PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1915, pp. 1–298,

WITH 10 PLATES and 70 TEXT-FIGURES.

PRINTED FOR THE SOCIETY,
SOLD AT ITS HOUSE IN REGENT'S PARK.

LONDON:
MESSRS. LONGMANS, GREEN, AND CO.,
PATERNOSTER ROW.

LIST

OF THE

COUNCIL AND OFFICERS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

1915.

Patron.

HIS MAJESTY THE KING.

COUNCIL.

HIS GRACE THE DUKE OF BEDFORD, K.G., F.R.S., *President.*

RICHARD H. BURNE, ESQ., M.A., *Vice-President.*
ALFRED H. COCKS, ESQ., M.A.
THE RT. HON. THE EARL OF CROMER, G.C.B., F.R.S.
F. G. DAWTREY DREWITT, ESQ., M.A., M.D.
CHARLES DRUMMOND, ESQ., *Treasurer.*
THE EARL OF DUNMORE, V.C., M.V.O.
ALFRED EZRA, ESQ.
SIDNEY FREDERIC HARMER, ESQ., M.A., Sc.D., F.R.S., *Vice-President.*
SIR EDMUND GILES LODER, Bt., *Vice-President.*
Prof. ERNEST W. MACBRIDE, M.A., D.Sc., F.R.S., *Vice-President.*
GUY A. K. MARSHALL, ESQ.
E. G. B. MEADE-WALDO, ESQ.
P. CHALMERS MITCHELL, ESQ., M.A., D.Sc., LL.D., F.R.S., *Secretary.*
W. R. OGILVIE-GRANT, ESQ.
ALBERT PAM, ESQ.
THE EARL OF PORTSMOUTH.
THE MARQUESS OF SLIGO, F.S.A., *Vice-President.*
AUBYN TREVOR-BATTYE, ESQ., M.A.
ANTHONY H. WINGFIELD, ESQ.
ARTHUR SMITH WOODWARD, ESQ., LL.D., F.R.S., *Vice-President.*

PRINCIPAL OFFICERS.

P. CHALMERS MITCHELL, M.A., D.Sc., LL.D., F.R.S., *Secretary.*
FRANK E. BEDDARD, M.A., D.Sc., F.R.S., *Prosector.*
R. I. POCOCK, F.R.S., F.L.S., *Curator of Mammals and Resident Superintendent of the Gardens.*
D. SETH-SMITH, *Curator of Birds and Inspector of Works.*
EDWARD G. BOULENGER, *Curator of Reptiles.*
Prof. H. MAXWELL LEFROY, *Curator of Insects.*
HENRY G. PLIMMER, F.R.S., M.R.C.S., *Pathologist.*
HENRY G. J. PEAVOT, *Librarian and Clerk of Publications.*
JOHN BARROW, *Accountant.*
W. H. COLE, *Chief Clerk.*

LIST OF CONTENTS.

1915, pp. 1–298.

EXHIBITIONS AND NOTICES.

PAPERS.

ALPHABETICAL LIST

OF THE

CONTRIBUTORS,

With References to the several Articles contributed by each.

(1915, pp. 1–298.)

INDEX.

1915.—Pages 1–298.

[New names in clarendon type. Systematic references in italics. (Z. S. L.) indicates additions to the Society's Menagerie.]

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

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1915.

PART I.

CONTAINING PAGES 1 TO 156, WITH 8 PLATES
AND 23 TEXT-FIGURES.

MARCH 1915.

PRINTED FOR THE SOCIETY,
SOLD AT ITS HOUSE IN REGENT'S PARK.
LONDON:
MESSRS. LONGMANS, GREEN, AND CO.,
PATERNOSTER ROW.

