which the trachea may be said to terminate. The wall of this terminal sac is shown in the drawing to be perforated by a foramen, which, I admit, may be artifact. I am unable to be positive about the matter. If it is not, then it must be a branch of the terminal sac. It must be further observed that the lung can be seen through the terminal sac which thus lies ventrally of that organ. I have satisfied myself that there is no communication between the terminal air-sac and the lung, except, of course, indirectly through the trachea.

So far as I can ascertain, there is nothing precisely similar to this known in other Snakes. Many anatomists, however, have described a continuation of the lung-tissue *up* the trachea, *i.e.* towards the head*. This may be merely an extension of the

* For instance, Meckel, *Anat. Comp.* (French translation), Paris, vol. ii. 1838; Schlegel, 'Essai sur la Physionomie des Serpents,' Amsterdam, 1837; Siebold & Stannius, *Handbuch der Zootomie*, 2^e Buch, Berlin, 1856 (2nd ed.); Milne-Edwards, 'Leçons sur la Physiologie et l'Anatomie comparée,' t. ii., Paris, 1857.

anterior bit of the lung which in *Ophiophagus* lies above the entrance of the bronchus, or it may be an increase and conversion into lung-tissue of the median membranous region of the trachea. Quite recently the late Prof. E. D. Cope has investigated—but apparently only in a preliminary way—the lungs of various snakes, some of which were known and others unknown to previous observers. In the long list of Ophidia investigated by Cope representatives of most groups occur, but he had not the opportunity of examining the Hamadryad. The pith of his paper*, so far as concerns the subject in hand, is contained in the following sentences:—"In the Solenoglypha, without exception, this extension of the dorsal † lung is present, and extends to the head, and its lumen is continuous with the trachea throughout its whole length. The same structure exists in the genera *Hydrus* and *Hydrophis*; and also in the Peropodous genus *Ungalia*, which differs besides from other Peropoda in having but one posttracheal lung. Finally the tracheal lung, as I shall call it, is distinct from the true lung in *Platyurus* and in *Chersydrus*. In the former of these genera the trachea is not separate from the lumen; while in *Chersydrus* it is distinct. It, however, communicates with the cells of which the lung consists in this genus by a series of regularly placed foramina on each side."

It is a little difficult to draw conclusions from so abbreviated a statement of fact; but I am inclined to suppose that *Chersydrus* (also a Colubrine, though aglyphous) comes nearest to *Ophiophagus* though obviously differing much in detail. I take it that the conditions which characterise *Ophiophagus* are an extreme modification of those apparently found in *Chersydrus*: that the metamerically arranged pouches in the former, with their series of single orifices into the trachea, are the remains of what Cope terms the "tracheal lung," in which the respiratory function has been replaced by some other use. In the absence, however, of complete details as to *Chersydrus* and the other genera to which Cope refers, it is rash to form a definite opinion. It must be borne in mind that there is in *Ophiophagus* no connection with the lung. The only structure among Sauropsida, other than serpents, which I can think of as obviously comparable to this series of pouches in *Ophiophagus*, is the tracheal pouch of the Emu‡. That bird in a quite similar fashion shows a slit on the trachea where the rings fail to meet in the middle line. It is, however, ventral rather than dorsal in position, and there is but a single slit. It leads into a thin-walled outgrowth of the lining

* "On the Lungs of the Ophidia," Proc. Amer. Phil. Soc. xxxiii. 1894, p. 217. The facts are also to be found in two other memoirs, viz. "The Classification of Snakes," Amer. Nat. xxviii. 1894, p. 831, and "The Classification of the Ophidia," Trans. Amer. Phil. Soc. xviii. p. 188.

† "Dorsal" as used by Cope is the equivalent of "right" in Mr. G. Butler's paper "On the complete or partial Suppression of the Right Lung in the Amphisbænidæ and of the Left Lung in Snakes and Snake-like Lizards and Amphibians," P. Z. S. 1895, p. 691.

‡ Cf. Murie, "On the Tracheal Pouch of the Emu (*Dromæus novæ-hollandiæ*)," P. Z. S. 1867, p. 405, where previous literature is cited.

membrane of the trachea exactly as in *Ophiophagus*. Moreover, a kind of septum appears to divide that pouch into two, so that there are, at least, traces of metamerism. There is, however, no evidence of any connection in the past between this pouch and the lung.

3. Report on the Fishes collected by Mr. Oscar Neumann and Baron Carlo von Erlanger in Gallaland and Southern Ethiopia. By G. A. BOULENGER, F.R.S., V.P.Z.S.

[Received October 29, 1903.]

(Plates XXIX.-XXXI.*)

Mr. Oscar Neumann has entrusted to me for study the fishes collected on the expedition from Zeila through Southern Ethiopia to the Upper Nile in 1900-1901, of which he gave an account at the Geographical Society in June 1902, and which is printed in the 'Geographical Journal' for October 1902, with a map, to which I refer the readers for the position of the localities mentioned in this report.

The fishes are all from East of the Nile system and were obtained in the following waters:—

Modjo, Iraro, and Wabbi Rivers, affluents of the Webi Shebeli; Kassam, Gadschimboda, and Suksuk Rivers, affluents of the Hawash; Maki River, flowing into Lake Zwai; Omo River, flowing into Lake Rudolf; and Lake Gandjule, south of Lake Abaia.

The following list of 19 species, 4 of which are described as new, extensively supplements our scanty knowledge of the fishes of that part of Africa, based on the small collections previously made by Marquis Antinori, Capt. Bottego, Prince E. Ruspoli, and Dr. Donaldson Smith, which have been reported upon by Dr. Vinciguerra † and Dr. Günther ‡. Collections had also previously been made in the Kassam and Maki Rivers by Mr. E. Degen on his way to Lake Tsana, but the five new species discovered by him and described by me § are, curiously, not represented in the collection made in those rivers by Mr. Neumann and Baron v. Erlanger.

MORMYRIDÆ.

1. MORMYRUS KANNUME Forsk.

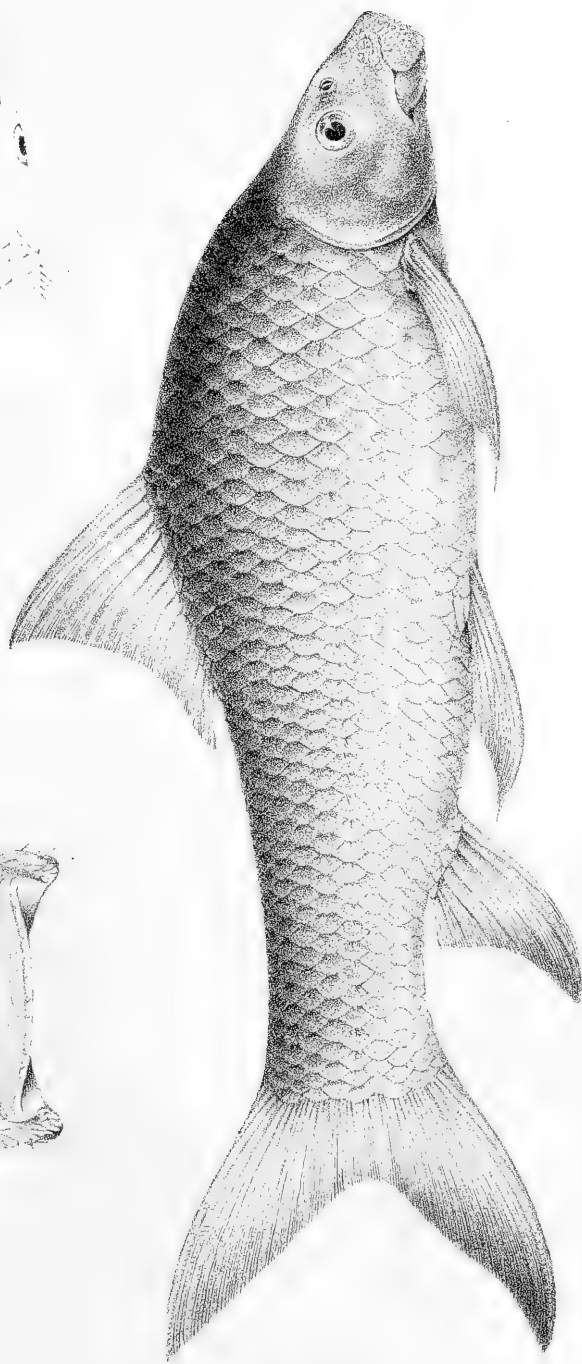
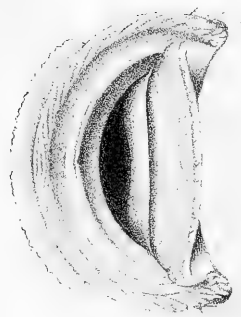
A single specimen, from the Wabbi River.

* For explanation of the Plates, see p. 334.

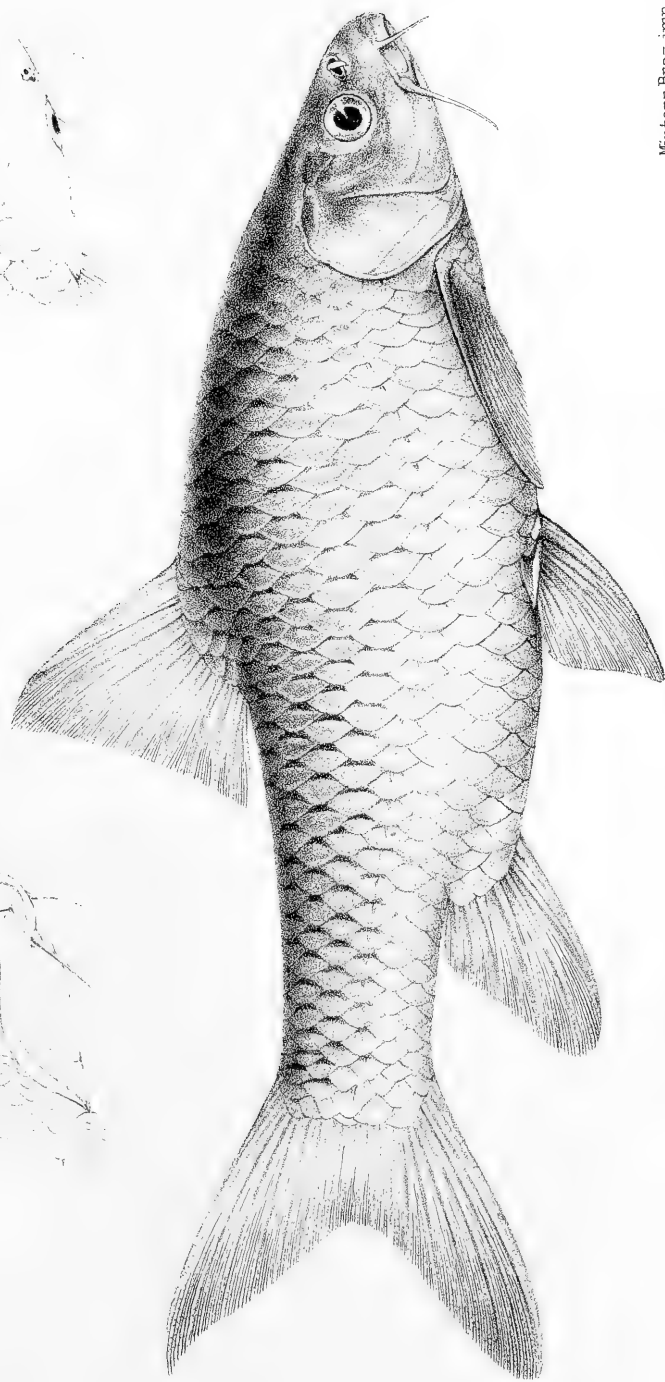
† Ann. Mus. Genova, xviii. 1883, p. 691, xxxv. 1895, p. 21, xxxvii. 1896-97, pp. 24 & 343.

‡ P. Z. S. 1896, p. 217.

§ Ann. & Mag. N. H. (7) x. 1902, p. 421.











J.Green del.et.lith.

Mintern Bros.imp.

1.DISCOGNATHUS MAKIENSIS. 2.DISCOGNATHUS BLANFORDII.
3.CHILOGLANIS MODJENSIS.

CHARACINIDÆ.

2. *HYDROCYON FORSKALII* Cuv.

Several young specimens from Lake Gandjule.

3. *ALESTES AFFINIS* Gthr.

Several specimens, from the Wabbi and Modjo Rivers.

4. *ALESTES MACROLEPIDOTUS* Cuv.

Several specimens from the Omo River.

5. *MICRALESTES ACUTIDENS* Peters.

Several specimens from the Omo River.

This fish, originally described from Mozambique, has since been found in the Ubanghi, in the Nile, and in the Niger.

CYPRINIDÆ.

6. *LABEO NEUMANNI*, sp. n. (Plate XXIX.)

Depth of body $3\frac{1}{4}$ to $3\frac{3}{4}$ times in total length, length of head $4\frac{1}{3}$ to $4\frac{2}{3}$ times. Head $1\frac{1}{4}$ to $1\frac{1}{3}$ as long as broad; snout rounded, with small horny warts, its length $\frac{2}{5}$ to a little less than $\frac{1}{2}$ that of the head; eye perfectly lateral, its diameter $4\frac{1}{3}$ to $5\frac{1}{2}$ times in the length of the head; interorbital width $\frac{1}{2}$ length of head, $2\frac{1}{3}$ to 3 times the diameter of the eye; mouth strongly arched, its width $\frac{2}{5}$ to $\frac{1}{2}$ the length of the head; lips with small papillæ forming transverse plicæ; lower lip with a fringe of conical papillæ; rostral flap large, with denticulate edge; a minute barbel in the corner of the mouth, hidden under the folds of the mouth. Dorsal fin composed of III 11–12 rays, a little nearer the end of the snout than the root of the caudal, its upper edge concave, the last simple ray longest and as long as or slightly longer than the head. Anal with III 5 rays, falcate, its longest ray nearly as long as the head, reaching or nearly reaching the root of the caudal. Pectoral subfalciform, as long as or a little longer than the head, not quite reaching the ventral, the first ray of which falls below the 4th or 5th branched ray of the dorsal. Caudal fin deeply emarginate, crescentic when fully spread out. Caudal peduncle $1\frac{1}{4}$ to $1\frac{1}{3}$ as long as deep. Scales finely striated longitudinally, 39–40 $\frac{7\frac{1}{2}}{4\frac{1}{2}-10\frac{1}{2}}$, 5 between the lateral line and the base of the ventral, 16 or 18 round the caudal peduncle. Olive above, whitish beneath; fins greyish (in spirit).

Five specimens, measuring 140 to 320 millimetres, from the Modjo and Wabbi Rivers.

Distinguished from *L. gregorii* Gthr. by the broader interorbital space and the more numerous scales.

Three very small specimens, measuring from 18 to 27 millimetres, from the Wabbi, may, I think, be safely referred to the same species.

7. LABEO CYLINDRICUS Peters.

Two specimens, measuring 64 and 150 millimetres respectively, from the Modjo River. Diameter of eye $4\frac{1}{2}$ and 5 times in length of head. D. III 9. Sq. 35-37 $\frac{5\frac{1}{2}}{7\frac{1}{2}}$, 4, 16.

8. DISCOGNATHUS MAKIENSIS, sp. n. (Plate XXXI. fig. 1.)

Body feebly compressed, its depth 5 to 6 times in the total length. Head as broad as deep, $1\frac{1}{2}$ as long as broad, $\frac{1}{3}$ to $\frac{1}{4}$ total length; snout rounded, projecting beyond the mouth; inter-orbital region convex, its width not quite half the length of the head; eye lateral, but better visible from above than from below, in the middle of the length of the head, its diameter 4 to $5\frac{1}{2}$ times in the length of the head and twice to twice and a half in the interorbital width; width of mouth not quite $\frac{1}{3}$ the length of the head; upper lip well developed, not fringed; lower lip forming a mental disk which is broader than long; two barbels on each side, measuring $\frac{2}{3}$ to $\frac{4}{5}$ the diameter of the eye. Dorsal with 10 rays, 7 of which are branched, equally distant from the end of the snout or the nostrils and from the root of the caudal; first branched ray longest, a little longer than the head. Anal II 5, first branched ray longest, $\frac{3}{4}$ to $\frac{5}{6}$ the length of the head. Pectoral as long as or slightly longer than the head, not reaching the ventral, which is situated below the middle of the dorsal. Caudal fin deeply emarginate, longer than the head. Caudal peduncle $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as deep. Scales 38-40 $\frac{5\frac{1}{2}}{7\frac{1}{2}}$, $3\frac{1}{2}$ or 4 between the lateral line and the ventral, 16 round the caudal peduncle. Olive above, white beneath.

Six specimens, measuring from 48 to 80 millimetres. Maki River, running into L. Zwai.

9. DISCOGNATHUS BLANFORDII Blgr. (Plate XXXI. fig. 2.)

Several specimens from the Gadschimboda R., affluent of the Hawash.

10. DISCOGNATHUS QUADRIACULATUS Rüpp.

Several specimens from the Gadschimboda and Suksuk Rivers.

Eye in the middle of the length of the head, its diameter $3\frac{1}{2}$ (young) to 5 times in the length of the head; barbels $\frac{1}{2}$ to $\frac{2}{3}$ the diameter of the eye; mental disk small, feebly marked, a little longer than broad. Scales 39-42 $\frac{5\frac{1}{2}}{7\frac{1}{2}}$, 4 between lateral line and ventral. The largest specimen is 55 millimetres long.

Described from Abyssinia by Rüppell under the names of *Gobio quadrimaculatus* and *G. hirticeps*. Young specimens from Lake Arsadé, south of Shoa, have been described by Vinciguerra as *Discognathus chiarinii*.

We are now acquainted with six African species of the genus

Discognathus, which may be distinguished by means of the following synopsis:—

- I. Pupil of the eye in the second half of the length of the head; barbels not more than half diameter of eye; caudal peduncle $1\frac{1}{3}$ to $1\frac{1}{2}$ as long as deep; scales in lateral line 37 to 40.
- Snout projecting strongly beyond the mouth, the width of which is less than half the length of the head; upper lip well developed, with a series of papillæ forming a fringe *D. dembeensis* Rüpp.
- Snout projecting feebly beyond the mouth, the width of which equals half the length of the head; upper lip scarcely developed, not fringed *D. johnstonii* Blgr.
- II. Pupil of the eye in the middle, or anterior to the middle, of the length of the head.
1. Mental disk well developed, with free posterior border.
- Barbels $\frac{2}{3}$ diameter of eye; eye lateral; dorsal fin equally distant from centre or posterior border of eye and root of caudal; caudal peduncle as long as deep; lat. l. 35-38 *D. vinciguerræ* Blgr.
- Barbels $\frac{1}{2}$ to $\frac{2}{3}$ diameter of eye; eye supero-lateral; dorsal fin equally distant from eye and root of caudal, or a little nearer the latter; caudal peduncle $1\frac{1}{2}$ to $1\frac{1}{3}$ as long as deep; lat. l. 33-37. *D. blanfordii* Blgr.
- Barbels $\frac{2}{3}$ to $\frac{5}{8}$ diameter of eye; eye lateral; dorsal fin equally distant from end of snout or nostrils and root of caudal; caudal peduncle $1\frac{1}{2}$ to $1\frac{3}{4}$ as long as deep; lat. l. 38-40 *D. makiensis* Blgr.
2. Mental disk very indistinct, or reduced to a mere pad, without free posterior border; barbels $\frac{1}{2}$ to $\frac{2}{3}$ diameter of eye; dorsal fin equally distant from centre or posterior border of eye and root of caudal; caudal peduncle about $1\frac{1}{2}$ as long as deep; lat. l. 37-42 *D. quadrimaculatus* Rüpp.

11. BARBUS ERLANGERI, sp. n. (Plate XXX.)

Depth of body 3 to $3\frac{1}{3}$ times in total length, length of head $3\frac{1}{2}$ to $4\frac{1}{3}$ times. Snout rounded or subacuminate, prominent, its length 3 to $3\frac{1}{2}$ times in length of head; diameter of eye $3\frac{1}{3}$ (young) to 5 times in length of head, interorbital width $2\frac{1}{2}$ to 3 times; mouth small, inferior, its width $\frac{1}{5}$ to $\frac{1}{4}$ length of head; lips well developed, the lower continuous across the chin, forming a small, rounded median lobe; barbels two on each side, the anterior $\frac{2}{3}$ the diameter of the eye in the young, $1\frac{1}{3}$ in the adult, the posterior longer, as long as the eye in the young, twice as long as the eye in the adult, the distance between them measuring $\frac{1}{2}$ (young) to 1 diameter of eye. Dorsal IV 9; last simple ray very strong, bony, smooth, its ossified part $\frac{2}{3}$ to $\frac{5}{6}$ the length of the head; the border of the fin feebly emarginate; the distance of the dorsal from the occiput equal to or a little less than its distance from the root of the caudal fin. Anal with III 5 rays, not reaching, or nearly reaching, the caudal when folded. Pectoral fin pointed, as long as or a little shorter than the head, not reaching ventral; latter originating slightly in advance of first

ray of dorsal. Caudal fin deeply forked. Caudal peduncle $1\frac{1}{2}$ to $1\frac{2}{3}$ as long as deep. Scales finely striated, 30–35 $\frac{5\frac{1}{2}-6\frac{1}{2}}{4\frac{1}{2}-5\frac{1}{2}}$, $2\frac{1}{2}$ between lateral line and ventral fin, 12 or 14 round caudal peduncle.

Silvery, back olive-brown (in spirit).

14 specimens, measuring from 65 to 270 millimetres.

Wabbi, Modjo, and Iraro Rivers.

A very close ally of *B. duchesnii* Blgr., differing in the shorter anterior barbels.

12. BARBUS PALUDINOSUS Peters.

Several specimens from the Suksuk River.

13. BARILIUS NILOTICUS Joannis.

Several specimens from the Omo River, between Malo and Koscha.

14. BARILIUS LOATI Blgr.

A single young specimen, same locality as the preceding.

15. NEOBOLA BOTTEGI Vincig.

Several specimens from the Wabbi and Modjo Rivers, and from the Omo River.

The genus *Neobola* is very closely related to *Chelathiops*, from which it differs in the origin of the dorsal fin corresponding or nearly corresponding to that of the anal, and in the absence of a ventral keel. The snout of *Neobola bottegi* is shorter and more obtuse than that of *Chelathiops bibie*, and does not at all project beyond the mouth; the pectoral fin does not extend or extends but very slightly beyond the root of the ventral. The largest specimen collected by Mr. Neumann measures 73 millimetres.

SILURIDÆ.

16. CLARIAS ROBECCHII Vincig.

Three specimens, Hawash River and its affluent the Kassam River.

17. CHILOGLANIS MODJENSIS, sp. n. (Plate XXXI. fig. 3.)

Body slightly compressed, its depth $5\frac{1}{2}$ times in the total length. Head depressed, $1\frac{1}{3}$ as long as broad, its length 3 times in the total length. Eye directed upwards, in the second half of the head, its diameter 7 times in the length of the head, $1\frac{2}{3}$ or twice in the interorbital width, which is greater than the distance between the eye and the posterior nostril; premaxillary teeth in two large contiguous groups, forming 4 or 5 transverse series; a group of 7 to 9 slender mandibular teeth; maxillary barbel $\frac{1}{4}$ the

length of the head, longer than the lower labials. Dorsal I 5; spine not serrated, not quite $\frac{1}{2}$ the length of the head. Adipose fin low, its base measuring about $\frac{2}{3}$ its distance from the rayed dorsal. Anal III 6-7. Pectoral spine not serrated, $\frac{3}{5}$ the length of the head. Ventral extending to a little beyond the origin of the anal. Caudal peduncle twice and a half as long as deep. Dark brown above and on the sides, with three yellowish bars, the first in front of the dorsal fin, the second above the ventral, the third on the caudal peduncle; lower parts white.

Total length 40 millim.

Two specimens from the Modjo River.

The four species now known of this genus differ in the following characters:—

A. Maxillary barbel much longer than eye.

C. deckenii Peters.—Depth of body $5\frac{1}{2}$ to $6\frac{1}{3}$ times in total length; interorbital width equal to distance between posterior nostril and eye; D. I 5; A. III 6; pectoral spine more than $\frac{2}{3}$ length of head.

C. modjensis Blgr.—Depth of body $5\frac{1}{2}$ times in total length; interorbital width greater than distance between posterior nostril and eye; D. I 5; A. III 6-7; pectoral spine $\frac{2}{3}$ length of head.

C. niloticus Blgr.—Depth of body 4 to $4\frac{1}{2}$ times in total length; interorbital width greater than distance between posterior nostril and eye; D. I 6; A. III 8; pectoral spine $\frac{2}{5}$ length of head.

B. Maxillary barbel scarcely longer than eye.

C. brevibarbis Blgr.—Depth of body 6 times in total length; interorbital width greater than distance between posterior nostril and eye; D. I 5; A. III 7; pectoral spine $\frac{2}{3}$ length of head.

The new species may therefore be regarded as intermediate between the two previously described, *C. deckenii* from German East Africa, and *C. niloticus* from the Upper Nile.

CYPRINODONTIDÆ.

18. HAPLOCHILUS ANTINORII Vincig.

A single specimen from the Suksuk River.

The species was only known from Lake Arsade, south of Shoa, in the district of the Adda-Gallas, whence the types of the *Discognathus chiarinii* noticed above (p. 330) were also obtained.

CICHLIDÆ.

19. TILAPIA NILOTICA L.

Numerous specimens. Lake Gandjule, and Wabbi, Modjo, and Suksuk Rivers; also in the hot springs of the Hawash River near Filoa.

EXPLANATION OF THE PLATES.

PLATE XXIX.

Labeo neumanni, p. 329, reduced $\frac{1}{2}$, with upper view of head, reduced $\frac{1}{2}$, and open mouth, nat. size.

PLATE XXX.

Barbus erlangeri, p. 331, reduced $\frac{3}{5}$, with upper and lower views of head, same reduction.

PLATE XXXI.

Fig. 1. *Discognathus makiensis*, p. 330, nat. size, with upper (a) and lower (b) views of head, $\times 1\frac{1}{2}$.

2. *Discognathus blanfordii*, p. 330, do., do.

3. *Chiloglanis modjensis*, p. 332, nat. size, with upper (a) and lower (b) views of head, $\times 2$.

December 1, 1903.

Dr. HENRY WOODWARD, F.R.S., Vice-President, in the Chair.

Mr. F. Martin Duncan exhibited, by means of the Bioscope, a series of pictures of Zoological subjects, and made the following remarks:—

For many years past I have kept a permanent record of my investigations in various branches of Natural Science, by means of the Camera, using in the field various forms of hand and stand cameras, and in the laboratory a special photomicrographic outfit.

My first application of photography as a means of recording scientific investigations was in helping my father (the late Professor P. Martin Duncan, F.R.S.) in his works on the Fossil and Recent Corals and Echinoderms. Although in many cases a single photograph or a series of photographs will, to a greater or less degree, demonstrate the appearance or phenomena under investigation, I have always felt in zoological work, particularly in studying the movements and habits of animal and insect life, that ordinary photography left much to be desired. Although a long series of photographs will give us an animal in various positions, very often the one most characteristic position desired is not obtained, and the point, therefore, missed. This is particularly the case in dealing with the mode of seeking and capturing prey by the Carnivora; and when I brought my photographic efforts to bear upon work relating to the habits of wild animals in their natural environment, when seeking and seizing their food, I found the ordinary series of snap-shots failed lamentably to give a graphic idea of the facial expressions and characteristic movements of the animal.

It was this want which led me primarily to consider the advisability of applying Animated Photography to Zoological study. As a lecturer and teacher of Zoology and Botany, I felt at once that if it were possible to place before my audience or class "living pictures" of animal, insect, and vegetable life, I should have a very

important educational factor in my hands. Modern methods of teaching all go to prove the importance of teaching through the agency of the eye as well as the ear, and it is a matter of common knowledge amongst teachers that a lecture demonstrated by a graphic series of experiments or pictures is much more vividly impressed upon the minds of the students than a simple unillustrated oration.

As regards the application of Animated Photography to the Microscope, I was primarily led to attempt it through my investigations into various diseases of plants produced by Bacteria. I felt that the ordinary method of preparing bacteria for microscopic examination,—to wit: the fixing of the organisms to the cover-glass by passing the cover-glass through the flame of a spirit-lamp, and then staining (more often than not in heated stain),—gave one anything but an accurate idea of the natural appearance of the organisms under examination. It appeared to me that, working on such lines, one might as well take a sheep out of the meadow, roast it whole in front of the fire, dip it into a bath of stain, and then hold it up as a true likeness of what a sheep browsing in a meadow appears like. Also, in lecturing, I felt that it would be a great advantage if I could project on to a screen an “animated photograph” of such subjects as the circulation and rotation of protoplasm, the circulation of the blood, &c.

Of course, the great difficulty in seeing living bacteria, with any degree of comfort, is the close affinity of their refractive index to the media in which they are cultivated. However, after some months of experimenting, and trying various optical formulæ, I succeeded in finding a combination of lenses which would permit of accurate examination of living, unstained bacteria. The results have been very interesting, and I hope on another occasion to have the pleasure of bringing them before the notice of the Society.

Increase of teaching and literary work put a stop for a period to my attempting to experiment with Animated Photography in my work; but I was fortunate enough, some little time back, to join hands with Mr. Charles Urban (of the Charles Urban Trading Co., Ltd.), who has very great experience in Cinematography and is the inventor of the Bioscope. The difficulties that had to be overcome in applying Cinematography to Natural Science subjects, particularly zoology, and to the microscope, were many, but have now practically been overcome.

How far I have succeeded in applying Animated Photography to Natural Science, as a means of recording and demonstrating phenomena, you will now have an opportunity of judging for yourselves. I will now project a series of Animated pictures showing the life of the Hive-Bee; a comparison of the mode of capturing food employed by three reptiles, viz., the Toad, Chameleon, and Boa Constrictor; and also some of my Animated Photomicrographs showing the circulation and rotation of protoplasm in *Elodea*, the Freshwater Hydra, &c., &c.

Mr. F. E. Beddard, F.R.S., exhibited and made remarks upon a portion of the large intestine and the cæcum of a Boa (*Boa constrictor*) which had recently died in the Society's Gardens. The walls of the intestine in the neighbourhood of the cæcum, and of the cæcum itself, were thickened and inflamed. The cæcum was filled with a hard mass consisting of small stones and a number of the snake's own teeth, the presence of which it was thought had given rise to the inflammation.

Mr. Beddard also exhibited, on behalf of Mr. G. A. Doubleday, a hairless specimen of the Common Rat (*Mus decumanus*) which had been caught in a trap at Leyton, Essex, and which agreed in its characters with a so-called variety (*Mus nudo-plicatus*) of the Common Mouse figured in the Society's 'Proceedings' (1856, p. 38, Mamm. pl. xli.).

Dr. Walter Kidd, F.Z.S., exhibited a drawing of a Beisa Antelope (*Oryx beisa*) showing a reversed area of hair along the median line of the back, a character which was found in Ruminants only, but not in all of them.

Mr. Oldfield Thomas, F.R.S., exhibited an example, the second known, of the peculiar little naked rodent described by him in 1885* as *Heterocephalus phillipsi*. This specimen had been presented to the National Museum by Dr. A. G. W. Bowen, R.N., to whom it was given, at Mogadishu, Italian Somaliland, by Dr. Dulio, Governor of the Italian Protectorate.

Dr. Dulio stated that these animals lived in colonies of from 50 to 100 in the sandy districts near the coast, that they burrowed very rapidly in the loose soil and were for that reason difficult to obtain.

Mr. Thomas said that the chief interest of this specimen lay in the fact that, like the type, it had only two cheek-teeth in each jaw above and below, while the larger and better-known *Heterocephalus glaber* had three. As this important character was thus shown to be constant, which could not be assumed from the single specimen hitherto available, Mr. Thomas thought that a special genus would have to be formed for the two-toothed group, and suggested for it the name of *Fornarina*†. The other differences between *Fornarina phillipsi* and *Heterocephalus glaber* had been more fully detailed in the papers referred to in the footnote‡.

A form of true *Heterocephalus* occurred also in British East Africa, which Mr. Thomas took this opportunity of describing:—

HETEROCEPHALUS ANSORGEI, sp. n.

General characters as in *H. glaber*, but size smaller (see skull-

* P. Z. S. 1885, p. 612.

† A famous nude by Titian.

‡ P. Z. S. 1885, p. 845; Ann. Mus. Génov. (2) xv. p. 3 (1895).

measurements) and the cheek-teeth very much smaller in diameter, their transverse and longitudinal diameters subequal. In *H. glaber* the transverse diameter of the middle tooth considerably exceeded the longitudinal. Palate ending almost immediately behind the last molar. Incisors feebler than in *H. glaber*, the inner half of their anterior surface slightly concave, in correspondence with the ill-defined grooves found in this position in *H. glaber*. General shape of lower jaw as in *H. glaber*, but the teeth equally modified with those of the upper.

External characters, apart from size, apparently quite the same as in *H. glaber*, but the tail has been lost in the single specimen.

Dimensions:—

Head and body (approximately) 94 mm.; hind foot 20·5.

Skull—front of nasals to junction of sagittal and lambdoid crests 19 mm.; greatest zygomatic breadth 16·8; nasals $6·8 \times 3·4$; inter-orbital breadth 7·3; intertemporal breadth 5·6; palate, length from henselion 10·3; diastema 7; combined length of three cheek-teeth 3·2; transverse diameter of middle tooth 1·2. Lower jaw, back of angle to front of symphysis 18·6; to back of coronoid 11; lower tooth-series 3·3.

Hab. "Between Ngomeni and Kinani," Makindu country, British East Africa.

Type. Male. B. M. No. 98.9.25.3. Collected 31 October, 1896, and presented by Dr. W. J. Ansorge.

Dr. Ansorge had noticed that this *Heterocephalus* "was throwing out earth with its hind feet from a tiny circular hole at the bottom of a small crater-shaped mound of red earth."

Mr. G. A. Boulenger, F.R.S., exhibited a young hybrid Newt (*Molge marmorata* ♂ \times *M. cristata* ♀) bred by Dr. Wolterstorff, of Magdeburg, in his aquarium, as reported in the 'Zoologischer Anzeiger,' Sept. 21, 1903. This specimen agreed in all external characters with *M. blasii* de l'Isle, of which one of the original specimens, from near Nantes, S. Brittany, forming part of M. Lataste's collection, was also exhibited.

Prof. E. Ray Lankester, F.R.S., exhibited two drawings representing the arrangement of the hair on the fronto-parietal surface of the head of two specimens of Okapi. The drawings are reproduced in text-figs. 41 and 42. Text-fig. 41, p. 338, is from the subadult female sent over by Sir Harry Johnston, described by Prof. Lankester in the Trans. Zool. Soc. vol. xvi. p. 279, and now mounted and exhibited in the Natural History Museum. The second drawing (text-fig. 42, p. 339) is from a *smaller* specimen of an apparently adult female in the possession of the Hon. Walter Rothschild at Tring, by whose kind permission the drawing is published. Prof. Lankester made the following remarks:—

The hair is represented diagrammatically in both cases, the arrow-heads corresponding to the free ends of the hairs.

Text-fig. 41.

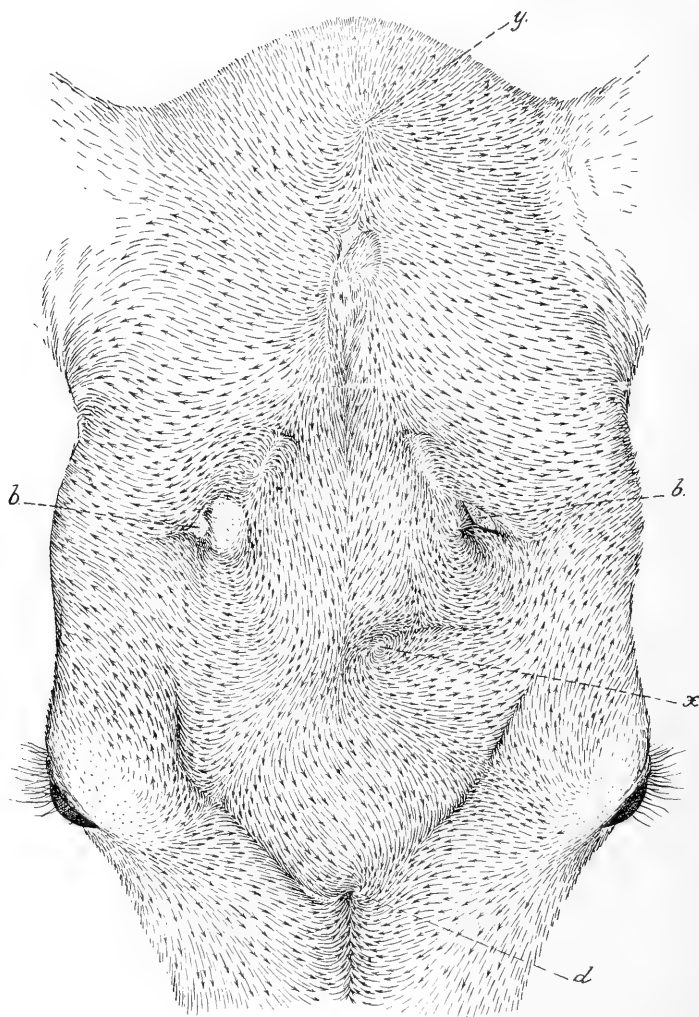


Diagram of the hair-whorls and hair-streams on the fronto-parietal region of the head of a female specimen of *Okapia* in the British Museum.

Okapia erichsoni Lankester. (Sir Harry Johnston's specimen, presented to the British Museum.)

b, b, paired bare spots corresponding in position to the horns of the male. Medial of the right-hand spot is a bare patch caused by rubbing; it is not represented on the left-hand side of the head.

d, single supra-nasal vortex or meeting-point of three hair-streams.

x, single spiral whorl on the left frontal region (asymmetrical in position).

y, occipital radiating centre.

Text-fig. 42.

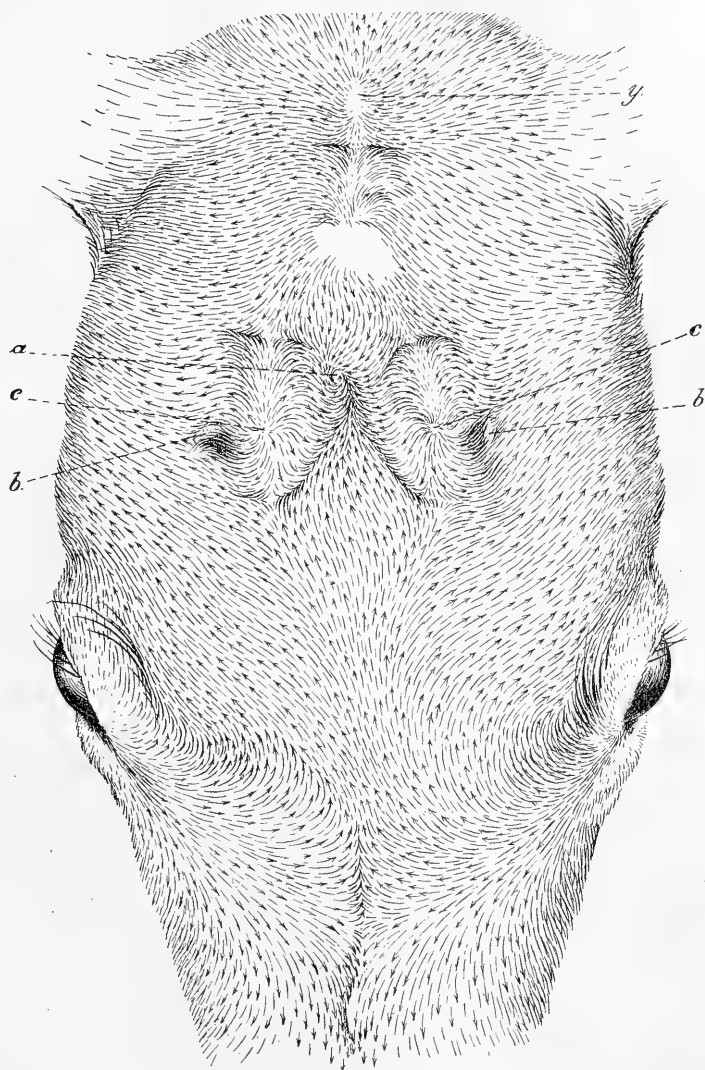


Diagram of hair-whorls and hair-streams on the fronto-parietal region of the head of a small adult female specimen of Okapi in Mr. Rothschild's Museum.

a, median inter-cornual spiral whorl and meeting-point of hair-streams (*not* present in text-fig. 41).

b, *b'*, as in text-fig. 41.

c, *c'*, right and left inter-cornual radiating centres (*not* present in text-fig. 41).

y, occipital radiating centre, as in text-fig. 41.

It will be observed that there is considerable difference between the arrangement of the hair-whorls, hair-spirals, hair-radiant-centres, and hair-streams in the two specimens. We do not yet know enough of these curious dispositions of the hair-growth to say what value should be attached to one or other difference as indicating distinctness of race or species—or whether, indeed, any such value can be attached to these structures.

The publication of this pair of diagrams taken from so interesting a creature as the Okapi will, it is hoped, lead to a more extensive and complete study of the subject, not only in the various skins of Okapi which may be hereafter or have been already received, but in large series of other species—such as the Antelopes.

The differences between the two specimens of Okapi in regard to the hair-whorls are best to be appreciated by an examination of the diagrams (text-figs. 41, 42, pp. 338, 339) and the explanation given below the figures. But it may be briefly pointed out that the British Museum specimen (which it will probably be necessary, as I have elsewhere pointed out, to distinguish as *Okapia erichsoni*) has a single median supra-nasal or interorbital vortex or meeting-point of three hair-streams (text-fig. 41, *d*) which is not present in Mr. Rothschild's specimen. Also it has an asymmetrical single spiral whorl of hairs on the left frontal region (text-fig. 41, *x*). This also is not present in Mr. Rothschild's specimen.

On the other hand, in Mr. Rothschild's Okapi there is a median spiral vortex or meeting-point of hair-streams between the sites corresponding to the position of the horns in the male (text-fig. 42, *a*). Also there are, at no great distance from this median spiral, a right and a left "radiant centre" (text-fig. 42, *c, c*) from which hairs radiate evenly in every direction. Nothing corresponding to these is seen in the British Museum *Okapia erichsoni*.

The spiral vortex *a* of the Tring specimen may perhaps be considered as represented in some fashion by the one-sidedly placed spiral vortex *x* of *Okapia erichsoni*, as though *a* had moved forward and to the animal's left.

In connexion with this apparent asymmetry, I may draw attention to the fact that Dr. Forsyth Major has found that the horns of the male specimens of Okapi submitted to him by the Congo State Museum are invariably asymmetrical.

Prof. Lankester also exhibited and made remarks upon some specimens of Medusæ reported to have come from the Victoria Nyanza, and sent home by Sir Charles Eliot, K.C.M.G., H.B.M. Consul-General and Commissioner in the British East-African Protectorate.

The following papers were read :—

1. The Mammals of Cyprus. By DOROTHY M. A. BATE*.

[Received October 26, 1903.]

(Text-figure 43.)

I. *Introduction.*

A list is given below of all the species of mammals—other than domesticated—known up to the present date to occur in Cyprus.

Hitherto very little has been published with reference to the Mammalia of this island. Drs. Unger and Kotschy in 'Die Insel Cypern'† recorded eight species; in 1879 Dr. Günther‡ mentioned four species in a note on a collection of mammals and reptiles from Cyprus; and recently the Hare and Spiny Mouse have been described as peculiar to this locality. In the collection of the British Museum (Natural History) there are also some specimens procured by various collectors and presented by the late Lord Lilford.

This present list is chiefly compiled from material obtained during a visit of eighteen months to the island in 1901 and 1902. Two bats, *Rhinolophus blasii* and *Myotis myotis*, previously recorded from Cyprus, were not included in my collection.

Compared with the number found in other Mediterranean islands, and considering the extent of Cyprus, which contains 3584 square miles, Mammals are but poorly represented, inasmuch as the total number of species does not exceed fifteen. It might be thought that the dry and barren condition of the greater part of the country is the cause of such lack of variety, but this appears unlikely when it is remembered that the character of the island has completely altered within historic times. This change has been due chiefly to deforesting, which for long continued unchecked, with the natural consequence that a large proportion of the rainfall, which is small, is now wasted. Parts of the central mountain-range still support a somewhat scanty growth of pines, ilex, and arbutus, but these have little chance of spreading, for most of the seedlings are either burnt up by the great summer heat or destroyed by the numerous flocks of goats. In former days even the Mesoreæ, which stretches from the west coast to the east, was densely clothed with trees, whilst now it is a bare, dusty plain save for a few months in the year during the growth of the cereal crops.

I am much indebted to Mr. Oldfield Thomas for his kind assistance and for so courteously giving me access to the specimens in the Collection of the British Museum (Nat. Hist.).

II. *List of Species.*1. *ROUSSETTUS ÆGYPTIACUS* E. Geoffr.

A Fruit-Bat has long been known to occur in Cyprus, though

* Communicated by OLDFIELD THOMAS, F.Z.S.

† Wien, 1865.

‡ Proc. Zool. Soc. 1879, p. 741.

not always considered to be of this species. However, the question of its identity has been fully discussed by the late Dr. Anderson*, who came to the conclusion that it ought, without doubt, to be referred to as *Rousettus ægyptiacus*, which is also found in Palestine and Egypt.

Excessively common in Cyprus, this Bat often does considerable damage to the fruit-crops, particularly to the oranges and dates, though whilst the latter are ripening they are often enveloped in sacks or matting as a protection against the depredations of this marauder. During the summer it is said to roost in thick trees, in winter taking up its quarters in the roofs of old buildings and caves in company with rock-pigeons. Extremely noisy, even in the daytime and when undisturbed, its shrill note can be heard some little distance off. On entering a cave numbers may be found hanging head downwards from the roof in closely packed bunches; very restless, every moment one or two detach themselves to fly off squeaking from one group to another.

2. RHINOLOPHUS FERRUM-EQUINUM Schreb.

Only one specimen of the Horseshoe Bat was procured, which, with the following species, had already been obtained by one of the late Lord Lilford's collectors.

3. RHINOLOPHUS HIPPOSIDEROS Bechst.

Common, found in caves.

4. RHINOLOPHUS BLASII Peters.

Four specimens of this Bat were obtained by one of the late Lord Lilford's collectors and are now in the collection of the British Museum. I did not meet with it during my stay in the island.

5. PIPISTRELLUS KUHLLII (Natt.).

This seems to be the commonest of the small Bats of Cyprus. Its occurrence was recorded by Dr. Günther in 1879†. It is unpleasant to handle owing to its heavy, disagreeable odour. In June 1901 several were brought to me, one being kept in a box for the night. The following morning it was found that two young ones had been born; they were perfectly naked, and appeared pink owing to the transparency of their skins. The mother carried one on either side of her body under the wings.

6. MYOTIS MYOTIS (Bechst.).

This species is included in Unger and Kotschy's list under the name of *Vespertilio murinus* Schreb., but was not amongst those I procured.

* 'Zoology of Egypt,' Mammalia, pp. 87-89 (London, 1902).

† Proc. Zool. Soc. 1879, p. 741.

7. *MINIOPTERUS SCHREIBERSI* (Natt.).

I obtained a single specimen of this Bat in a small cave in the sea-cliffs at Cape Pyla, Famagusta District.

8. *ERINACEUS AURITUS* Gmel. (Text-fig. 43.)

Three examples were obtained of this Hedgehog, which had already been recorded from Cyprus*. These appear to resemble in every respect specimens from Egypt in the collection of the British Museum. The species is common over the greater part of the island, and is said to be eaten by the natives. In June 1902 a villager brought me three young ones, which I kept for some

Text-fig. 43.

*Erinaceus auritus.*

months with an old one found subsequently. They were very active, and neither shy nor frightened even when first caught. They fed and allowed themselves to be handled without showing any signs of fear, unlike our English hedgehog under similar circumstances. Amongst themselves they were extremely pugnacious, continually fighting, and at the same time giving vent to loud squeals resembling the "miaoul" of a cat. A favourite mode of attack was to seize hold of one of their opponent's feet, thus effectually preventing it from retreating within its protecting

* 'Zoology of Egypt,' Mammalia (Dr. Anderson), p. 158 (1902).

spines. They fed well on bread and milk, hard-boiled eggs, and small pieces of raw meat. A Cypriote told me that in summer hedgehogs are often found in the vineyards, where they feed on the grapes, which they would have no difficulty in reaching, for in Cyprus the vines are not trained on poles, but are every year cut back, only a short stump being left, so that the grapes may often be seen lying on or almost touching the ground. The accompanying photograph (text-fig. 43, p. 343) is of a young animal taken shortly after its capture.

Erinaceus europæus is included in the list of mammals given by Unger and Kotschy*, but this name, no doubt, was meant to apply to *E. auritus*, which appears to be the only species of hedgehog found in the island.

9. CROCIDURA RUSSULA CYPRIA, subsp. n.

The Shrew obtained undoubtedly belongs to what may be termed the *C. russula*-group. Taking that from Western Europe as the typical form, it will be found that races intermediate between it and the one from Cyprus occur in different parts of the Continent. It is therefore proposed to distinguish the Cypriote Shrew by the above subspecific name, denoting the habitat of this island race. It differs considerably from typical specimens, from which it may be readily recognised by the following characters:—Size and general build slighter, approaching that of *C. whitakeri* de Winton, from Morocco†; skull smaller, tail longer, and average length of fur much shorter, this being particularly marked in the summer coat.

The three examples procured are all females—one, caught in March, being in winter coat, while the other two, caught in July, show the lighter-coloured and shorter summer fur. The following measurements (in millimetres) were taken in the flesh, and those of a specimen from Liège in the collection of the British Museum are given for comparison:—

	Head & body.	Tail.	Hind foot.	Ear.
No. 66 (♀)	58	46·5	11	9
No. 71 (♀)	60	41	11	9
No. 111 (♀ type)	60	43	12·5	10
Specimen from Liège (♀) ...	79	37	12·5	—
(B.M. No. 95.1.1.11.)				

Only one skin (No. 111) is accompanied by a skull, though several portions of skulls found in the earth of a cave in the Kerynia Hills are, in every respect, similar to the recent one. This last measures 19 mm. in extreme length and 9 mm. in breadth, whilst the corresponding measurements of the skull belonging to the specimen from Liège mentioned above are 21 mm. and 9·5 mm. respectively.

* *Op. cit.*

† Proc. Zool. Soc. 1897, p. 954.

The type is now No. 3.12.4.23 of the British Museum Collection.

The Cypriote Shrew in the colour of its winter coat resembles the browner and less speckled specimens from Western Europe, although the average length of the hairs is very much less, being 3.5 mm. as opposed to 5 mm. In summer the hairs are shorter still, averaging only 2.5 mm.; also at this season the fur of the dorsal region is much lighter and greyer.

I have been unable to find any previous record of the occurrence of a Shrew in Cyprus, and it seems likely that it is not very plentiful, for I succeeded in trapping only three specimens, all of them being caught within a hundred yards of the same place. This was close to a stream, flanked by steep banks thickly clothed with grass, brambles, and other plants, not far from Papho in the south-west of the island.

10. *VULPES VULPES* (Linn.).

It was expected that the Cypriote Fox would resemble that of Syria, which is evidently identical with the *V. persica* of Blanford *. However it is quite distinct, being a small red form very similar both in size and coloration, though somewhat yellower dorsally, to a specimen from Asia Minor in the National Collection, the skull of which was unfortunately not preserved.

The Cypriote race probably ought to be included in one of the subspecies of the typical form, and may perhaps be found to be identical with the Fox of Southern Europe (*V. melanogaster* of Bonaparte)†. Its skull agrees in size with that of *V. v. ægyptiaca*.

Five specimens of this fox were procured, four in thick winter coats and one in summer, which latter was shot on Troödos at a height of about 6000 feet above sea-level. In this the fur is very thin and scanty, and except on the head and limbs has lost almost all trace of red or tawny colouring, being brown on the back and dull brownish white on the underparts.

It is commonly found all over Cyprus, and is the only wild carnivore known to occur in the island at the present day. It is especially plentiful about the cliffs of Cape Pyla, where the natives shoot large numbers in winter, selling the skins to be made into rugs.

11. *MUS RATTUS* Linn.

This species is represented in Cyprus by the brown form with lemon-white underparts (*M. tectorum*, Savi). In spite of the reward offered by Government for the destruction of these rats in the port-towns (to guard against the introduction of the bubonic plague by their means), they are excessively common, being found everywhere, both in or near buildings and at a distance from any inhabited houses. Mr. Gennadius, Director of Agriculture in

* Zool. East. Persia, 1876, p. 39, pl. 11.

† Icon. Fauna Ital. 1832, i. pl. i.

Cyprus, writes * that they cause much damage to the Karoub trees, the fruit of which forms one of the most important exports of the island. They are very easily trapped, and were especially plentiful in the Papho District close to the streams, many of which have high banks densely covered with brambles and bushes. In this growth, generally at a height of eight or ten feet, they build their nests, which are loosely made of leaves and coarse herbage, and lined with finer grasses, or else entirely composed of leaves of the tall bamboo-like reeds that here and there edge the streams. The entrance is at one side of the nest, which is flatly domed like a squirrel's drey, and, from a casual inspection, would appear to be nothing more than a bunch of rubbish or dead leaves, which the thickness of the vegetation prevented falling to the ground.

These rats move about without difficulty amongst trees and bushes, often at a considerable height above the ground. One evening, whilst passing through an orchard, I saw one sitting in a clump of brambles about a couple of yards away and busily feeding on the blackberries which it held to its mouth with both fore paws in an attitude similar to that adopted by a squirrel when eating a nut. These rodents also make use of holes in banks and amongst rocks, making it seem likely that the nests built in bushes may be used only during the warmer months of the year.

I never met with any examples of the typical black form, but was told of some having been seen in a store-house at Larnaka, the chief port of the island.

The Brown Rat from Cyprus has previously been recorded as *Mus decumanus* † and also as *M. alexandrinus*, but the latter name appears to be strictly applicable only to the brown form of *M. rattus* with grey underparts—a house-haunting race ‡.

12. *MUS MUSCULUS GENTILIS* Brants.

The specimens of this mouse from Cyprus resemble those from the Soudan in the collection of the British Museum, the fur of the underparts being pure white, with the proximal ends of the hairs grey in only some examples.

In the five specimens obtained the tails are long, in each case exceeding the length of the head and body, in this respect reversing the proportions that obtain in the wild form of *M. musculus* found in Portugal §. This mouse is common in the island, being found not only in the open country but also in out-houses and buildings near towns, and although it seems most likely, I am unable to say whether or not this form also haunts the houses in towns. I do not remember seeing any of the darker coloured typical *M. musculus*.

* 'The Carob Tree,' by P. Gennadius. Nikosia, Cyprus, 1902.

† Unger and Kotschy, *op. cit.*

‡ See 'Zoology of Egypt,' Mammalia (Anderson), 1902, p. 274.

§ Mr. Oldfield Thomas, "On a wild-living Mouse of the *Mus musculus* group in Portugal," Zoologist, vol. xx. 1896, pp. 137-9.

13. *ACOMYS NESIOTES* Bate.

From the size and general appearance of the adult of this species it might be considered an island form of *A. dimidiatus*, which it resembles somewhat closely. On the other hand, the grey coloration of the young, which persists until the animal has attained almost its full size, points to a possible connection between *A. nesiotes* and *A. cahirinus*.

A description of the Cypriote Spiny Mouse has already been published*. At that time it had only been procured near Dikomo at the foot of the Kerynia Range, but it has since been found near Limassol in the south, so that it probably occurs over the greater part of the plains and low hills in the island†.

The type specimen is now No. 3.12.4.37 of the British Museum.

14. *LEPUS CYPRIUS* Barr.-Ham.

Mr. Barrett-Hamilton's description of the Cypriote Hare‡ was founded on three skins—accompanied by two very much damaged skulls—presented to the National Collection in 1875 by the late Lord Lilford. The specimens procured by me do not agree very well with these skins, which are possibly somewhat faded; therefore this further material being now available, it is thought that a few additional notes on the species may be of interest. The following measurements (in millimetres) were taken in the flesh:—

	Head and body.	Tail.	Hind foot.	Ear.
No. 94 (♂)	558	89	133	107·5
No. 91 (♂)	533	82	120	107·5
No. 166 (♂)	508	...	126·5	105
No. 93 (♀)	546	89	126·5	101·5

The greatest and basilar lengths (in millimetres) of the two skulls obtained are as follows:—

	Greatest length.	Basilar length.
No. 166 (♂)	95	76
No. 163 (♂)	90	71

In size *L. cypricus* is apparently similar to *L. creticus*, a specimen of the latter being 21 inches (532·5 mm.) from the tip of the nose to the end of the tail (collector's measurement). The skulls of these two species are also much the same, the total length of that of one of the type specimens of *L. creticus* being 97·5 mm.

The newer examples of the Cypriote Hare resemble the Cretan species more closely than does the type specimen, particularly in showing the light-coloured rump and a slight amount of white on the anterior surfaces of the ears, but lack the grizzling on the upper lips which is present in all the five skins from Crete in the British Museum Collection.

* Ann. Mag. Nat. Hist. ser. 7, vol. xi. pp. 565-7 (1903).

† See P. Z. S. 1903, vol. ii. p. 260.

‡ Ann. Mag. Nat. Hist. ser. 7, vol. xi. pp. 126-7 (1903).

The Cypriote Hare is distributed all over the island and is plentiful in many parts, in spite of the numbers that are every year shot by the natives. They not infrequently do a considerable amount of damage in vineyards, and consequently are looked upon as vermin and, subject to certain restrictions, may be killed at any time of the year and without a license.

This hare is included in Unger and Kotschy's list under the name of *Lepus timidus*.

15. OVIS OPHION Blyth.

No list of the mammals of Cyprus would be complete without mention being made of the Moufflon, which is still found in the forests of the western part of the Troödos Range, this being the wildest and least inhabited district in the island. On more than one occasion during the summer of 1902 some were seen on Olympus, the highest point in the island, and probably the most easterly to which they now roam.

During my visit in 1901 and 1902 none were allowed to be shot, and at all times a special license is necessary. In spite of this it is supposed that many are still killed by the peasants; I myself saw several skins and horns, mostly of immature specimens, that were undoubtedly illegally come by, to judge by the secrecy with which they were brought for inspection. As a rule the horns are hidden or thrown away in the forest, where some have subsequently been found by the police.

The measurements of the largest horns of the Cypriote Moufflon mentioned in 'Records of Big Game'* are:—Length on front curve 25 inches, and circumference at base 8 inches. The owner of this trophy is given as Mr. H. Williamson, but it is probable that the one referred to is the very handsome mounted specimen shot and presented by him to the English Club at Limassol, Cyprus.

2. On the Cause of Death of a Polar Bear recently living in the Society's Gardens. By REDCLIFFE N. SALAMAN, M.A., M.B. Cantab., F.Z.S., Acting Director of the Pathological Institute, London Hospital.

[Received November 12, 1903.]

A fine well-grown male Polar Bear (*Ursus maritimus*), presented to the Society by Mr. Arnold Pike in 1895, died suddenly on Nov. 1. There was no history of illness, and the animal had been taking its food regularly and was in no way emaciated. A preliminary examination was made on Monday, Nov. 2, and I completed the *post-mortem* next day.

* Rowland Ward, 3rd edition, 1899, p. 385.

On opening *the Thorax* an enormous quantity of recent blood was found filling both pleuræ.

The Lungs were collapsed owing to the large effusion, but showed no signs of any disease, nor was there any sign of pleurisy.

It was interesting to note that the lungs showed almost as much anthracosis as is found usually in the lungs of human city-dwellers.

The Heart and the Aorta to within a few inches of the diaphragm were found to be perfectly normal; however, the latter part of the dorsal aorta was found to be bound down by recent adhesions to the vertebral column and on its antero-mesial surface to be fused to a structure about the size of a hen's egg. On removing the latter six inches of the dorsal aorta and the new fibrous structures above described, it was found that the aorta was ruptured on its anterior surface, forming a hole ($\frac{1}{4}$ " in diameter) which led into a cavity contained within the above fibrous mass. This cavity had a volume equal to that of the egg of a blackbird; it was filled with greyish and red laminated clot. The walls of the cavity consisted therefore of clot and of fibrous tissue on the outer, left, and anterior surfaces, whilst on the mesial surface the laminated clot came into direct contact with the bodies of the vertebræ, which were slightly eroded. At its posterior extremity this sac had ruptured into the thoracic cavity. There was evidence that there had been some slight leakage at any rate some hours before the fatal hæmorrhage, as there was found on the posterior surface of the left lung a blood-stained roughened area which corresponded in life to the position of the sac.

We have therefore to deal with an aneurysm of the aorta, itself perfectly healthy except for the small rupture which forms the aperture into this aneurysmal cavity. No part of the aortic wall has shared in the formation of the aneurysm, which therefore falls into the group known as "false aneurysms."

The ætiology of the morbid process remains obscure, and, notwithstanding the fact that the œsophagus was without obvious lesion, it is conceivable that, at some time previous, some sharp bone, penetrating the œsophageal wall, may have lacerated the aortic wall, and thus been the starting-point of leakage from the latter and formation of a "false aneurysm."

I am indebted to Professor McFadyean for having kindly informed me that aneurysm is, so far as he knows, an unknown condition in wild animals and excessively rare in the domestic carnivora.

The aneurysms in horses are examples of dilatation of the aorta, and are quite distinct from the aneurysm found in this case.

3. On the Development of the Adult Colouring in the Yellow-billed Cardinal (*Paroaria capitata*) from S. America.
By ARTHUR G. BUTLER, Ph.D., F.L.S., F.Z.S., &c.

[Received November 17, 1903.]

In the 'Avicultural Magazine' for July 1903 (pp. 294-298) I had occasion to point out that *Petronia albigularis* of Brehm was not an immature plumage of *P. dentata*, but a distinct species, specimens of both birds having been in my possession for over five years, and, though unaccompanied by a cock of either species, building and laying at intervals during the whole time in which I owned them.

In the same Magazine for December 1903 I have a short paper with an opposite tendency, dealing with two forms of *Paroaria* which have hitherto been regarded as distinct species. I have not, however, entered into details, in that brief account, of the method of the growth in colour which gradually established the identity of the supposed species: this I now propose to do.

In July 1893 I imported a fully adult male of *Paroaria capitata* in perfect plumage; unhappily it was subjected to rough treatment during the journey home from La Plata, and so only survived about six months. However, I had a beautiful skin made of it, thus enabling me to have something better than a mere illustration for future reference.

This year (September 1903) a consignment of Lesser Cardinals was brought into the London bird-market by an Italian, who sold his stock to an enthusiastic friend of mine, Mr. J. B. Housden of Sydenham, who later brought some of the Cardinals to me as "Yellow-billed Cardinals" (*P. capitata*); but, as soon as I saw them, I knew that the more advanced examples were unquestionably the so-called Brown-throated Cardinal (*P. cervicalis*); some, however, were fortunately in the interesting nestling dress. I secured four specimens in various stages of colour-growth.

The young bird at first is somewhat browner above than the adult, the white of the under surface less pure; the flanks ash-grey; the head and gular streak pale sandy buff excepting the region of the so-called "crest" (*P. cucullata* is the only species with a true crest) which is purplish ashy; the beak ochre-yellow, with the tip and the culmen and tomium of the mandible blackish; tarsi flesh-pink, slaty-grey in front.

The complete change from this plumage to the fully adult colouring appears to take from nine to ten weeks; and during the whole time not a single feather is moulted out, but each feather gradually changes from day to day. I am certain of this, because I put the youngest bird with one more advanced in a large box-cage, so that no feathers could be dropped without the certainty of their being seen lying on the sand; moreover, the

change is so extremely slow that, not one but seventy or eighty moults would have been required to show all the transitions.

The first thing which one notices is that the buff of the head and throat becomes dulled and deepened (perhaps the "ochreous-brown" described in the Museum Catalogue of Birds, vol. xii. p. 812); then little flecks of crimson appear dotted over the surface, which increase in extent from day to day until the full brilliant crimson of the head is attained; but shortly after the appearance of these crimson flecks on the chin a small blackish spot appears at the extremity of the gular streak, which works regularly backwards until it has deepened the distal third of that streak (each feather, however, being left reddish at its base); then it throws out a flanking line which extends rapidly up each side of the beard-like streak, whilst from behind the chin a third central line begins to travel in the opposite direction. With the encroachment of the distal patch and the extension laterally of these three lines, the whole of the gular streak becomes black with reddish bases to the feathers; simultaneously the flanks become paler and the edges of the feathers white, offering an indistinctly streaky appearance; the back also becomes blacker, but the blackish streaking of the mandible and dark tip to the maxilla are generally more or less well-defined, though they appear to be sometimes lost at a very early stage.

At this period the bird has therefore assumed the characters of *Paroaria cervicalis*; but, unfortunately for the validity of that species, they continue still to develop; the beak becomes wholly bright ochreous, the tarsi become wholly flesh-pink, the reddish bases disappear from the feathers of the throat, the grey almost entirely disappears from the flanks, the upper surface becomes quite black; and our *P. cervicalis* has become adult *P. capitata*. I am afraid the fact is quite indisputable.

The habitat of the species should therefore stand as—Argentine Republic and Paraguay northward to Bolivia and Matto Grosso.

It is possible, as Dr. Sharpe suggests (Catalogue of Birds, xii. p. 814, footnote), that *P. gularis* may be a further variation of the species; but I should think it more likely that it was distinct. The variation in the amount of black in the region of the eye may be due to immaturity, as in the black of the throat of *P. cervicalis*, which does not cover the bases of the feathers. It is certain that not one of the Cardinals recently imported showed a trace of the black fusiform patch over the lores and behind the eye of *P. gularis*: nor did any of them show the slaty maxilla illustrated in the Museum Catalogue (vol. xxii. pl. xvi.); but perhaps this was an artist's license, like the raised crests on the crowns of figures 2 to 6 of that plate,—birds which are perfectly incapable of erecting the feathers on their crowns like *P. cucullata*.

4. On the Occasional Transformation of Meckel's Diverticulum in Birds into a Gland. By P. CHALMERS MITCHELL, M.A., D Sc., Secretary to the Society.

[Received December 1, 1903.]

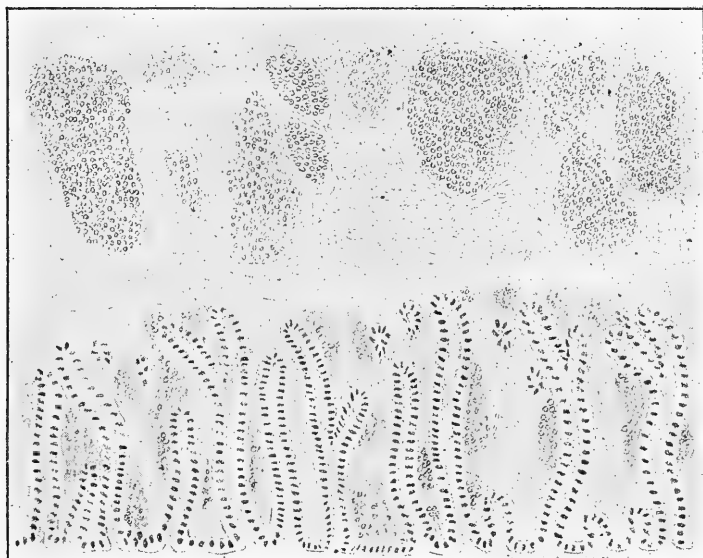
(Text-figure 44.)

Soon after I began to study the varying dispositions of the intestines in Birds I, like other observers, was struck by the occasional presence of a well-marked cæcum about the middle of the course of the small intestine. This cæcum is identical morphologically with what is known as Meckel's diverticulum in the case of Man, and is the vestige of the embryonic yolk-sac. In a communication (Trans. Linn. Soc. ser. 2, Zool. vol. viii. pt. 7, pp. 173-275, 1901) in which I reviewed the structure of the intestinal tract in many hundreds of birds belonging to practically all the families, I was able to add considerably to our knowledge of the occurrence of this structure and to point out its morphological significance as a point of orientation. In mammals, its presence in the adult appears to be rare and to be only an individual variation. In birds, the curious state of the case is that its presence or absence appears not to be an individual variation but to mark coherent assemblages. In most cases, when present, it is a true vestige of the embryonic condition, an apparently functionless rudiment sometimes still containing small granules of yolk. In such cases it appears to get smaller with age, but on this point I have not a large collection of observations to guide me. In other cases, a more peculiar condition occurs—the yolk-sac vestige has, so to speak, burst out again into a second life. It has become a glandular organ of a highly elaborate nature. I have already stated this fact (*loc. cit.* p. 264) and mentioned that Lönnberg and Jägerskiöld have drawn attention to it; but as the microscopic structure of this new organ has not been described, I propose here to give a short account of it.

The glandular condition of Meckel's diverticulum is particularly well-marked in the Woodcock (*Scolopax rusticula*). In that bird it is more than half an inch long, thick and very firm, with a narrow lumen slightly distended towards the apex and communicating with the cavity of the gut. The figure (text-fig. 44) shows part of a longitudinal section through the diverticulum. The epithelium lining the lumen, and continuous with that of the intestine, is thrown into a set of deep glandular folds forming a branching system that occupies nearly half the wall. In the interspaces between these tubular glands, numerous patches of lymphatic tissue occur. Towards the apex of the gland this secreting layer is much thinner and more regular, and there is less lymphatic tissue. The rest of the thickness of the wall of the gland is composed of longitudinal and circular muscle-fibres, rather irregularly arranged, and of loose connective-tissue stroma in which

are embedded very numerous and large masses of lymphatic tissue, these latter also being more scanty towards the extremity of the gland. All the specimens that I have been able to examine were obtained from birds that had been dead at least for some hours, and the lining epithelium was partly decomposed and mixed with the contents of the lumen.

Text-fig. 44.



Meckel's diverticulum in the Woodcock. Part of a longitudinal section of the wall: the lower half of the section shows the intestinal epithelium thrown into glandular folds, with patches of lymphatic tissue; the upper part shows longitudinal and circular muscle-fibres and connective-tissue stroma, with islands of lymphatic tissue.

There can be no doubt from the structure of this organ that it is a definite gland, but we are so profoundly ignorant of the physiological processes in all animals, except Man and a few creatures commonly used in experimental laboratories, that there are practically no data for making even a suggestion as to its function. It is obviously similar in structure to the paired cæca in certain birds, as, for instance, most of the Passeres, where these are glandular nipples. It is interesting to note that the glandular condition of Meckel's diverticulum occurs in birds that are otherwise specialised and does not appear to occur in birds which in other features of their anatomy are archicentric or primitive. This supports my inference that the glandular condition is a new feature, probably of recent origin in the history of birds.

The mode of origin of new organs is a morphological problem to which little attention has been given, although it is of great biological interest. The most obvious analogies with the present case are such changes of function and structure as the transformation of the lower part of the pharynx into the thyroid gland or the metamorphosis of part of a gill-slit into the middle chamber of the ear; but I do not remember any case exactly similar to the present where the protoblastic structure, having fulfilled its function, degenerates, but is replaced by a deutero-blastic structure with a new function. It is interesting to notice that the raw materials for this deuteroblastic growth occur in many birds, inasmuch as the relic of the yolk-sac, or protoblast, lingers throughout life, but it is only in a few cases that the relic sprouts again and becomes the new organ.

5. On some Nudibranchs from East Africa and Zanzibar.

Part III.* By Sir C. ELIOT, K.C.M.G., H.M. Commissioner for the East Africa Protectorate, F.Z.S.—
Dorididæ Cryptobranchiatæ, I.

[Received October 16, 1903.]

(Plates XXXII.—XXXIV.†)

This paper contains the results of an examination of a number of Cryptobranchiate Dorids from Zanzibar and the East Coast of Africa referable to Bergh's subfamilies Archidorididæ, Discodorididæ, Dialulidæ, Kentrodorididæ, and Platydorididæ. They include the following species:—

Archidoris Bergh.

1. „ *africana*, sp. n.
2. „ *minor*, sp. n.

Staurodoris Bergh.

3. „ *depressa*, sp. n.
4. „ *calva*, sp. n.

Discodoris Bergh.

5. „ *bokoliensis* Bergh.
6. „ *cærulescens* Bergh, *variegata*, subsp. n.

Peltodoris Bergh.

7. „ *angulata*, sp. n.
8. „ *aurea*, sp. n.

Thordisa Bergh.

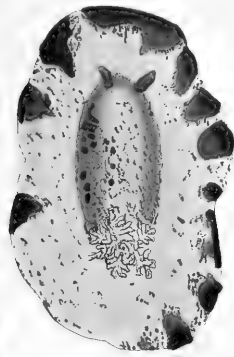
9. „ *villosa* (A. & H.).
10. „ *stellata*, sp. n.
11. „ *crosslandi*, sp. n.

* For Part II. see P. Z. S. 1903, vol. i. p. 250.

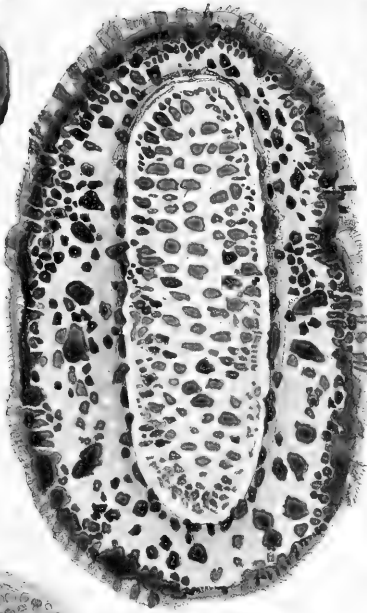
† For explanation of the Plates, see p. 385.



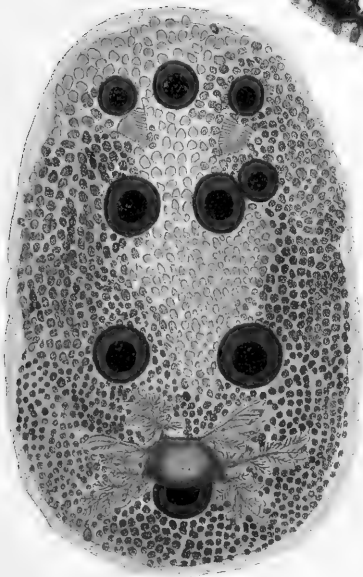
1.



2.



3.



4.

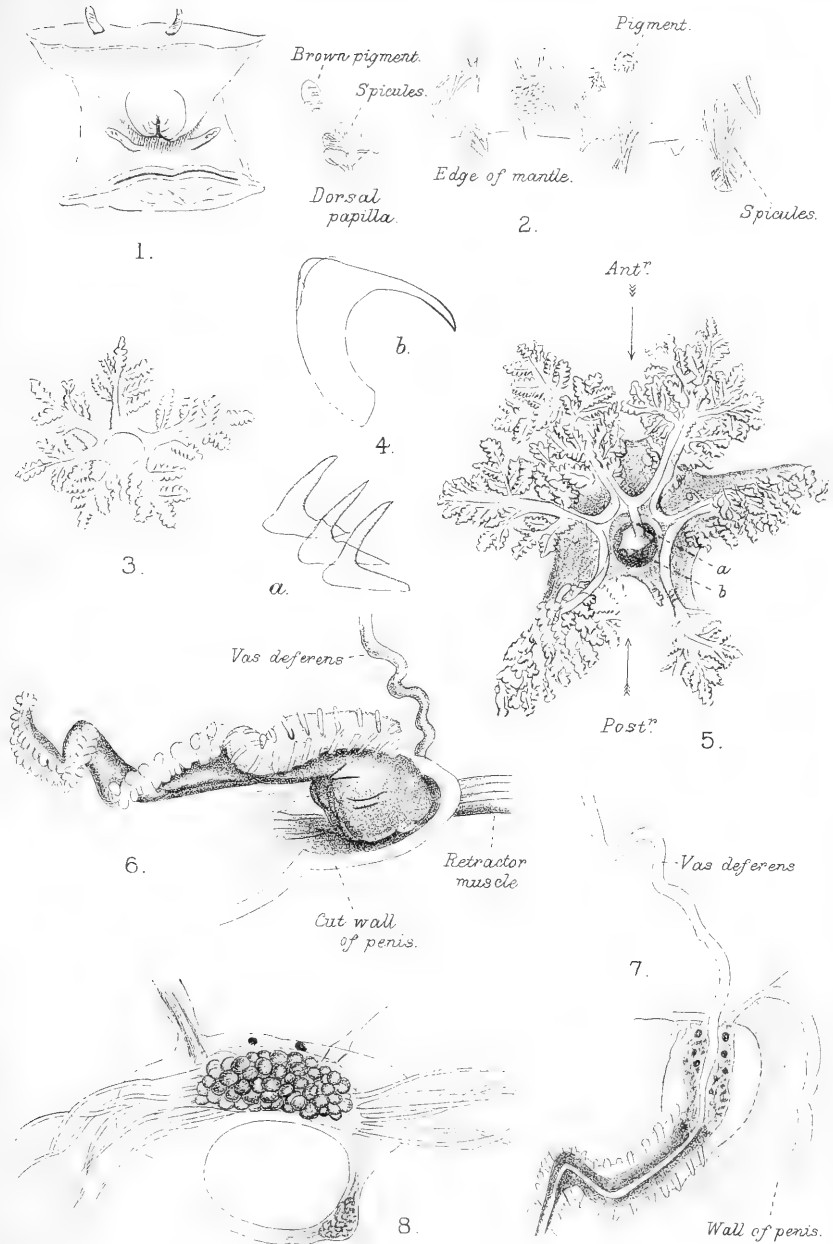


5.

C. Crossland del.
A. Willey del fig. 5.

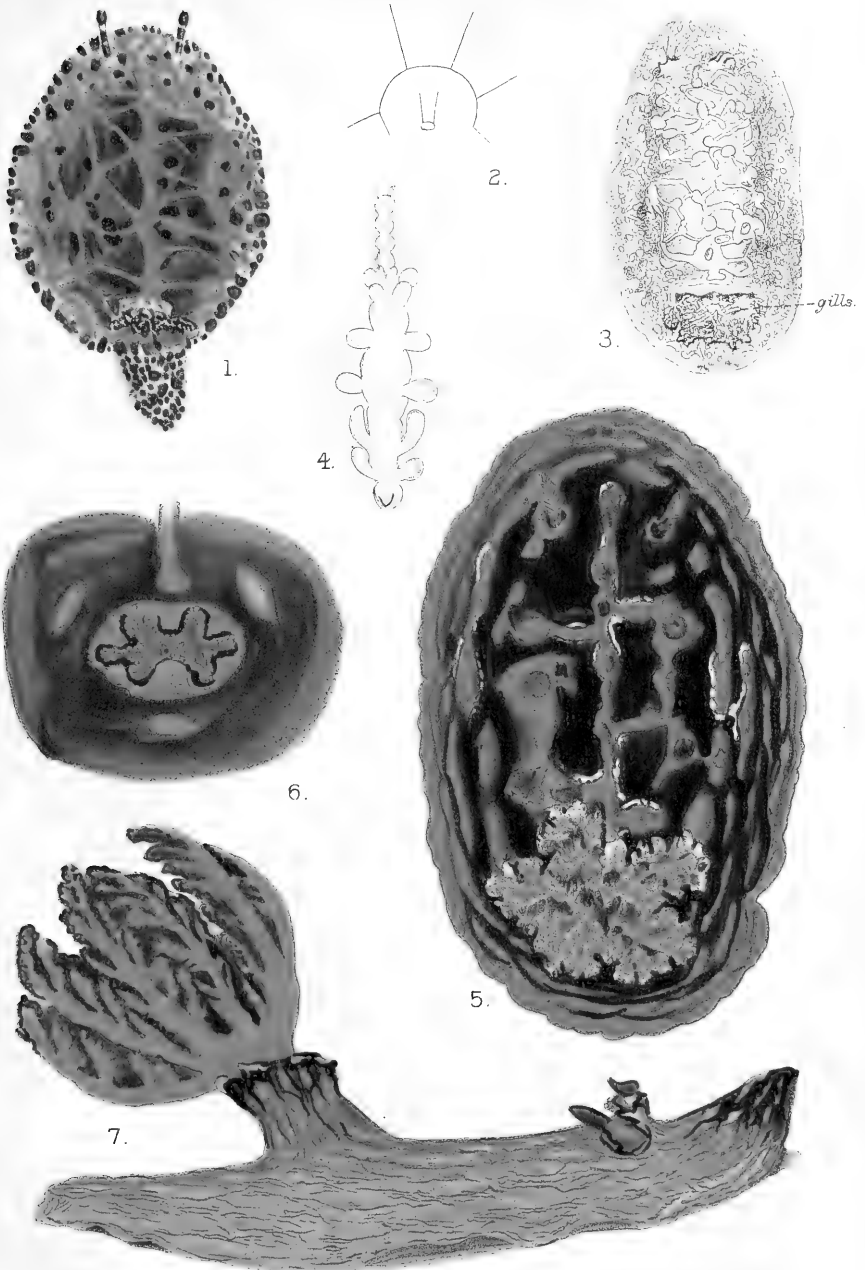
Huth, Lith. London.

1, 2. THORDISA VILLOSA. 3. T. CROSSLANDI.
4. TRIPPA MONSONI. 5. HALGERDA WILLEYI.



C. Crossland del.

Huth, Lith? London.



C. Crossland del.

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- 1, 2. HALGERDA WASSINENSIS. 3. SCLERODORIS CORIACEA.
 4. PARASITIC COPAPOD. 5, 6. ASTERONOTUS HEMPRICHI.
 7. KENTRODORIS RUBESCENS.



- Trippia* Bergh.
 12. " *areolata* (A. & H.).
 13. " *monsoni*, sp. n.
Fracassa Bergh.
 14. " *tuberculosa*.
Halgerda Bergh.
 15. " *willeji*, sp. n. (From the Loyalty Islands.)
 16. " *wasinensis*, sp. n.
Kentrodoris Bergh.
 17. " *rubescens* Bergh.
Platydoris Bergh.
 18. " *eurychlamys* Bergh.
 19. " *scabra* (Cuvier).
 20. " *formosa*? (A. & H.).
 21. " *elliotti*? (A. & H.).
 22. " *pulchra*, sp. n.
 23. " *incerta*, sp. n.
 24. " *papillata*, sp. n.
Sclerodoris Eliot, gen. n.
 25. " *osseosa* (Kelaart).
 26. " *tuberculata*, sp. n.
 27. " *minor*, sp. n.
 28. " *rubra*, sp. n.
 29. " *coriacea*, sp. n.
Asteronotus Ehrenberg.
 30. " *hemprichi* Ehrenberg.

The Cryptobranchiate Dorids are distinguished by having branchiæ which are completely retractile into a permanent pocket. The rhinophores also are retractile into permanent pockets and are perfoliate. A radula is always present. In number of species they form one of the richest groups of the Nudibranchiata, but they show less variety of form than the Dorididæ Phanerobranchiata, and it is not easy to find good generic characteristics. The most distinctly marked group is that consisting of the large genus *Chromodoris* (with more than 100 species) and some allied genera such as *Casella* and *Ceratosoma*. These possess a characteristic shape, lip-plates, a radula with differentiated teeth, and simply pinnate branchiæ. Well characterised genera are also found in the Miamiiradæ (*Miamira*, *Orodoris*, *Sphærodoris*) and the Cadlinidæ (*Cadlina*, *Tyrinna*). There remain the five subfamilies mentioned above, which agree in being usually flat and oblong in form and in having a radula without a central tooth, consisting of numerous laterals which are generally hamate and uniform, though often smaller near the rhachis and degraded or denticulate at the outer end of each row.

Anyone who describes new forms of these Dorids, however much he may disclaim any such ambitious task as a revision of

the group, is bound to consider the value of the existing generic distinctions. The five subfamilies are divided into about 30 genera all created by the great master of the Nudibranchiata, Prof. Bergh, and several of them consisting of a single species. He himself observes (on *Thordisa* in Semper's 'Reisen',*, xv. p. 666) that the definitions of many of these genera seem to be too precise, and as new forms are discovered the old divisions are found to melt away. The discoverer of a new form often finds that it does not accurately fit in to any of the existing genera, and must ask himself whether he should create a new genus or enlarge the definition. I have little doubt that in most cases the latter is the preferable course. If animals are not divided by natural differences, there is no object in emphasising the importance of minute peculiarities. If *Chromodoris* is allowed to consist of 100 species showing a considerable range of variation, including the presence or absence of median teeth, there seems to be a want of proportion in splitting up the other Cryptobranchiata into so many genera.

The genus *Staurodoris* offers a good example of the difficulty of classifying new forms. Taken by itself, the typical species *St. verrucosa* is remarkably well characterised in both the scientific and popular sense. Anyone could recognise it at first sight. The back is covered with club-like tubercles, the rhinophorial and branchial pockets are protected by similar tubercles which act as valves, and the branchiæ are simply pinnate. On the other hand, *St. pseudoverrucosa* (von Ihering) has no tubercles on the branchial pocket and has bipinnate branchiæ. Bergh also refers to this genus the *Doris pustulosa* of Abraham, which has bipinnate branchiæ and small, but apparently not valve-like, tubercles. I have specimens from the Indian Ocean which have the dorsal surface tuberculate and the following additional characteristics:— A. has the rhinophores arising among tubercles and simply pinnate branchiæ, but no tubercles on the branchial pocket (*Staurodoris pecten*). B. has five pinnate gills, the anterior margin of the foot entire, and small tubercles set on the edges of the gill-pocket and partly closing it (*Staurodoris calva*). C. has tubercles round the rhinophores, none on the branchial pocket, and thin bipinnate branchiæ (*Archidoris africana*). D. has tubercles on the rhinophore pockets but not around the branchial opening, and tripinnate gills (*Archidoris minor*). Of these, I think we must admit A. and B. to be *Staurodoris*, if we accept *St. pseudoverrucosa*. But *Archidoris kerguelensis*, *A. australis*, *A. rubescens*, *A. incerta*, and *A. nyctea* are all described by Bergh as having tubercles on the edge of the branchial and rhinophorial pockets, and must come very near the less typical members of *Staurodoris*. It is hard therefore to say whether C. should be classed as *Staurodoris* or *Archidoris*. There seems to be a complete series of links between the two genera, and, this being so, we must either unite

* The letters S. R. in this paper refer to Prof. Bergh's "Malacologische Untersuchungen," published in 'Reisen im Archipel der Philippinen,' von Dr. C. Semper.

the species in question, or draw an arbitrary dividing line. In the latter case, I think we must say that the typical *Staurodoris* has simply pinnate branchiæ and valve-like tubercles closing the rhinophorial and branchial pockets. One or other of these features may be absent or obscure in a species which otherwise possesses the generic characteristics; but when both are absent, as in C., the animal, I think, must be referred to *Archidoris*. Again, *Staurodoris pseudoverrucosa* has the dorsal tubercles sometimes connected by ridges, and the same phenomenon is found in Garstang's *Doris maculata* (which appears to be a *Staurodoris*), and, sporadically, in the true *St. verrucosa*. But, as will be seen from a species described below, *Halgerda wasinensis*, this character brings *Staurodoris* very near to *Halgerda*.

It will be well to examine the value of the chief points by which the subfamilies and genera under consideration can be differentiated. They are as follows:—

(a) The dorsal surface and general texture. The back is rarely quite smooth, as it is in *Chromodoris*; *Halgerda* and *Asteronotus* have the skin smooth but raised into ridges or lumps. As a rule, the surface is covered with projections which may be either minute granulations (*Platydoris*, *Discodoris*, &c.), papillæ (*Thoridisa*, &c.), tubercles (*Archidoris*, &c.), clavate tubercles or warts (*Staurodoris*), compound tubercles (*Trippa*, *Fracassa*). There is sometimes a ridge down the centre of the back. Some genera, notably *Platydoris*, are exceedingly hard; others, such as *Trippa*, are so soft as to be almost gelatinous. On the whole, these external characters of the skin and texture form a fairly good indication of relationship. *Platydoris*, in which I should be disposed to include *Hoplodoris*, forms a distinct natural group, and the warty or tuberculate forms (*Archidoris*, *Staurodoris*) also hang together*.

(b) Rhinophores and branchiæ. Neither the rhinophores themselves, nor the pockets into which they are retractile, seem to offer good generic characters, though they may often serve to distinguish species. But even within a species there may be variety: *Archidoris tuberculata* has the rims of the rhinophore pocket sometimes smooth and sometimes tuberculate.

The branchiæ also are disappointing as a means of classification. For instance, it does not seem possible to unite *Staurodoris* with the other genera having simply pinnate branchiæ (*Chromodoris*, *Casella*, *Ceratosoma*, *Sphaerodoris*, *Halla*, *Thorunna*, *Rostanga*), and these simple branchiæ often show a tendency to divide at the tip and become, strictly speaking, bipinnate. Similarly, we cannot bring together bipinnate forms and oppose them to the tripinnate. Perhaps the distinction between ample and scanty branchiæ will prove to be of generic importance. The branchial pocket is of various shapes: round, crenulate, or stellate. However,

* I find it hard to agree with Prof. Bergh's criticism of his own family Archidoridae that it will prove "ganz unhaltbar und künstlich." With the exception of *Peltodoris* the other forms seem to hang well together.

it does not seem possible to make any classification according to this shape, and to unite, for instance, all the stellate forms.

In most of the Cryptobranchiata the tentacles appear to be digitate, but the Archidorididæ have a tendency (not without exceptions) towards a flattened and furrowed form. *Sphærodoris* has no tentacles, and the same is said of *Halla* and *Echinodoris*. No part of preserved Nudibranchs is more liable to distortion than the tentacles, which may be variously contracted, flattened, or crumpled by the action of the preserving fluid or the pressure of the adjacent parts.

(c) The foot appears to offer good characters; as a rule, but not invariably, the forms which have a broad foot and narrow or moderate mantle-margin belong in other respects to groups different from those which have a narrow foot overhung on every side by a wide mantle-margin. The Archidorididæ and Discodorididæ have both, as a rule, broad feet, but the body of the former is plump, and of the latter flattened. The Platydorididæ have flat bodies and narrow feet.

In most forms the anterior margin of the foot is deeply grooved, and the upper lamina notched so as to form two flaps, which in the Kentroдорididæ are very ample. Many (though not all) of the Archidorididæ have the anterior margin simply grooved and otherwise entire. In a few genera (*Trippa*, *Halla**, *Sphærodoris*) the divided upper lamina is attached to the sides of the head, but it does not seem possible to bring together the forms which present this peculiarity.

(d) In the internal anatomy, the mouth-parts are perhaps the most important for classification. It is clear that considerable structural differences in other organs are generally accompanied by a difference in the radula. For instance, *Acanthodoris* and *Lamellidoris*, which bear a strong superficial resemblance to the Cryptobranchiata but have no permanent gill-pocket, have also a totally different radula, and most of the larger divisions of the Nudibranchiata have a characteristic arrangement of teeth. But it is hazardous to conclude from this that *small* differences of the radula have a generic value. One common variation from the ordinary hamate type of radula is the serrulation of the outer teeth. This may be present or absent in the same genus (e. g. *Staurodoris verrucosa* and *St. bicolor*), and in some species (*Platydoris argo* and *Halgerda formosa*†) is only found in some of the rows of teeth. As a general rule the innermost and outermost teeth are smaller: the latter often rudimentary or degraded. But it appears that these characters are only of specific, not of generic importance.

* [I venture to point out that the generic name *Halla* is preoccupied by a Polychæte (Lunbriconereid) worm named by A. Costa in 1844 (cf. Ann. Acad. d. Aspiranti Naturalisti Napoli, ii. p. 63 (1844).—C. CROSSLAND.

† In a specimen of *Halgerda formosa* from the Berlin Museum, given me by the courtesy of Prof. Martens, I found at the end of some but not all of the rows small rudimentary teeth, some but not all of which bore a few irregular serrulations. This is not quite the same arrangement as observed by Prof. Bergh.

Another point of importance is the presence or absence of a labial armature, that is to say, of a ring or plates on the labial cuticle composed of a compact mass of minute hooks or rods. There is some reason for dividing the group into those which possess and those which do not possess this armature, but still I think that an absolute dichotomy of this kind presents difficulties. Firstly, a rudimentary labial armature is of some inconvenience in classification. Bergh has described such an instance in *Platy-doris variegata*; and the animal described below as *Thordisa crosslandi* has two small areas on the labial cuticle which cannot be called plates, but consist of a loose collection of minute rods. In *Platydoris pulchra* the labial cuticle is strengthened with similar rods, distributed through its extent, but not collected into rings or plates. Secondly, though *Discodoris* B. is a well-defined genus, the same can hardly be said of the family Discodoridæ, the genera of which mostly agree only in having a labial armature. Thus *Fracassa* and *Carminodoris* appear to be akin to *Trippa*, *Hoplodoris* to *Platydoris*, and *Halla* to *Chromodoris*. It would seem that the more primitive forms of the Cryptobranchiata are those which have a labial armature and some differentiation of the teeth, such as occurs in *Chromodoris* and *Cadlina*, and that the forms with no labial armature and uniform hamate teeth are more recent developments. If this be so, it is easy to understand that in many groups a few forms have survived in which the labial armature has persisted. Thus *Fracassa* is practically a *Trippa* which has preserved this character, and it appears to me that its analogies to *Trippa* are greater than those to *Discodoris*.

(e) Considerable use has been made by Prof. Bergh of the reproductive organs as a character for classification*. That great weight must be attached to important variations in these organs—such as the presence of one or two spermathece—is obvious; but while fully admitting the necessity of examining the internal anatomy and the futility of describing only the external characters of Nudibranchs, it must also be admitted that it is not convenient to found genera of fairly large animals upon minute internal characteristics which can only be discovered by an expert microscopist, and by him only in a well-preserved and mature specimen. Such a criterion seems desirable only if it is of great anatomical importance. But what are the variations presented by these organs in the Cryptobranchiata? (i.) Accessory organs are sometimes present. These are generally accompanied by other characters of systematic importance as in *Kentrodoris* and *Asteronotus*. (ii.) The male branch of the hermaphrodite system sometimes broadens and sometimes does not into a dilatation called the prostate. It does not appear that this difference is generally accompanied by other characters of importance: e. g. a

* But see System. d. Nud. Gast. p. 1088. "Bei dem jetzigen Stande unserer Kenntniss . . . ist es sehr gewagt eine systematische Gruppierung derselben zu versuchen. Es ist es nun so mehr als der generische Werth der bei der hier versuchten Gruppierung dem genital System, besonders den verschiedenen Conformationen seiner Ausführungsgänge, beigelegt ist, als solcher kaum sicher gestellt ist."

prostate is present in both *Discodoris* and *Platydoris*, which are otherwise so distinct, and is absent in *Archidoris* but present in *Anisodoris*, which are otherwise identical. (iii.) In many genera is present an armature of the reproductive organs, that is, one or many spines, hooks, or plates generally only on the male branch. The value of this feature, as estimated by the concomitance of other important characters, varies. In the families of Doridopsidæ and Phyllidiadæ and in the well-marked genus *Platydoris* of the Cryptobranchiata an armature is, so far as we know, characteristic. On the other hand, we find two genera like *Diaulula* and *Gargamella* apparently identical but for its presence or absence. In the Aeolidiadæ also a hook or spine is present or absent in closely allied genera. It appears to me that such an armature is not sufficient to constitute generic rank without other characters.

(f) The other internal organs do not offer many features which serve our purpose of classification. It does not appear that we can unite the forms in which the stomach is enclosed in the liver, or in which there is only a single instead of a double blood-gland, or in which the nervous system is very concentrated.

As a result of these considerations, I think that the most profitable way of classifying new Dorids of the group treated of here, is to refer them when possible to the following genera taken in a wide sense:—*Archidoris*, *Discodoris*, *Thordisa*, *Trippa*, *Halgerda*, *Kentrodoris*, *Platydoris*, *Asteronotus*, and *Sclerodoris* (gen. n.). No doubt, remarkable forms have been and will be found which require special genera for their accommodation, but the majority of species seem to me to fall under one or other of the divisions mentioned.

Archidoris is distinguished by a fairly plump shape, broad foot, and a warty or tuberculate back. No member of this group is known to possess a labial armature, and a genital armature is rare. The radula generally consists of uniform, simply hamate teeth: more rarely some or all are denticulate. I include in this genus, in its wide sense at least, *Anisodoris*, *Homoiodoris*, and *Artachæa*. As mentioned above, though it is easy to define the generic characters of a typical *Staurodoris*, the genus seems to pass into *Archidoris* by a complete series of connecting links.

Discodoris.—I should be inclined to extend this genus so as to mean flat, oval animals, not hard, with both foot and mantle-brim fairly broad. Back granulate. A genital armature is usually absent; a labial armature is either present (Section *Discodoris*) or absent (Section *Peltodoris*).

Thordisa.—Flat, soft animals, much like *Discodoris*, but with the back neither granulate nor warty, but covered with soft pointed papillæ. No member of this group is known to possess a well-developed labial armature, though a rudimentary one is found in *Th. crosslandi*.

Trippa.—Soft, and sometimes spongy or gelatinous. The back is covered with tubercles which themselves bear smaller prominences or filaments. A labial armature is occasionally present (Section *Fracassa*). Some species have special glands set round the buccal mass, and the sides of the head connected with the foot, but it does not appear to me that the absence of these characters ought to exclude a form from the group.

Halgerda.—The texture is entirely smooth and somewhat stiff, though ridges may be present. In the known species the branchiae are scanty. No member of this group is known to possess a labial armature.

Kentrodoris.—Broad, soft, and flat, with the dorsal surface minutely granulated. The broad foot is deeply grooved in front, and the upper lip, which is notched in the middle, is developed into wing-like expansions on each side. The reproductive system is sometimes armed, and accessory organs are present. In some species, at any rate, the branchiae are unusually large.

Platydoris.—Very flat forms, of a peculiar hard consistency. The back is minutely granulated and rough to the touch. The foot is narrow. The branchial pocket is stellate in the known forms. A labial armature is rare (*Pl. variegata*). There is a characteristic genital armature of scales bearing hooks.

Asteronotus.—Of a characteristic leathery consistency. The back is quite smooth in texture, but bears lumps and ridges. No labial or genital armature.

Sclerodoris.—This new genus is proposed for certain forms which appear to have never come into the hands of Prof. Bergh, though I think Alder & Hancock's *Doris osseosa*, *carinata*, *apiculata*, and *tristis* ("Notes on a Collection of Nudibr. Moll. made in India," Trans. Z. S. vol. iii. 1864) should be referred to this genus. It is characterised by having the same hard texture as *Platydoris*, but the back, instead of being smooth, is marked with various ridges and depressions. In the known species there is no labial or genital armature. I should wish to bring my *Sclerodoris* under Prof. Bergh's *Dictyodoris*, but the generic characters as formulated by him do not include the hard texture and raised reticulate pattern.

Of the above-named genera, *Asteronotus* and *Kentrodoris*, though well characterised and not rare, have not hitherto proved numerous in species.

1. ARCHIDORIS AFRICANA, sp. n.

One specimen marked "Chuaka, shore." No notes as to living animal.

Alcoholic specimen 5 centimetres long, 1.6 high, with a fairly uniform breadth of 2.7, plump and not flat. The colour is a dirty greyish yellow, with traces of violet. The back is covered with tubercles: those in the middle are largest and measure 4 millimetres across; they decrease in size outwards, and are quite small at the mantle-edge. The top of each is lighter, and

was probably of a different colour in life. It is noticeable that the tubercles in the middle are all large and not mixed with small ones. The mantle-brim is moderately ample, thick, and stiff, and bears numerous irregular tubercles *on the lower side* which are probably glandular in character. The rhinophore openings are indistinctly bilabiate, not much raised, and bear small tubercles on the sides and edges. The rhinophores are large, ample, and deeply perfoliate. The branchial pocket is also not much raised, indistinctly bilabiate, and at the same time with five irregular and not very distinct crenulations. There are tubercles on the sides but none on the edges. The branchiæ are eight, tripinnate, but not ample: the two hindmost are smaller than the others. The foot is large and broad, with a shallow groove anteriorly and a split upper lip. The tentacles, which are set at right angles to the head, are unusually large and long (5 millimetres). The labial cuticle is black, and corrugated but unarmed. The radula consists of 33 rows containing about 60 simple white hamate teeth; the innermost are smaller, but the outermost are much the same size as the rest. No prostate or genital armature was discernible. There was a large purple double blood-gland, deeply cleft in both parts so that it seemed to have four divisions.

2. *ARCHIDORIS MINOR*, sp. n.

One specimen from Wasin. There are no notes on the living animal.

The alcoholic specimen is 2·9 centimetres long, 1·8 broad, and 9 millimetres high. The colour is rather bright yellow, with traces of a darker tint near the mantle-edge. The back is covered with flat warts, largest towards the centre, and decreasing towards the mantle-edge, but smaller ones are mingled with the larger; they show indications of a lighter colour at the top. The underside is of a uniform yellow. Round the rhinophore pockets are two or three tubercles, which look as if they had been high in life. The rhinophores are high, straight, and narrow, strongly recalling Bergh's figure of those of *Staurodoris januarii* (S. R. Supp. i. plate C, fig. 14). The branchial pocket is slightly raised, bilabiate, and indistinctly crenulate. Though there are tubercles near the edge, these in no sense close over it or act as valves. The branchiæ are eight, tripinnate, but high, thin, and scanty. The central papilla, also, is very high and thin. The foot is fairly broad, and grooved in front, with the upper lamina notched. The tentacles are small and conical. There is no labial armature. The radula consists of 30 rows, each containing about 50 long hamate teeth on either side of the rhachis; the innermost are crowded and smaller, the outermost not much smaller. At the side of the base is a groove, terminating in a slight projection at the bottom of the hook.

This specimen has many points of resemblance with *Archidoris africana*, but I am inclined to think that it is specifically distinct, for the following reasons:—(1) The prevailing colour is yellow,

whereas in *A. africana* it is violet, both externally and in the intestines; (2) the tentacles are small; (3) there are no tubercles on the underside of the mantle-edge; (4) the rhinophores and their pockets are somewhat different from those of *A. africana*; (5) so are the teeth.

It is possible that this is the *Doris rusticana* of Alder & Hancock ("Notes on a Collection of Nudibranchiate Mollusca made in India," Tr. Z. S. iii. p. 120), but in view of their statement "No oral tentacles (?); the head with lateral angles; branchial plumes five," identification is not possible.

3. *STAURODORIS DEPRESSA*, sp. n.

One specimen from Wasin. No notes as to living animal.

The alcoholic specimen is 6.3 centimetres long and 4.9 broad. The general shape is broad and flat. The thick and fleshy mantle-brim is 2 centimetres wide, and the foot consequently unusually small compared with the dorsal surface, being only 2.7 mm. long and about 8 mm. broad. The colour is a uniform greyish white, with a slight tinge of violet anteriorly and down the middle of the back. The whole upper surface is covered with warts, which are small at the mantle-edge but increase in size towards the centre. The top of the larger ones, which measure 5 millimetres across, is flat and hard, consisting of a mass of densely-crowded spicules, and is of a somewhat different shade from the rest and in life possibly distinctly coloured. On the underside of the mantle-edge are numerous small tubercles of glandular appearance. The openings of the rhinophores and branchiæ are tuberculate. The latter orifice is indistinctly stellate and also indistinctly bilabiate, but it is not clear what its original shape may have been. Both the branchial and rhinophorial orifices are closed in the alcoholic specimen. The branchiæ are six in number, but the hindermost pair are deeply bifid so that there appear to be eight. They are mostly bipinnate and rather scanty. The foot is grooved and notched in front. The tentacles are large, distinct, and somewhat flattened, with rather uncertain traces of a groove. There is no labial armature. The radula is broad and white, the formula being about $70.0.70 \times 32$. The teeth are simply hamate and all of much the same size. On some of the inner ones I was able to see eight or ten very minute denticles on the inside of the hook. This extremely fine serrulation is difficult to detect, but I expect that it is present on all the teeth except the outermost. The stomach is not free, but is enclosed in the liver. The female reproductive organs are armed with small transparent brick-like scales.

This form offers analogies to both *Homoiodoris* and *Artachaea* Bergh, particularly the latter, and the thick leathery mantle and large warts also remind one of *Asteronotus*. On the whole I class it, though very doubtfully, as *Staurodoris*, mainly because the openings of the rhinophores and branchiæ are closed by the surrounding tubercles.

4. *STAURODORIS CALVA*, sp. n.

One specimen from Kokotoni Harbour, Zanzibar; dredged in about 5 fathoms.

The living animal was of a dirty grey colour, but with very little pigment at all; the gills and rhinophores sandy, the under surface and the smooth band near the rhinophores pinkish. The dorsal surface was covered with tubercles, large and small, of various sizes, but decreasing towards the mantle-edge, where they were minute; small tubercles were set on the edge of the slightly raised gill-pocket, which was partly closed by them. The anterior portion was prolonged into a nose-like projection. Across it extended a smooth pinkish strip, which bore no tubercles. Immediately behind this strip were set the rhinophores. It is possible that this singular arrangement may have been an unnatural distortion. Some species of *Platydoris* undoubtedly remain fixed in crevices until their shape is altered. Still, the present specimen showed no trace of tubercles having been effaced on the bare patch, and there is no reason to suspect the character except that it is, as I believe, unique among the Dorididæ.

The alcoholic specimen, 2 centimetres long and 1.3 broad, is much like the living animal. The broad foot has the anterior margin entire and not grooved. The dorsal tubercles are surrounded by numerous very distinct spicules arranged in a stellate form. The tentacles are small and furrowed. There is no labial armature, and the radula consists of 48 rows of simple hamate teeth containing about 70 teeth on each side of the rhachis. The stomach is large and free. The branchiæ are five in number and bipinnate. The branchial pocket is almost closed by the valve-like tubercles on the edge of it. No reproductive armature was discovered.

This form seems referable to *Staurodoris*. Though the branchiæ of this genus are typically only pinnate, they appear to be bipinnate in both *S. pseudoverrucosa* (v. Iher.) and *S. pustulosa* (Abr.).

5. *DISCODORIS BOHOLIENSIS* B.

[S. R. xii. p. 519, xvii. p. 897.]

Two specimens from Zanzibar.

The body of the living animal was flat, with a very ample flexible mantle. A high, narrow dorsal keel extended from the branchial pocket to between the rhinophores. The ground-colour was yellowish drab, with a black edging round the wavy mantle-edge, which in places extended inwards. The whole back was covered with small papillæ, some brown, some white. The dorsal keel was blotched with brown and black. The rhinophores and branchiæ were black. The underside was dirty white, with black and brown blotches at the side of the foot. The living animal was $2\frac{1}{2}$ inches long and 2 broad. The large specimen displayed the phenomenon of self-mutilation. The rhinophore openings

were raised and crenulate, the rhinophores bent backwards. The branchial opening is a transverse slit, the two lips almost meet in the middle but separate at the sides. The branchiæ are six, tripinnate, the posterior pair bifid. The labial cuticle bears two small yellowish plates composed of minute rods. The radula formula is about $23 \times 40.0.40$. The teeth are simply hamate; the two or three outermost are rudimentary, the innermost are smaller and have rather shorter hooks as described by Bergh.

6. *DISCODORIS CÆRULESCENS VARIEGATA*, subsp. n.

[Bergh, in Semper's Reisen, xvi. Hälft i. p. 805.]

One specimen from Jembiani, Zanzibar.

The living animal was about an inch long and of a light slaty blue, with many small blackish blotches. The coloration of the underside was similar but rather lighter.

In alcohol the blue parts have become yellow, a remarkable change of tint which has also occurred in *Trippa monsovi*. The texture is leathery and stiff but not hard. The whole dorsal surface, including the rims of the rhinophore and gill-pockets which are raised, is covered with minute tubercles. The branchial pocket is roundish, with a jagged edge and very deep. Within it are six tripinnate branchiæ. The foot is grooved and the upper lip deeply cleft. Immediately above this cleft is the mouth, with a white, tapering, digitate tentacle on each side. In the upper part of the oral tube are two roughly triangular collections of minute rods, less definite in outline and consistency than the type of armature generally described as labial plates, but sufficiently large to warrant us in describing the cuticle as armed. The radula consists of 30 rows, containing about 45 white, simply hamate teeth on each side of the rhachis. The innermost and outermost are somewhat smaller, but not degraded in shape. The reproductive system is not armed. The prostate is bent and fairly large, but I was not able to discover the peculiar structure of the hermaphrodite gland mentioned by Bergh.

This animal appears to have all the chief characteristics of Bergh's *D. cærulescens*, and comes from much the same part of the world. Möbius's specimen (from Mauritius) was apparently of a uniform bluish white, whereas this one is mottled with darker blotches. Hence I describe it as a variety.

7. *PELTODORIS ANGULATA*, sp. n.

One specimen from Chuaka.

The animal has a close superficial resemblance to *Thordisa villosa*, but has six violet-brown spots symmetrically arranged in rows of three on each side of the median dorsal line between the rhinophores and branchiæ, and some round chocolate spots on the under edge of the mantle near the foot. The violet spots seem to be under the surface and visible through the dorsal skin. On a closer examination the superficial resemblances disappear:

the peculiar tubercles of *T. villosa* are absent; the general texture, though flexible, is not quite soft, but rather stiff; the back is minutely granulate but not harsh. The rhinophore pockets are raised and have jagged edges. The branchial pocket is raised with round smooth edges, turned very distinctly outwards. The branchiæ are six and tripinnate. The anterior pair are smaller than the others. The most characteristic feature of this specimen is, the foot, which has a wide thin margin all round, dilated anteriorly into tentacular expansions, similar to those found in the Aeolididæ, and 3.5 millimetres long. The front part seems to be grooved in the middle and the upper lamina to be attached to the head on each side. Admitting that it is dangerous to speak positively of such characteristics on the strength of a possibly distorted alcoholic specimen, I think it is clear that the anterior portion of the foot must be expanded in a way unique among the hitherto described species of Dorididæ. The tentacles are thin and digitate. No labial plates were discernible. The buccal mass was large for the size of the animal. The formula for the radula appeared to be about 45.0.45 × 38. The teeth are the ordinary simple hamate type; the innermost are not smaller; the 3-5 outermost are degraded but are not serrulated. The stomach is large and free, laminated internally. There seemed to be traces of an inconspicuous armature of transparent scales on the glans, but I was not able to satisfactorily make out its arrangement.

The dorsal spots in this specimen seem to resemble those described by Bergh in *P. mauritiana*, but this animal must be specifically distinct from that form.

8. PELTODORIS AUREA, sp. n.

Three specimens captured near Wasin.

The living animal is flat, with an ample mantle which extends far beyond the head and tail. The texture is not hard but also not flabby; one specimen is much stiffer than the others. The general colour is a rich light orange, due to the back being covered with little flat orange warts on a sandy ground. At regular intervals round the mantle-edge are spots of dull violet; there is also a spot just in front of the gills and one behind the rhinophores. The underside is yellowish with a few brown spots. The dimensions are 2.2 centimetres length, and 1.4 centimetres breadth. Both the rhinophore and gill-pockets are somewhat projecting, but though they rise among tubercles they cannot be described as tuberculate. The gill-pocket is large, somewhat contracted in the middle and expanded at the sides, so that the 8 tripinnate gills fall in two bundles, right and left. The foot is 1.6 centimetres long and only 3 millimetres broad; grooved and notched in front. The tentacles are small and button-like. There is no labial armature. The radula is small and fragile: it consists of twenty rows, each containing about 25 white, simply hamate teeth; the innermost and outermost are somewhat, but not conspicuously smaller. The

stomach is quite free from the hepatic mass. No armature was discernible in the reproductive organs.

I have some hesitation in classifying this specimen as *Peltodoris*, as the back is not minutely granulated but covered with small warts. The shape, however, is not that of *Archidoris*, and both the stiffness and small radula are in favour of the position here assigned to the form.

9. *THORDISA VILLOSA* (A. & H.). (Plate XXXII. figs. 1 & 2; Plate XXXIII. figs. 1-3.)

[Alder & Hancock, Trans. Zool. Soc. Lond. vol. iii. (1864) p. 119, pl. xxxiii. fig. 1; Bergh, Semper's Reisen, Heft xii. (1877) p. 540; Bergh, Danish Exped. to Siam, Opisthobranchiata, 1902, p. 182.]

One specimen was dredged in Zanzibar Harbour on a sandy bottom with a little *Zostera* (Pl. XXXII. figs. 1 & 2). The ground-colour of the living animal is a translucent yellow, like a bit of crystallised fruit. On the ample and transparent mantle-margin were blotches of peaty red and of different sizes. Smaller spots of the same colour are scattered over the whole body, particularly above the visceral mass. The under surface is uniform bright yellow with a few brown dots. The whole dorsal surface is covered with colourless transparent papillæ (Pl. XXXIII. fig. 2), some simple (especially on the mantle-edge), and some compound with two or more filaments. It is also plentifully supplied with spicules set in a stellate arrangement, but the general consistency is quite soft and not stiff. The rhinophore and branchial openings are slightly raised and tuberculate, but not stellate. The rhinophores are large and slightly bent back; the stalk is rather longer than the laminated portion. The branchiæ are six and mostly only bipinnate, though tripinnate branches also occur (Pl. XXXIII. fig. 3). They are grey with a brown rhachis. The foot is grooved in front but not notched. The tentacles are thin and digitate. There is no trace of labial armature. The radula consists of about 47 rows of simply hamate teeth, each row containing 40-50 on either side of the rhachis. They are all of the same shape and size, except the outermost five or six, which bear from seven to ten long fine hair-like denticles on each side of the much reduced central hook. No armature was discoverable in the reproductive system.

The alcoholic specimen is quite flat, and is 2.5 centimetres long by 1.6 broad, but the living animal was capable of assuming two shapes—one flat with a broad mantle-edge, and one high with a much narrower edge (Pl. XXXIII. fig. 1).

I think this animal may be safely identified with the *Doris* (*Thordisa*) *villosa* of A. & H. Bergh seems to think that this species is probably identical with his *Thordisa maculigera*, and I share this view, though the formation of the outermost teeth is not exactly like either his description or his plate, as the denticles are longer and the central hook, though much reduced, has not vanished.

10. *THORDISA STELLATA*, sp. n.

One specimen from Chuaka.

The living animal was soft, but yet distinctly harsh to the touch. The colour is a yellowish grey with small sandy patches and also dull chocolate blotches, the latter at the mantle-edge and round the visceral mass. The underside is of a greyish white, with pronounced chocolate blotches round the foot, and a much fainter ring of the same halfway to the mantle-edge.

The preserved specimen, which is much bent, is 2·8 centimetres broad, and would be at least 3·5 centimetres long if straightened out. The texture is rather leathery, but the back is covered with small soft papillæ of various sizes and colours, and all simple. The rhinophore-openings are slightly raised, closed, and apparently crenulate. The branchial pocket is slightly raised, stellate, and entirely closed by six lobes. The branchiæ are yellow, tripinnate, five or six in number according as one much smaller than the others is reckoned separately or as an appendage. The rhachis is very thick and broad. The foot is grooved and notched in front. The tentacles are close together above the mouth and somewhat flattened. No labial armature could be found. The radula consists of 36 rows, each containing about 70 hamate teeth of the ordinary type. The innermost are smaller and the outermost less distinctly formed, but neither rudimentary nor denticulate. No genital armature was discoverable.

This specimen appears referable to *Thordisa* and bears a strong resemblance to *T. villosa*, but differs in the more leathery consistency, the stellate branchial opening, and the outermost teeth of the radula.

11. *THORDISA CROSSLANDI*, sp. n. (Plate XXXII. fig. 3 & Plate XXXIII. figs. 4-8.)

Many specimens of this form were captured at Chuaka, on the East Coast of Zanzibar, in 1901-02.

The animals are large, the measurements of a fine alcoholic specimen being, length 12·5 centimetres, breadth 9·1, height 2·5. The shape is therefore flat and oval. The coloration is in its general effect inconspicuous. The upper surface is sandy with blotches of brown irregularly bordered with black. The under surface (Pl. XXXIII. fig. 3) is whitish with numerous brownish spots and a brownish border. But when the upper surface is carefully examined it presents a great variety of shades of light and dark brown which cannot be easily described or depicted. The back is covered with thick-set pointed papillæ, some of which are developed into distinct filaments at their extremities. The general texture is soft. The openings for the rhinophores and branchiæ are slightly raised, and may be described as tuberculate since they open among tubercles, but they do not appear to be provided with special tubercles. The branchial pocket is an irregular oval and not stellate or crenulate. The branchiæ (Pl. XXXIII. fig. 5) are six in number and tripinnate. The

rhinophores are bent backwards. The foot is fairly broad: it is grooved anteriorly, and the upper lamina is notched and developed into fairly ample flaps on each side of the division. The oral tentacles are digitate, and white with yellow ends. On the white labial cuticle are two small yellow patches, measuring 1 millimetre in length in the largest specimens. They are composed of an irregular collection of rods, similar to those which form the labial armature of the Discodorids, but can hardly be described as plates since the outline is ill-defined and the texture loose. The radula consists of about 45-55 rows, containing about 80 teeth, on each side of the naked rhachis, over which the innermost teeth close so as to render it invisible. The teeth (Pl. XXXIII. fig. 4, *a* & *b*) are of the ordinary hamate shape and all alike, except that the innermost are distinctly smaller. At the outer end of some, but not all the rows, is found a small degraded tooth. The stomach is free from the hepatic mass, and the lower part is somewhat muscular and laminated internally. The genitalia are remarkable for the structure of the glans (Pl. XXXIII. figs. 6 & 7), which is long, twisted spirally, and provided with two rows of tubercles. The central nervous system (Pl. XXXIII. fig. 8) is much concentrated, as in *Asteronotus*, and the different ganglia cannot be distinguished.

All my specimens were found adhering to the underside of stones in a manner suggestive of sedentary habits. The animal is able, however, to swim well upon occasion with a motion somewhat resembling that of a sole. It has also some power of self-mutilation, and can cast off portions of the mantle, though it does so less readily than some allied forms. The branchiæ are very sensitive, and retract if the shadow of a hand is allowed to fall on them. The dorsal papillæ are kept in constant motion.

It is extremely difficult to determine the true affinities of this species. It has the general form and soft pointed papillæ of *Thordisa*, and to that genus I think it had better on the whole be referred. But it has also a rudimentary labial armature, a concentrated nervous system, and a peculiar conformation of the genitalia. In this last point it offers some, but not complete, analogies to *Phialodoris*, in which, however, the back is minutely granulated and not covered with papillæ.

12. TRIPPA AREOLATA (A. & H.).

[A. & H., "Notes on a Collection of Nud. Moll. made in India," Tr. Z. S. iii. 1864, p. 119.]

Two specimens, one from Mombasa, the other from Wasin.

Alder and Hancock's figure gives a good idea of the living animal, but hardly emphasises sufficiently its extraordinary resemblance to a piece of old worm-eaten sponge. Though conspicuous enough when placed by itself in a basin, it is invisible in its natural haunts, among sponges and seaweeds. Both my specimens were detected by touch only, not by sight, and I suspect that the creature is really common.

The living animal was spongy and almost gelatinous in texture. The alcoholic specimens though flabby have become considerably shrunk and hardened. The larger one (to which all the measurements given below refer) is 5·7 centimetres in length, 3·8 in breadth, and 2·3 in height. Down the centre of the back runs a somewhat indistinct ridge, on each side of which is a row of five pits, with black bottoms. There is one similar pit behind the branchial pocket. In the smaller specimen the distribution of the pits is different, and it would appear that no particular arrangement can be regarded as characteristic of the species. In this specimen also the dorsal ridge and a knotty crest between the rhinophores are much more distinct than in the larger one, bearing out Alder and Hancock's remark that these features are most conspicuous in the young individuals. In both specimens the back is covered with irregular tuberculate warts or prominences. The rhinophores project out of tubes which are about 5 millimetres high and thickly studded with tubercles, about five being set round the edge. The branchial pocket projects about 6 millimetres and opens backwards. In the larger specimen it is distinctly bilabiate. The upper lip is thickly tuberculate in its whole extent and bears three compound tubercles on its edge which close like a valve; the lower lip has no tubercles on the edge and is altogether smoother than the other. In the smaller specimen the pocket opens backwards, but is round and not two-lipped. It is probable that the tubercles increase in number and size as the animal grows older. The branchiæ are large and strong, tripinnate, and apparently five in number, but so deeply bifid that it would hardly be wrong to call them ten. In both specimens the foot is deeply grooved and notched in front and the upper lamina united to the head below the mouth, an arrangement which differs from that seen in *Sphærodoris (lævis)*, where the mouth seems to be between the two laminae.

The labial cuticle is very strong and much puckered, but no armature was discernible. Round the buccal mass, at the posterior end of the oral tube, are set a number of glands, of which I found ten in one specimen and eight in the other. They are mostly three-fingered in shape. The radula consists of only 23 rows, each containing about 40 teeth on either side of the naked rhachis, but looks large and broad on account of the unusual size of the teeth, which are simply hamate with yellowish bases and colourless hooks. The innermost teeth are very small, but gradually increase in size up to the 15th, after which they are equal. The two or three outermost are reduced. The stomach is small but free. No armature was discernible in the reproductive organs.

I think these specimens are clearly the *Doris areolata* of A. & H., and equally clearly referable to the genus *Trippa*, Bgh. Probably *Doris spongiosa* Kelaart (Ann. Mag. Nat. Hist. (3) iii. 1859, p. 303) is the same species. *Trippa (Phlegmodoris) mephitica* Bgh. is a closely allied form, and I should not be surprised if it even turned out to be a variety of, or identical with,

this species, for these animals evidently undergo great changes, both of shape and colour, in alcohol.

13. *TRIPPA MONSONI*, sp. n. (Plate XXXII. fig. 4.)

One specimen dredged at Chuaka on the East Coast of Zanzibar.

I made the following description of the living animal:—About one inch long and lively in its movements. The mantle ample, covering both foot and head completely. The foot narrow, grooved in front and slightly notched on the upper lip. The tentacles on each side of the mouth white and conical. The whole body is of a soft, spongy texture. The back is covered with small purplish-white prominent reticulations and also bears white tubercles, particularly on the edges of the mantle, branchial and rhinophore pockets. Both the tubercles and reticulations bear small papillæ or bristles. Between the reticulations are small purple pits and, as a result, the general colour seems purple. Besides these, there are four large pits, set symmetrically in a square in the centre of the back. They are brownish at the sides and deep purple at the bottom. There are five other similar but rather smaller pits, three in front of the rhinophores, one behind the gills, and one placed quite symmetrically at the side of the upper right-hand large pit. A white line runs round the edge of the mantle. The rhinophores are yellow and finely perfoliate. The gills are usually exposed, though they are completely retractile into a rather small pocket. They are six in number, yellowish and tripinnate. The under surface of the animal is purplish white; there are no spots on the foot, but two rows of purplish blotches on the underside of the mantle.

The alcoholic specimen is 1.1 centimetre long and .5 broad. It is very spongy, like the living animal, but the colour has changed to a uniform light yellow. Only the four central pits remain distinct, the others having disappeared. There is no labial armature. The radula consists of 28 rows of hamate teeth, bearing three very small triangular denticles on the side of the hook. The innermost teeth are small and less distinctly formed than the others; the three or four outermost are rudimentary, and sometimes bifid or trifid. There is no genital armature.

I think this form may be referred to *Trippa*: the spongy texture, the pits, and the small internal teeth all seem characteristic. In making the dissection, I unfortunately omitted to search for the ptyaline glands, and am now unable to say whether they are present or not.

14. *FRACASSA TUBERCULOSA*, sp. n.

One specimen from the East Coast of Zanzibar on the reef.

The living animal was of a dirty-white colour with dull green patches on the centre and edges of the back; the whole upper surface was sprinkled with small bright blue dots with chocolate borders; also there were several dull yellow spots. The under surface was white with an irregular and indefinite network of dull green. The junction of the foot with the under surface of the mantle

was marked by a thick line of chocolate with numerous small bright blue blotches. The dorsal surface was arched and covered with large irregularly shaped tubercles bearing secondary knobs.

The alcoholic specimen is of a uniform greyish white. It is 4.7 centimetres long, 2.9 broad, and 1.9 high. The margins of the rhinophore-pockets are raised and smooth. The branchial pocket is not much raised and in itself forms a fairly regular circle, which is, however, somewhat distorted by the surrounding tubercles. The margin, however, is not tuberculate as *e.g.* in *Staurodoris*. The branchiae are eight and tripinnate, the anterior pair being much larger than the others. The anal papilla is large. The spots at the junction of the foot and mantle appear to be glandular. The foot is grooved and notched in front. On each side of the mouth are two small conical tentacles. There is a labial armature of two small yellowish plates composed of minute rods. The short but very broad radula consists of only 28 rows, containing about 65 yellowish teeth on each side of the rhachis. The teeth are hamate; the innermost fold over the rhachis: there is an accessory denticle in the four or five outermost, and the outermost of all are smaller and rudely formed. The reproductive system is unarmed; there are ample folds surrounding the orifices and a prostate is present.

15. HALGERDA WILLEI, sp. n. (Plate XXXII. fig. 5.)

One specimen captured by Dr. A. Willey, at Lifu, Loyalty Islands, and kindly given by him to me, seems referable to this genus. It was accompanied by a drawing (*vide* Pl. XXXII. fig. 5) and this note:—"Lifu, Sandal B., 3.10.96. Reddish yellow (rich ochreous) ribbed Doris. The ribs are ochreous and intervening valleys have black linear pigment. Tentacles (*i.e.* rhinophores) white tipped with black girdle. The rest of ground-colour is dull greyish black. Cloacal rim a dirty white. Foot orange, produced behind. On passing the hand over branchiae so as to produce a shadow they were retracted." I have captured an Ophiuroid at Zanzibar, the coloration of which exactly resembled Dr. Willey's drawing, so that it is possible that this remarkable pattern may be cryptic in certain surroundings.

The preserved animal is considerably shorter and broader than the drawing. The length is 3.1 centimetres and the breadth 1.8. The general shape is flat; the foot long and narrow (2.3 centimetres long by .5 broad), grooved but not cleft in front. The mantle-margin is thin but ample, though a large piece has apparently been bitten out behind. The general consistency is tough and leathery, but there is no rough feeling as in *Platydoris*. Though smooth to the touch, the back is covered with a series of low ridges and valleys arranged in an elaborate pattern, which will be best understood from the figure (Pl. XXXII. fig. 5). It starts partly from the mantle-edge and partly from the median dorsal line, by which it is divided into two parts, though there is no raised crest. On the dorsal surface the ridges are yellowish brown and the valleys black. On the lower surface the coloration is much the same, there being

numerous black lines instead of valleys. The tentacles are knob-like but large and distinct. The rhinophore-openings are quite smooth, whitish yellow, and fairly large; they are flattened, but look as if they had once projected. The branchial pocket is fairly large, quite smooth, and whitish yellow. The rim is thin but projects amply. The direction of the opening is posterior, not vertical. The branchiæ (as shown in the figure) consist really of two plumes arising one on each side of the anal papilla, but each is split into three subdivisions, so that there appear to be six. They are scanty and irregular; mostly bipinnate, but partly tri-pinnate. The buccal parts are protruded and are yellowish white with black spots. There is no trace of labial armature. The radula consists of whitish and simply hamate teeth; the outermost are not denticulate or degraded; the innermost are smaller and more crowded than the others. On the left side under the mantle is a curious gland-like projection, which is perhaps merely a blister caused by alcohol. On the right side in the usual place is a large yellow lump with black spots on which are placed the genital orifices; they are surrounded by strong folds, but no armature was discoverable in the organs themselves.

I propose to call this species *Halgerda willeyi*.

16. HALGERDA WASINENSIS*, sp. n. (Plate XXXIV. figs. 1 & 2.)

Three specimens captured by Mr. Crossland at Wasin Island, East Africa.

They differ from *H. formosa* and *H. willeyi* in having not only a pattern formed of ridges on the back, but also distinct knobs at the points where the lines of this pattern join one another.

In the living animal (Pl. XXXIV. fig. 1) the mantle-edge was white, but the ground-colour was a dull red-brown; numerous brown spots of a deeper colour were arranged round the mantle-edge and a few scattered over the central dorsal area. Over the whole dorsal surface was a raised pattern in brilliant orange. The white foot was also spotted with deep reddish brown. This colour also appeared on the rhinophores in broad bands alternating with white, and in broad lines on the rhachis of the white gills. The foot projected behind the mantle in crawling.

The largest alcoholic specimen is 1.9 centimetres long, 1.2 broad, and .7 high; the contracted foot is 1.4 long and .4 broad. Traces of the original colour remain, but the yellow has mostly disappeared. The raised network starts from a central ridge and is developed in a pattern composed of roughly triangular spaces. The foot is 1.2 centimetres long and only 3 millimetres broad; the tail is 5 millimetres long. The anterior margin of the foot is grooved and the upper lip notched. No oral tentacles are visible, but in all the specimens the head is so contracted that it would be unsafe to say none exist in life. The rhinophore-openings are set in a tubercle and are very difficult to see. The rhinophores are long, but only a small part is lamellate. The branchial pocket is quite

* This name is wrongly spelt "*wassinensis*" on Plate.

round, very small, with a thick white rim round it, so that in the preserved specimen it resembles a dorsal tubercle. The bipinnate branchiæ are somewhat scanty and irregular; they are arranged as in the diagram (Pl. XXXIV. fig. 2), the three posterior plumes being quite small. There is no labial armature. The radula consists in one specimen of 18 and in another of 24 rows; in both specimens the longest rows contain 26 teeth on each side; the rows bend downwards near the rhachis, the ten or twelve innermost teeth being smaller and more crowded than the others. All are simply hamate except the outermost. These are rudimentary; sometimes they bear three or four long denticles and sometimes seem to be split up into small separate rods. There is no trace of any armature in the genital apparatus; the organs are small and possibly even the largest specimen is immature.

This form presents resemblances to *Staurodoris*, some species of which have bipinnate branchiæ, but the dorsal tubercles are few, and none are present round the pockets of the branchiæ or rhinophores, both of which openings are differently formed from those of *Staurodoris*.

17. *KENTRODORIS RUBESCENS* B. (Plate XXXIV. fig. 7.)

[Bergh, S. R. x. p. 411.]

Several specimens were obtained at Chuaka in August 1901. The distribution was apparently very local and the species was found only on this one occasion. The alcoholic specimens have unfortunately been lost, but I give a figure drawn from the living animal and the following notes:—

The animal was large (about 17 cm. long and 5 broad), soft and almost gelatinous. Its most remarkable feature was the great size and elevation of the seven quadripinnate gills, which were retractile into a large cup. Their tips were as much as 8 centimetres above the level of the back. The mantle projected anteriorly and formed an ample loose hood over the head. The ground-colour was a light pinkish drab with dull yellow spots and brown blotches dorsally. There were also a number of thin chocolate lines running more or less longitudinally but often branching laterally. The under surface was of a light drab-brown, with similar chocolate lines on the foot. The dark colour of the gills was due to a multitude of such lines.

The animals were infested by a number of yellow parasitic Copepoda.

I think this animal is Bergh's *Kentrodoris rubescens*, though, as the specimens are unfortunately lost, it is hard to be quite sure. The huge erect gills are even a more prominent feature here than in Semper's figure (*loc. cit.* pl. xxxiii. fig. 8).

18. *PLATYDORIS EURYCHLAMYS* B.

[Bergh, S. R. xii. p. 510, Suppl.-Heft i. p. 61, xvi. p. 802.]

Two specimens from Chuaka.

According to notes made from the living animal, the texture was hard and rough. The larger specimen was 8 centimetres long

and 4.5 broad. The dorsal surface was covered with reddish-brown granulations, each surrounded by a grey or white ring, and there were also in one specimen eight chocolate-coloured blotches with white edges, four around the rhinophores and four in front of the branchial pocket. The rhinophores were dark brown, the gills grey, with a thin white line down each pinna. In the smaller specimen (which appeared to be indubitably the same species) there were no blotches and the gills were drab-coloured. The blotches have also vanished from the alcoholic specimen, which is of a dull reddish brown, darker in places owing to aggregations of minute black spots. The under surface is of a uniform reddish brown. The texture is hard and rough, as usual in the genus. The visceral mass is 3.2 centimetres high and arched, but the mantle-margin is low and flat. This margin is exceedingly ample, measuring as much as 2.6 centimetres at the sides, 2.2 behind the tail, and 1.7 before the head, although the dimensions of the whole alcoholic specimen are only 6.9 by 6.1. The small foot is grooved and notched in front but not very deeply. The rhinophore-pocket is slightly raised and crenulate. The branchial pocket is entirely closed by six lobes. The anterior and posterior lobes are broad flaps, and considerably larger than those at the side, which are narrow and pointed. The gills are six, tripinnate, not very large or very sensitive. There is no labial armature. The radula was injured, but was clearly large and composed of closely-packed simply hamate teeth. Perhaps the formula may have been about $50 \times 100.0.100$. The innermost teeth are smaller than the rest; the outermost irregular in shape. The stomach is large and free, thin, and only partly laminated. The large double blood-gland is partly anterior and partly posterior to the central nervous system. There is a genital armature of discs and hooks as described by Bergh.

19. *PLATYDORIS SCABRA* (Cuv.).

Three specimens from Wasin.

The alcoholic specimens have preserved the hue of the living animal unusually well. The ground-colour is yellowish white, with irregular violet mottlings of varying intensity formed mostly by minute rings of the same colour with yellowish-white centres or by spots. The underside is a clear yellowish white, with no markings except at the sides of the foot which are mottled like the back. The branchiæ are light yellow with grey axes; the rhinophores, buccal mass, and viscera all light yellow, and there is a thin rim of the same colour round the pockets of the rhinophores and branchiæ.

The largest specimen is 9 centimetres long, 5.2 broad, and 2.2 high. The visceral mass is somewhat arched and the wide mantle-margin undulated. It is 1.9 centimetres broad at the sides, 1.5 in front of the head, and 1.2 behind the tail. The foot is small and narrow; it is grooved and notched in front but not very deeply, and the upper lip is thick. The branchial pocket has six lobes, as in *Platydoris eurychlamys*, the anterior and posterior lobes being

larger than the others. The branchiæ are six, tripinnate, very ample and delicate. The tufts at the side of the posterior pair are almost separate, so that the whole number might be reckoned as eight. The rhinophore-pockets are closed by indistinct crenulations. The oral tentacles are of a fair size, white and conical. There is no trace of labial armature. The radula formula is about $48 \times 60.0.60$. The teeth are simply hamate, the innermost smaller, the two or three outermost irregular. The penis is armed with the hamiferous disks characteristic of the genus apparently set in four rows, and the vagina provided with strong folds.

The animal, both when alive and when preserved, is exceedingly hard and rough. It is very sluggish, and I have always found it fitted into crevices on the underside of stones, as if it had not moved for a long period.

20. *PLATYDORIS FORMOSA*? (A. & H.), var.

[Alder & Hancock, "Notes on a Coll. of Nudibr. Moll. made in India," Tr. Z. S. iii. 1864, p. 116.]

One specimen from Chuaka.

The notes on the living animal describe it as bright scarlet, shaded in places by minute brown specks, very flat, and rough to the touch all over. The end of the mantle had been thrown off, probably by self-mutilation, so that the body terminated abruptly behind the gill-pocket.

The alcoholic specimen is much bent, but if straightened out would be about 5 centimetres long; the maximum total breadth is 4 and the maximum width of the mantle-margin 1.4. The somewhat projecting rhinophore-pockets have slightly crenulate edges, as has also the branchial pocket, which is nearly round. The branchiæ are six, tripinnate, and rather small. The foot is somewhat broader than usual in the genus, grooved and notched in front. The oral tentacles are large and slightly grooved on the outer side. The buccal mass is very large and muscular. There is no labial armature but a large dark radula, consisting of simply hamate teeth, the innermost smaller, the outermost irregular in shape. The formula is about $60.0.60 \times 40$. The genital organs are very strong and muscular, the male branch set with numerous yellow hooks of the shape usual in the genus: the female branch with strong folds and lumps.

I think this specimen may be referred to *Pl. formosa*, or at least that there is not sufficient ground for creating a new species. It is certainly not *Pl. arrogans* (*cruenta*), which has scarlet blotches but a pattern formed by minute dark lines, not spots. Allowing for the variations so common in this genus, the coloration corresponds fairly well with Alder and Hancock's description, and the grooved tentacles are a remarkable point in common. The chief discrepancy is that the branchial pocket is not distinctly lobed or stellate, as in the typical *Pl. formosa*; but I have noticed in many species of *Platydoris* that though on an average this character may be very well marked, it may be indistinct in some individuals.

21. *PLATYDORIS ELLIOTI* (?) (A. & H.).

[Alder & Hancock, "Notes on a Coll. of Nud. Moll. made in India," Tr. Z. S. iii. 1864, p. 116.]

One specimen from Wasin, dredged in 10 fathoms.

The notes on the living animal describe the dorsal surface as being on the whole of a reddish brown, very beautifully mottled with various shades of sandy colour, the visceral mass being darker than the rest. The under surface was white: just outside the edge of the foot was a row of dark brown spots, and nearer the mantle-edge a bright orange border formed of spots set near together.

The alcoholic specimen measures 6.4 centimetres in length, 4.4 in breadth, and 2.4 in height. Like *Pl. scabra*, it is hard and rough. The colour is a mottled pattern of white, a sandy tint, and reddish brown. Beneath, the sides of the foot and the adjacent parts of the broad mantle, which is 2.2 centimetres wide, are thickly spotted with chocolate marks arranged so as to give the impression of a continuous band. Seventeen chocolate spots are irregularly arranged round the foot on a yellowish ground; then comes a fainter band also composed of chocolate spots; then a yellowish border extending to the mantle-edge. The foot is long and narrow, grooved and notched in front but not deeply. The rhinophore-pockets are closed by six projections. The branchial opening is also six-lobed, the anterior and posterior lobes being larger than the others, as in *Pl. eurychlamys* and *scabra*. The branchiae are six, tripinnate, not very large. The oral tentacles are much retracted, white and conical. The buccal mass is large and muscular, the labial cuticle very strong but unarmed. The radula about $40 \times 70.0.70$; the teeth yellowish, simply hamate, the outermost smaller but not much degraded. The stomach is large and free, strongly laminated in parts; it appeared to contain sand, as well as alimentary matter. The penis is armed with two rows of hook-bearing scales of the usual type, but set very close together, each fitting into the next; the vagina with lumps but no scales.

I feel somewhat doubtful whether this animal should be called *Pl. ellioti*. Neither my specimen nor those described by A. & H. present any very definitely distinguishing characters. But, on the other hand, there is no feature of importance which militates against the identification, and the colours (which A. & H. record as varying) are sufficiently alike.

22. *PLATYDORIS PULCRA*, sp. n.

Two specimens from the neighbourhood of Wasin, dredged in 10 fathoms.

The living animal was of a beautiful orange-red, covered closely with minute lighter spots. Round the mantle was a border of dull white containing purplish-black spots and small specks in one specimen, and in the other dull violet spots. The under surface is described in the notes on living specimens as of uniform lighter orange, but in the alcoholic specimens there is a rim of faint

mottlings round the foot. The rhinophores were dark brown with white lamellæ; the branchiæ sandy-coloured. The animals were very stiff and harsh to the touch.

The larger alcoholic specimen is 3·8 centimetres long, and broader behind than in front, the maximum breadth being 2·2. The whole dorsal surface is covered with extremely minute granulations, which can only be seen under a strong lens. The rhinophore-pockets are very slightly raised and crenulate. The branchial pocket is stellate, with six not very distinct lobes; the branchiæ are six, tripinnate, small and deeply retracted. The anterior end of the foot grooved and notched as usual; the oral tentacles distinct, white and conical. The labial cuticle is strengthened by some minute rods, but they are not combined into a plate or rim. The radula consists of 36 rows, containing about 50 teeth on each side of the rhachis. The innermost and outermost teeth are smaller, the two or three outermost degraded but not denticulate. The male branch of the reproductive organs is armed with colourless scales, bearing erect spines, not hooks. The female branch has strong folds.

23. *PLATYDORIS INCERTA*, sp. n.

Seven specimens, found on brown sponges at low tide, Prison Island, Zanzibar.

The largest of the living animals was about an inch and a half long. They were all very flat in shape, sluggish, strongly adherent, and, though smooth, of the stiff coarse texture characteristic of the genus. The coloration rendered the animal invisible on the sponge, but was somewhat variable. As a rule it was yellowish brown, but one specimen was tinged with red and another with green. On the dorsal surface were collections of minute sandy dots, which in some specimens formed a line down the middle of the back. The underside was lighter in colour and without markings. The rhinophores were tipped with white, the gills brown or sandy.

The alcoholic specimens are all of a uniform dirty yellow. The measurements of the largest are: length 1·6 centimetres, breadth 0·9, height 0·4; the foot is 1·5 long and 0·7 broad. The rhinophore-pockets are crenulate, in some specimens slightly raised, in others closed and almost flat. The rhinophores have an unusually long stalk bearing a thick bunch of perfoliations, out of which rises a narrow bare tip slightly bent backwards. The gill-pocket is rather indistinctly stellate, with about six lobes, and contains six somewhat small bipinnate branchiæ. The foot is grooved in front and the upper lamina notched. The tentacles are narrow and digitate. There is no trace of labial armature. The radula formula is about $35.0.35 \times 60$. The teeth are white and simply hamate, of a rather thick and clumsy shape; the innermost are smaller but formed like the rest, the two or three outermost are degraded. The reproductive organs appear to be immature, but both the penis and vagina are armed with transparent, colourless, brick-like scales, apparently arranged in four

rows, each containing about ten scales. The central nervous system is as usual, with very large and distinct eyes.

The idea that the specimens are immature is supported by the size, which is small for the genus, and perhaps by the fact that a good many were found together. They are possibly the young of some already described form, and offer certain analogies with *Pl. vicina*, in which, however, only the male reproductive organs appear to be armed with scales (Bergh, Semper's Reisen, Suppl.-Heft i. 1880, p. 63).

24. *PLATYDORIS PAPILLATA*, sp. n.

Nine specimens from Chuaka.

The living animals were of varying but somewhat sombre coloration, ranging from dark peaty brown to yellowish brown, in all cases blotched with grey or black markings, greatly varying in extent and pattern. The under side of the ample mantle had a whitish border, then a yellowish area covered with minute brown dots, and, lastly, chocolate-brown blotches near the foot, sometimes few and separate, sometimes united in a band. The foot was greyish. The gill-pocket closed as in *Asteronotus*. The dorsal surface was covered with numerous small simple papillæ, and also bore some much larger-branched papillæ, which may have been as much as half a centimetre long. In the living animal they looked exactly like bits of sand. Their number varied greatly in different specimens: in some they were numerous, in others there were only a few near the mantle-edge. The largest living specimen was 11 cm. long and 7 broad.

The measurements in alcohol are: length 8.1 cm., breadth 5.1, height 2.8. The mantle-brim very thick and 1.6 wide. The texture of all the specimens, particularly on the mantle-brim, is very distinctly leathery, but not hard or rough. One specimen, with an almost smooth back, presents the appearance of *Asteronotus*, but is clearly distinguished by the presence of a few branched papillæ. Also, in all specimens the back is granulate, and not smooth as in *Asteronotus*. The rhinophore-openings are slightly raised and indistinctly crenulate. The branchial pocket can be closed by six lobes which meet over it; they are not all of the same size, and vary in different specimens. The branchiæ are six, tripinnate, and large. The foot is fairly broad and rather amply developed in front, where it has the usual notch and groove. It is, perhaps, as a consequence of this development that the oral tentacles, being pressed between the foot and head, appear flattened in most of the alcoholic specimens, and in some expanded into lobes as in *Hexabranchus*. There is no trace of labial armature. The radula is broad, and consists of from 30 to 40 rows, containing from 60 to 70 teeth on each side of the rhachis. The teeth are long and simply hamate, the two or three innermost are somewhat degraded; the two innermost are not parallel to the rest of the row, but are set almost at right angles to it and project into the large bare rhachis (a somewhat similar though less-marked arrangement may be seen in Bergh's figure

of the radula of *Asteronotus bertrana* S. R. plate lxxviii. fig. 9). The male reproductive organs are armed with two rows of hook-bearing disks, each disk set at some distance from the next one. There appears to be an accessory gland on the female branch like the glandula amatoria of *Asteronotus*, but no hasta was discoverable. The central nervous system is much concentrated; above it anteriorly and posteriorly lie the two very distinct divisions of the blood-gland.

This species seems in many ways intermediate between *Platydoris* and *Asteronotus*. But as it has the characteristic genital armature of the former, and as one of the principal characters of the latter is that the back is quite smooth and neither granulate nor papillous, I have thought it better to refer my specimens to *Platydoris*.

The chief specific character is no doubt the branched dorsal papillæ. I think it probable that this animal is identical with the *Doris sordida* of Quoy & Gaimard from Mauritius, but as neither their description* nor their plate shows the branched papillæ, identification is impossible.

25. SCLERODORIS OSSEOSA (Kelaart).

[See Kelaart, "On new Species of Ceylonese Mollusca," in *Annals & Mag. of Nat. Hist.* vol. iii. 3rd ser. p. 298, 1859; and Alder & Hancock, "Notes on a Collection of Nudibranchiate Mollusca made in India," *Tr. Z. S.* iii. 1864, p. 121.]

Three specimens from the neighbourhood of Wasin. The notes on the living animals are unfortunately not forthcoming.

The alcoholic specimens vary in colour from pale yellow to greyish brown. They are hard and rough to the touch like *Platydoris*. The largest is 3·8 centimetres long, 2·2 broad, and 1·2 high. In all the specimens there is an indistinct dorsal ridge, and the back is irregularly reticulate and honeycombed; but while these markings extend over the entire upper surface in two specimens, they are confined to patches in the third. In all three there is one pit, larger and more conspicuous than the others, and surrounded by a protuberance in front of the gills. The mantle-brim is wide, and extends about 5 mm. beyond the head and tail. The rhinophore-openings are somewhat raised and closed by valve-like crenulations. The rhinophores are conical and not much bent back; the perfoliations cease before the tip. The branchial pocket lies at the end of the dorsal ridge and has raised edges; it is directed somewhat backwards and is crenulate. The branchiæ are six or seven, with the stem very large compared with the scanty perfoliations, which are bi- and sometimes tripinnate. The long and narrow foot is grooved and notched anteriorly. The tentacles are small, white, and conical. There is a strong bluish labial cuticle without any armature. The radula consists of about 40 rows, containing about 45 simply hamate teeth on

* Unless this feature is meant to be included under the observation "Cette espèce a un peu la forme d'une Onchidie."

either side of the rhachis; the innermost are smaller, the two or three outermost degraded and sometimes bifid. The vestibulum genitale, like the rest of the body, is full of rod-shaped spicules, but no armature could be discovered in the ducts.

I think this is undoubtedly the animal described by Kelaart (*l. c.* p. 298) and said to resemble a piece of bone or worm-eaten white stone. It is also not unlike Alder and Hancock's plate (*l. c.* xxviii. figs. 9 & 10). But their description does not entirely correspond with my specimens, particularly in speaking of the branchial pocket as "a cup, the margin of which is scalloped and produced into a large lobe in front." Kelaart, on the other hand, says there are four or five branchial plumes which emerge horizontally from under the posterior termination of the dorsal ridge, which is correct. The branchiæ seem to be somewhat variable in number, and, as is often the case with Dorids, admit of being counted in more than one way.

26. *SCLERODORIS TUBERCULATA*, sp. n.

One specimen from Prison Island, Zanzibar Harbour.

The following notes were made on the living animal:—"Dark brown with sandy spots, exactly like a sponge splashed with sand. Underside clear bright brownish red. Branchial pocket crenulate. The middle part of back covered with conical warts, which form an irregular keel; smaller warts on mantle-edge. Rhinophores red; branchiæ eight, voluminous; axes red, tips white. Animal alters shape, sometimes rather high, sometimes quite flat like *Platydoris*. Consistency quite hard and rather rough. Two depressions with deep black markings as in some species of *Trippa*." The alcoholic specimen bears a strong general resemblance to *Trippa areolata*, but is stiff and spiculose like *Platydoris*, and has nothing of the flabby gelatinous feeling which characterises *T. areolata*. The back is covered with irregular tubercles, simple and compound, of all shapes and sizes, all granulate and sometimes connected by ridges so as to form a reticulation. There is an indistinct median ridge and two large pits with black bottoms, one in front of the branchial pocket and one about half-way up on the right-hand side. The general colour is greenish grey. The length is 6.5 centimetres, the breadth 4.2, and the height 2.2. The oral tentacles are distinct, digitate, and white. The foot is grooved and notched in front, the upper lamina being attached to the head below the mouth. The labial cuticle is strong and puckered, but no armature was discovered nor any ptyaline glands as in *Trippa areolata*. The radula consists of 40 rows, containing about 50 teeth on each side of the rhachis. These teeth are white and simply hamate; the innermost are smaller than the rest, the two or three outermost degraded and often bifid. The stomach is free and laminated internally. No genital armature was discernible.

The rhinophore-pockets are raised and provided with nine valve-like tubercles, of which two are much larger than the others. The rhinophores are short and thick, with about 50 perfoliations. The branchial pocket is entirely closed by ten valve-like tubercles,

some of which are grooved outside and thus appear double. The branchiæ are eight in number, tripinnate, and very much retracted. The rhachis is very stout and strong.

27. *SCLERODORIS MINOR*, sp. n.

One specimen from Chuaka.

The living animal is described as superficially resembling *Platydoris papillata*, differing only in that the dorsal surface is covered with ridges which form a raised reticulate pattern. The colour was a uniform greyish brown, with a few patches resembling adherent sand. The underside of the mantle was warm grey with minute brown spots, the foot dirty orange. The gill-pocket did not close completely when the branchiæ were retracted.

The alcoholic specimen is 2·7 centimetres long, 1·6 broad, and 1·1 high. The texture is rough and leathery, with the peculiar feeling common in *Platydoris*. All the dorsal surface, including the reticulations, is covered with minute tubercles. There is a rather indistinct median keel, from each side of which extends a somewhat irregular reticulate pattern. The rhinophore-openings are slightly raised and very slightly crenulate. The branchial pocket is also slightly raised, of irregular shape, but not crenulate, ridged vertically, and nearly but not quite closed. The branchiæ are eight, the two posterior shorter than the rest; the others are tall, thin, and sparse, so that in the alcoholic specimen they appear simply pinnate, though they are really bi- and sometimes tripinnate. The foot is rather broad; the front notched and the upper lamina apparently attached to the head, at the side of which are the conical oral tentacles. The snout is protruded. There are scattered minute rods in the labial cuticle, but they are not combined into plates. The radula consists of 33 rows of yellow, regular hamate teeth, which do not diminish much in size, either at the rhachis or at the end of the rows: there are about 45 on the complete rows on each side of the rhachis. No genital armature was discernible.

This specimen bears a strong general resemblance to *Sclerodoris tuberculata*, and may perhaps be a young individual of the same species. The radula is, however, not quite the same, there are no pits on the back, and the reticulate pattern is more distinct than in the larger animal. It is possible that as the animal becomes older the tubercles and pits may develop at the expense of the pattern.

28. *SCLERODORIS RUBRA*, sp. n.

One specimen from the reef off the East Coast of Zanzibar.

The living animal bears a most remarkable resemblance to a vermilion sponge which is common at Zanzibar. It was not, however, found on the sponge, but alone among *Zostera* near the shore, and not in any way concealed. It was picked up under the impression that it was a species of sponge. The colour was red, with some very natural-looking sandy patches. The texture was

firm and fleshy, with something of the rough feeling characteristic of *Platydoris*.

The alcoholic specimen is dirty white in colour with greyish blotches. The measurements are: length 5.5 centimetres, breadth 2.7, height 2.6. It will therefore be seen that the shape is very distinctly arched. In the middle of the minutely granulated back is an indistinct keel from which extends on either side a low fleshy reticulation. Independent of this reticulation, and sometimes concealing it, are a number of excrescences which, even in the alcoholic specimen, present the most extraordinary resemblance to the miscellaneous growths and accretions found on old shells and sponges. Some are as much as 4 millimetres high. I endeavoured to pull them off, being sure they could not be part of the mantle. They are so, however, and afford an even more remarkable case of mimicry than *Trippa areolata*. The edges of the rhinophore- and gill-pockets are crenulate, but not raised. The eight tripinnate branchiæ are deeply retracted into the bottom of the pocket. The anal papilla is large and has a cleft down the posterior side which appears natural. In the alcoholic specimen the foot is narrow with the edges turned inwards, but it was probably fairly broad in life: it bears a shallow groove in front, the upper lip of which is notched. The tentacles are very small and digitate. The blood-gland is large, reddish, and double: the central nervous system in a reddish capsule and much concentrated. There is no labial armature. The radula, which is large and wide, consists of 42 rows, containing about 55 large blunt hamate teeth on each side of the rhachis: the innermost are smaller than the others, and one or two of the outermost are also smaller and distinctly bifid. The reproductive system is unarmed.

29. *SCLERODORIS CORIACEA*, sp. n. (Plate XXXIV. figs. 3 & 4.)

One specimen from a cave near Chuaka on the East Coast of Zanzibar.

The living animal was yellowish brown in colour above and light orange underneath. The preserved specimen is 2.4 centimetres long, 1.7 broad, and .8 high in the middle of the back, the sides of the mantle being very low. The foot is large, being 1.9 centimetres long and 1.1 broad: the sides are developed into wide and very thin expansions. The anterior margin is deeply grooved, but the upper lip is not split though it is indented. The rhinophore-openings have somewhat raised and indistinctly crenulate edges. The branchial pocket is wide, conspicuous, and somewhat two-lipped in shape. The edge is turned outwards and is not at all crenulate. The branchiæ are six and tripinnate. The general texture of the animal is leathery, and the whole dorsal surface is covered with a distinctly raised but somewhat irregular reticulate pattern. Both this pattern and the ground surface are granulate. The buccal tentacles are long, thin, and pointed. There is no labial armature. The radula consists of 40 rows, with about 40 teeth on each side of the naked rhachis.

The teeth are simply hamate; the innermost are smaller; the outermost smaller and imperfect in shape, bifid or irregularly serrulate. The stomach is large, muscular, and free from the liver. No armature was visible in the reproductive apparatus, and the genital orifices were unusually small and inconspicuous.

On the right side of the liver was found a parasite (Pl. XXXIV. fig. 4), extending from the fore end halfway down, the head being bent downwards round the fore end of the liver. The impression of the parasite on the liver was very distinct.

This form has not the hard feeling characteristic of *Sclerodoris*, but as the back is leathery, reticulate, and granulate, I hardly think it advisable to create a new genus for its reception.

30. *ASTERONOTUS HEMPRICH* Ehr. (Plate XXXIV. figs. 5 & 6.)

[Ehrenberg, *Symbolæ Physicæ, Animalia Evertebrata*, 1831.]

This large animal is common under rocks at Zanzibar and in all parts of British East Africa, between tides.

It has a characteristic feeling like leather or india-rubber, and not hard or rough like *Platydoris*. The ground-colour varies from black to olive or chocolate-brown. The skin is quite smooth, but bears a number of irregular lumps, resembling blisters in appearance. Towards the edges of the mantle they are smaller and somewhat confluent. Down the centre of the back runs a more or less elevated ridge, varying much in different specimens. All these protuberances are of a much lighter tint than the rest of the body. In some specimens there are small white lines round the lumps. The large branchiæ are white or pinkish. The under-side of the mantle is light yellow, with a row of chocolate blotches forming a line round the margin of the mantle and another round the foot. The coloration shown in the figure (Plate XXXIV. fig. 5), though an accurate representation of some specimens, is not the commonest. The greater number of individuals are more distinctly green. The animals are sluggish and show little inclination to move. The branchiæ are comparatively insensitive. Though completely retractile, they are not hidden when the teeth close over the pocket, but can be clearly seen at the bottom of the cavity (Pl. XXIV. fig. 6).

The largest alcoholic specimen measures 8·3 cm. in length by 6, and is 2·4 cm. high. The foot is 6 in length by 1·5; the anterior margin is deeply notched and grooved, the upper flap being very ample. The tentacles are large and in two specimens show a rudimentary foliation resembling that of *Hexabranchus*. This may be due to artificial compression, but I am not sure. The lips are also ample and protruding, so as to look like a second pair of tentacles. The rhinophore-pockets are somewhat raised and smooth, sometimes distinctly bilabiate. The branchiæ are six, ample, and quadripinnate. The margin of the pocket is produced into six lobes, which partially close over it. The radula consists of about 32 rows, each containing about 45 large yellow teeth on either side of the wide, naked rhachis. The teeth are simply hamate: the outermost two or three are smaller, and the inner-

most are set almost at right angles to the rhachis. The stomach is large and free, but thin and not laminated nor muscular. The blood-gland is large, and the nervous system is very concentrated. The generative system appears to be as described by Bergh, but the glandula and hasta amatoria are difficult to see and were satisfactorily detected only in one specimen.

These specimens are, I think, clearly Ehrenberg's *Asteronotus hemprichi*, from Massaua. He describes it as "sex-pollicaris, oblongus, glaber, vesiculosus, supra fuscus, lineis circulisque niveis sparsis, vesicas dorsuales cingentibus, subtus lateritus, pede flavido, branchiarum apertura lobulis sex stellatim positus præcludenda. . . . Branchiarum e dilute laterito seu carneo albicantium fasciculus amplus."

Prof. Bergh seems inclined to think (S. R. xvii. p. 917) that the real species of this genus are not more than three, *hemprichi*, *maquilla*, and *cæspitosus*. The differences between these three do not seem to me to be clearly defined, and my numerous specimens, which I unhesitatingly refer to one species, present connecting links, especially in colour, which make me think that the three species are merely varieties of one.

EXPLANATION OF THE PLATES.

N.B.—Except in the cases noted, the figures are drawn from the living animal.

PLATE XXXII.

Fig. 1. *Thordisa villosa* (p. 367), ventral view.

2. Dorsal view of the same.

3. *Thordisa crosslandi* (p. 368), ventral view. The margin of the mantle is turned here and there, showing the mobile papillæ which cover the dorsal surface.

4. *Trippa monsoni* (p. 371), dorsal view, much enlarged.

5. *Halgerda willeyi* (p. 372), from a drawing by Dr. Arthur Willey.

PLATE XXXIII.

Fig. 1. *Thordisa villosa* (p. 367), head and anterior end. The figure shows an extreme elevation of the body, which normally is flat.

2. Dorsal papilla of the same species, with flexible pigmented end and spicule-stiffened base. Also a portion of the mantle-edge magnified.

3. Branchiæ of the same.

4. *Thordisa crosslandi* (p. 368). Teeth from the radula: *a*, upstanding; *b*, laid flat.

5. Gills and anus of the same. A ridge (*a*) connects the higher part of the rhachis with the anal papilla (*b*).

6. Dissection of the retracted penis of the same, showing the shape and structure of the enclosed *glans*.

7. The glans penis of the same is slit open, showing it to be hollow and to contain a prolongation of the vas deferens which passes to its tip.

8. The central nervous system of the same in its sheathing of connective tissue.

PLATE XXXIV.

Fig. 1. *Halgerda wasinensis** (p. 373), dorsal view.

2. Diagram of the arrangement of its gill on the rhachis.

3. *Sclerodoris coriacea* (p. 383). Pencil drawing from the preserved specimen.

4. Degenerate Copepod parasite found in the liver of *Sclerodoris* (p. 384).

5. *Asteronotus hemprichi* (p. 384).

6. Enlarged view of the gill-opening when the branchiæ are as completely retracted as is possible.

7. *Kentrodoris rubescens* (p. 374), about half natural size.

* This name is wrongly spelt "*vassinensis*" on Plate.

6. A Note upon the Tongue and Windpipe of the American Vultures, with Remarks on the Interrelations of the Genera *Sarcorhamphus*, *Gypagus*, and *Cathartes*. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received October 15, 1903.]

(Text-figures 45-48.)

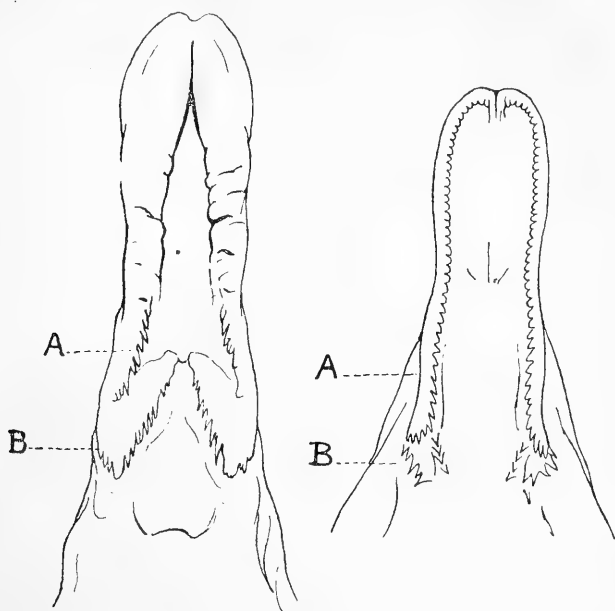
In a recent communication* which dealt to a slight extent with the arrangement of the papillæ upon the upper surface of the tongue in Accipitres, I referred to certain peculiarities in which the tongue of *Vultur* diverged from that of its allies, though agreeing with it in certain broad features that differ from the condition in the Falconine group of the Accipitres. I am not for the present again concerned with the latter subject, but with a more detailed account of the structure of the tongue in *Vultur* and its comparison with some other forms.

In an example of *Vultur calvus* (♂), the tongue is 35 mm. in length, and thick, of a boat-like form, the sides being bent upwards. There is the usual posterior row of spines, and, in addition to these, a lateral row on each side which commences quite posteriorly (see text-fig. 45) and extends anteriorly for a distance of 11 mm. on the left side and 10 mm. on the right. The spines are flattened and backwardly directed, getting blunter in form anteriorly; there are seven on the left side and five on the right. In *Vultur auricularis* the lateral rows of spines are more pronounced and somewhat different in form, thus affording, it may be remarked in passing, an additional character to distinguish the two species. In this bird the tongue measures 39 mm. in length, and the lateral rows of spines end at 14 mm. and 13 mm. respectively from the posterior end of the organ; as in *V. calvus*, the left row is the longest. It will be observed, therefore, that in both species the proportions of the spine-bedecked and spineless regions of the tongue are much the same. In *V. auricularis* the spiny papillæ are sharper and more numerous. I counted ten of them on the left side and eight on the right. An accurate notion of their shape and relations will be obtained from an inspection of the accompanying drawing (text-fig. 45). The form of the tongue, as well as the number of the lateral papillæ, differentiates *Vultur* from *Gypohierax*. The latter has a flatter, longer, and so far more typically "Accipitrine" tongue. It has no traces of the characteristic lateral spiny papillæ, which cannot, therefore, be regarded as a "Vulturine" character, correlated perhaps with diet. And though this one instance may not be regarded as sufficient of itself to emphasise the suggestion, it is supported by converse examples. In *Aquila chrysaëtus*, *Nisaëtus fasciatus*, and *Gypaëtus barbatus* there are distinct traces of these same papillæ

* "On the Syrinx in the Accipitres, &c.," P. Z. S. 1903, vol. ii. p. 157.

(three or four in number). In the larger species, moreover, the tongue is thick and boat-shaped, but not so markedly as in *Vultur*.

Text-fig. 45.

Left-hand figure: dorsal view of tongue of *Vultur auricularis*.Right-hand figure: dorsal view of tongue of *Gypagus papa*.

A, lateral spines; B, posterior spines.

I believe that these facts throw some light upon the extraordinary tongue of the American Vultures, which differs so much from that of other Accipitres that Prof. Fürbringer rightly uses it* as one of the many characters distinguishing these birds from the Old World Vultures. The general structure of the tongue in the Cathartidæ has been described: for example by MacGillivray† in *Cathartes atratus*, and by Gadow in *Gypagus papa*‡. In these birds and in the Condor the tongue is edged with a regular row of backwardly directed papillæ "like the teeth of a saw." Anteriorly these spines are blunter and shorter, and forcibly suggest the lamellæ on a Duck's bill. In *Gypagus* there may be, in addition to the lateral spiny papillæ, a few to the inside of each row;

* Untersuch. z. Morph. u. Syst. d. Vögel, Amsterdam, 1888, p. 1304.

† In Audubon, 'Ornith. Biography,' v. 1839, p. 347.

‡ Bronn's Thier-Reich, Vögel, pl. xxviii. fig. 4; this figure is referred in the explanation of the plates to "*Gyps* sp." I gather from the text that Dr. Gadow's description of the tongue was partly drawn from an unpublished memoir of Dr. W. Marshall, and that the drawing belongs to that MS. I feel sure that there is some mistake, and that the tongue figured is that of *Gypagus* or perhaps *Cathartes*.

and there are traces of these, perhaps reduced to one spine, in *Cathartes*. I cannot, however, with any confidence distinguish the tongues of the two genera. The point, however, which I wish to emphasise is that this single inner spine, if there be only one, which lies medianly of the lateral fringing row, is the vestige of the V-shaped edging of spines which borders the tongue of other Accipitres posteriorly. The tongue of the Cathartidæ, therefore, differs from that of other Accipitres in the nearly complete disappearance of the spines which border the tongue posteriorly, and the hypertrophy of the lateral spines which are indicated in some Accipitres, particularly in *Vultur*. I may remark finally that the numerous large glandular orifices (figured by Gadow) which are scattered over the tongue in *Gypagus* and *Cathartes* are not found in *Vultur*; nor is the slit of the glottis in the latter edged with spines as it is in the Cathartidæ.

In my work* upon the anatomy of Birds, I briefly drew attention to the fact that the "syrinx" in the American Vultures presents two types—one characterising *Cathartes*, and the other the two genera *Gypagus* and *Sarcorhamphus*. I take the opportunity of expanding that account. In remarking that the Cathartidæ are distinguished by their completely closed bronchial rings, I take it that Prof. Fürbringer had in view the genus *Cathartes* only. It is only *Cathartes* that figures in the description of the muscular anatomy of Birds contained in his great work. In supporting Dr. Fürbringer's statement, I found it necessary† to limit that statement to *Cathartes*, since in *Gypagus* and *Sarcorhamphus* the bronchial "rings" are in reality semirings, as in birds with a tracheo-bronchial syrinx. The actual difference, however, between *Cathartes* and the other types is one of degree. In *Cathartes* the bulk of the bronchial cartilages are complete rings, while a few at the end (I counted five of these in two specimens selected at random) are semirings. In *Gypagus*, on the other hand, all the bronchial cartilages are semirings. In this point *Gypagus* agrees with *Sarcorhamphus*. A further peculiarity is noteworthy as distinctive of the several genera of Cathartidæ with which I deal in the present communication. In *Sarcorhamphus* I have figured‡ the membrana tympaniformis as continued upwards along the trachea posteriorly, which results, therefore, in the production of tracheal semirings. This longitudinal fissure of the tracheal rings exists for some distance. In *Gypagus* precisely the same state of affairs is to be found, only it is less extensive than in the Condor. I can find no trace of any transverse break in the tracheal rings of *Cathartes*. I have been able to examine four individuals which include both sexes. If it occurs, the probabilities are in favour of its being exceptional. We have, therefore, in the structure of the windpipe in these American Vultures two distinct types—one developed in *Cathartes*, and the other in *Sarcorhamphus* and *Gypagus*.

* 'The Structure and Classification of Birds,' London, 1898.

† *Loc. cit.*, see also "On the Windpipe and Heart of the Condor," P. Z. S. 1902, vol. i, p. 239.

‡ P. Z. S. 1902, vol. i, text-fig. 39, p. 241.

*Interrelationships of the Genera CATHARTES, SARCORHAMPHUS,
and GYPAGUS.*

The foregoing remarks upon the windpipe lead to the consideration of the relationships *inter se* of the American Vultures. Garrod pointed out* the agreement of *Sarcorhamphus* and *Gypagus* in possessing the femoro-caudal, which is absent in *Cathartes*. Pycraft, in an osteological survey of the "Falconiformes"†, has noted characters, some of which lead him to bracket together *Gypagus* and *Sarcorhamphus*, though others do not apparently justify such a juxtaposition. On the whole, it seems to me to be clear that the skulls of *Sarcorhamphus* and *Gypagus* are more like each other than either is to the skull of *Cathartes*; and I shall attempt to justify this view by calling attention to a few minutiae which have not been dwelt upon in this connection.

The outline of the skull, as seen from the side, is very characteristic. *Cathartes* has, relatively speaking, a long low skull with a proportionately longer maxillary and premaxillary region; it is almost Cormorant-like in aspect. In the other two genera this region is deeper and shorter and descends with more of a curve, instead of possessing an upper contour-line which is almost a straight line. The premaxillary region, in fact the end of the beak region, is much more inflated in *Gypagus* and *Sarcorhamphus* than in *Cathartes*. The pervious nostrils are of greater length and narrower across in *Cathartes* than in the two other genera which agree with each other in this feature; moreover, in *Gypagus* and *Sarcorhamphus* the conjoined maxillary plates are visible as projecting forward beyond the posterior end of the nostril, more especially in *Gypagus*. In *Cathartes* they are not so visible. On the lateral aspect of the skull another curious though small difference may be noted, which serves to ally *Sarcorhamphus* and *Gypagus* and to divide them both from *Cathartes*. In the last-mentioned bird Mr. Pycraft has correctly figured‡ a groove which he terms the "nasal hinge." This appears to separate off the lacrymal (fused to the frontal) from the nasal in front. The suture in question is semicircular and with the convexity anterior. In both *Sarcorhamphus* and *Gypagus* the hinge is present but has more the form of a half ellipse; moreover, the concavity is forward and it thus appears as if a backward process of the nasal were embraced by the concave anterior margin of the lacrymal. Mr. Pycraft has also figured§, behind the nasal hinge in the same bird, a strong ridge which presumably marks the boundary of the lacrymal, and is prolonged so as to slightly overhang the orbit. This ridge is quite absent in both *Sarcorhamphus* and *Gypagus*, the orbital margin of which is here smooth. It must be admitted, however, that, in one point exhibited in this particular region of the skull, *Cathartes* is rather intermediate between the Condor at one extreme and *Gypagus* at the other. This is the backward direction of the

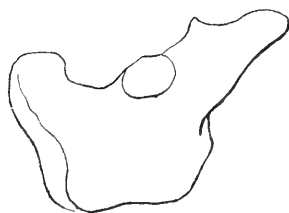
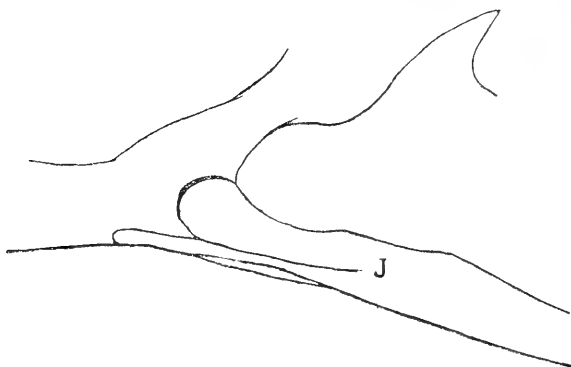
* Collected Papers, London, 1881, p. 210.

† P. Z. S. 1902, vol. i. p. 277.

‡ *Loc. cit.* pl. xxxii. fig. 1, *wh.*

§ Fig. 10. Wrongly ascribed in the explanation of plates to *Serpentarius*.

Text-fig. 46.

*Sarcorhamphus aequatorialis.*

Upper figure: insertion of maxillo-jugal (J).

Lower figure: mandible of the same, viewed from behind.

Text-fig. 47.

*Cathartes atratus.*

Upper figure: insertion of maxillo-jugal (J).

Lower figure: mandible, viewed from behind.

descending process of the lacrymal, not so pronounced as in the Condor, but more developed than in *Gypagus*, where it is indeed vertical in direction. Another difference which allows of a closer association of the Condor with the King Vulture than of either with *Cathartes*, is the condition of the interorbital septum. In both *Sarcorhamphus* and *Gypagus* there are two large vacuities, the larger being in front. In *Cathartes* the septum is less perforated, the posterior vacuity alone being present—a tiny hole* representing the anterior vacuity. Pycraft has called attention to a series of stages in the development of the attachment of the maxillo-jugal bar. It appears to me that the facts observable tend to suggest that *Gypagus* stands rather apart from both *Cathartes*

Text-fig. 48.

*Gypagus papa.*

Upper figure: insertion of maxillo-jugal (J).

Lower figure: mandible, viewed from behind.

and *Sarcorhamphus*. In the former genus (text-fig. 48) the bar divides only just before the insertion on to the maxilla. The upper lamella is of large size, and, as in the two other genera, fits on to a hollowed-out area of the maxilla. In *Cathartes* (text-fig. 47, p. 390) and *Sarcorhamphus* (text-fig. 46, p. 390) the division of the bar occurs much further back. The upper lamella is certainly larger than the lower bar, but it is relatively smaller than in *Gypagus*. In *Sarcorhamphus*, indeed, it is actually of the same breadth as in *Gypagus*, though the skull of the Condor is twice the size of that of the King Vulture. Furthermore, the forward

* This seems to be not always present. It is not figured by Pycraft.

edge of the upper lamella, which forms the joint, is neatly rounded off instead of projecting irregularly as in *Gypagus*. These points will be better understood after an inspection of the accompanying drawings (text-figs. 46-48). It will be seen that my reading of the facts differs slightly from that of Mr. Pycraft. Articular perfection appears to me to have been arrived at both in *Cathartes* and *Sarcorhamphus* from a lower stage such as persists in *Gypagus*.

On the ventral surface of the skull a very conspicuous difference defines *Cathartes* on the one hand from *Sarcorhamphus* and *Gypagus* on the other. In the two latter birds the basitemporal region is deeply excavated, and the sides are prolonged into very marked exoccipital processes. In *Cathartes*; on the contrary, this region of the skull is much flatter and there are no such conspicuous lateral processes. The inner lamina of the palatines is hooked and overhanging posteriorly in *Sarcorhamphus* and *Gypagus*; in *Cathartes* this region of the bone does not overhang posteriorly and is merely triangular in form. Moreover, in *Cathartes* the anterior half of the palatine has its broad surface in a plane horizontal, in the other genera it is rotated upwards and is at an angle to the horizontal plane. A final point to which I desire to direct attention is illustrated in the accompanying drawings (text-figs. 46-48). These sketches represent the mandibles of the three genera under consideration viewed from behind. The relatively, as well as actually, much greater thickness of the internal angle in *Sarcorhamphus* and *Gypagus* will be apparent.

The foregoing account does not at all pretend to be a detailed review of the structure of the skull in the American Vultures. I have economised space by simply dealing with those facts which appear to me to throw light upon the neutral relationships of the genera *Sarcorhamphus*, *Cathartes*, and *Gypagus*. Other facts which, in my opinion, do not bear upon this subject have been ignored. The result is, I think, to show that the Condor and the King Vulture are comparatively slight variations of the same type, while *Cathartes* stands equally apart from both, a conclusion which is quite in accord with current ornithological opinion. I think it is going rather too far, as has been done*, to include both the former Vultures in one genus; but it is, in my opinion, manifestly absurd to combine *Cathartes* and *Gypagus*, and to write of *Cathartes papa*, as has also been done†.

* 'Standard Natural History,' Boston, 1885, p. 268.

† Taschenberg, 'Bibliotheca Zoologica,' v. 1899, p. 3966.

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3 Hanover Square, London, W.,
October, 1903.

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FOR
SCIENTIFIC BUSINESS.
(AT 3 HANOVER SQUARE, W.)
Session 1903-1904.

1903.	
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1904.	
TUESDAY, JANUARY 19	TUESDAY, APRIL .. 19
,, FEBRUARY 2 and 16	,, MAY 3 and 17
,, MARCH .. 1 ,, 15	,, JUNE 7

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Secretary.

October, 1903.

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By order of the Council,

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*Secretary.*

3 HANOVER SQUARE, LONDON, W.,

October, 1903.

PROCEEDINGS  
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1903, vol. II.

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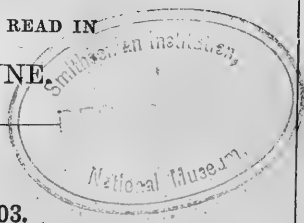
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The 'Proceedings' for the year are issued in *four* parts, forming two volumes, as follows:—

### VOL. I.

- Part I. containing papers read in January and February, in June.  
II. " " " March and April, in August.

### VOL. II.

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II. " " " November and December, in April.

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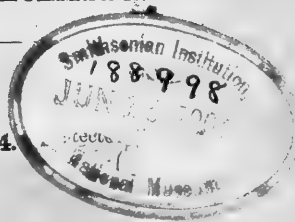
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## NOTICE.

The 'Proceedings' for the year are issued in *four* parts, forming two volumes, as follows:—

### VOL. I.

- Part I. containing papers read in January and February, in June.  
II. " " " March and April, in August.

### VOL. II.

- Part I. containing papers read in May and June, in October.  
II. " " " November and December, in April.

'Proceedings,' 1903, Vol. II. Part I. was published on October 1st, 1903.













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