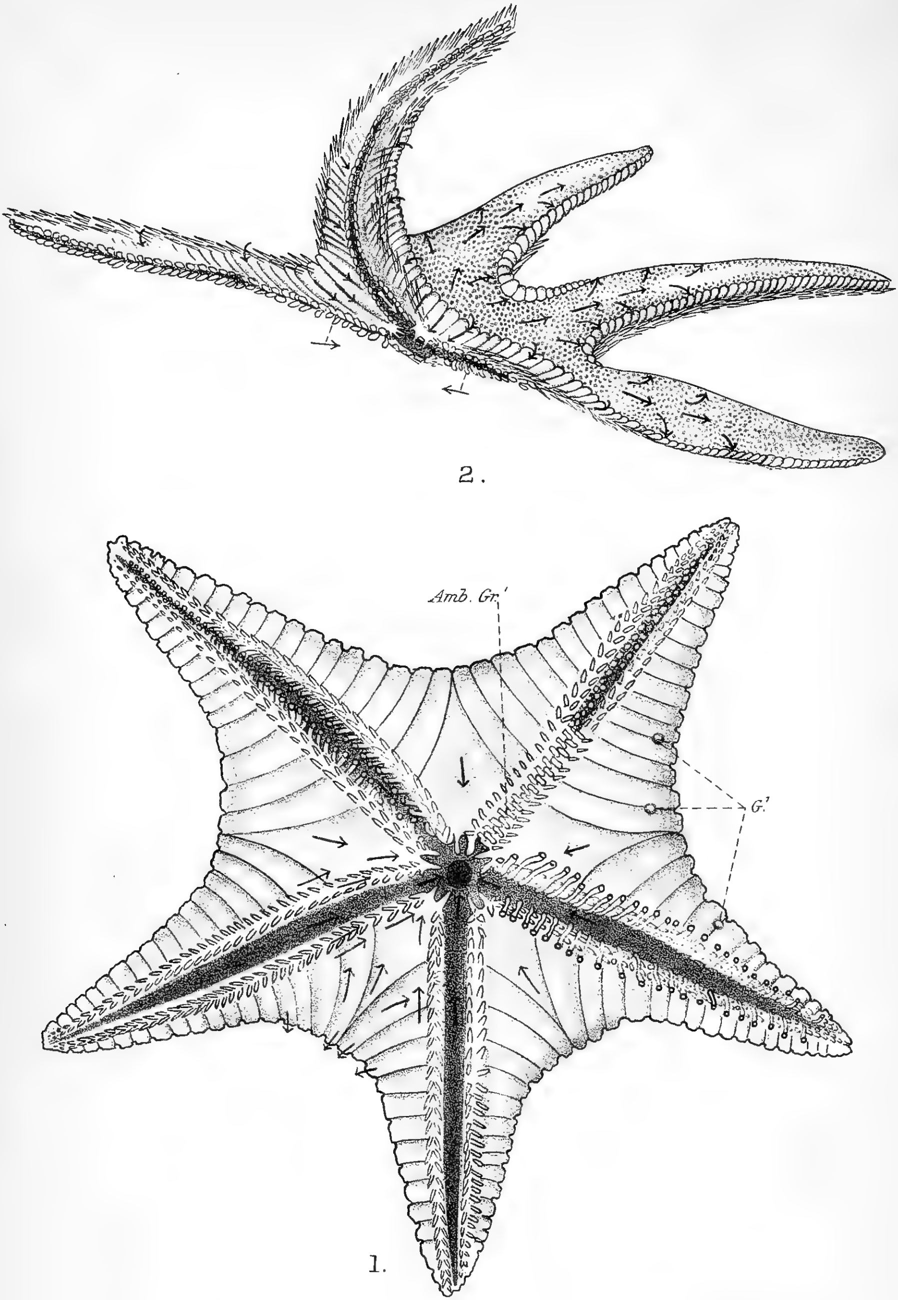
[*Price Twelve Shillings.*]

LIST OF CONTENTS.

1915, Part I. (pp. 1–156).

EXHIBITIONS AND NOTICES.

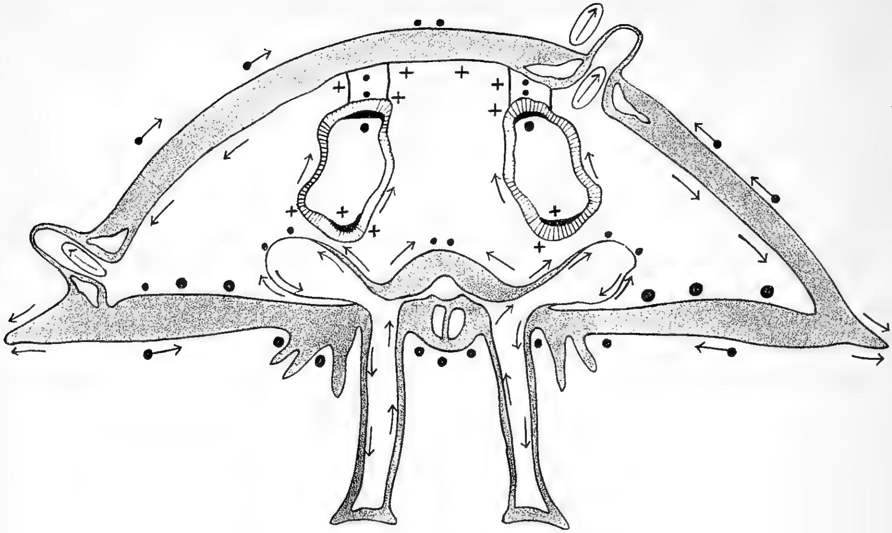
Contents continued on page 3 of Wrapper.



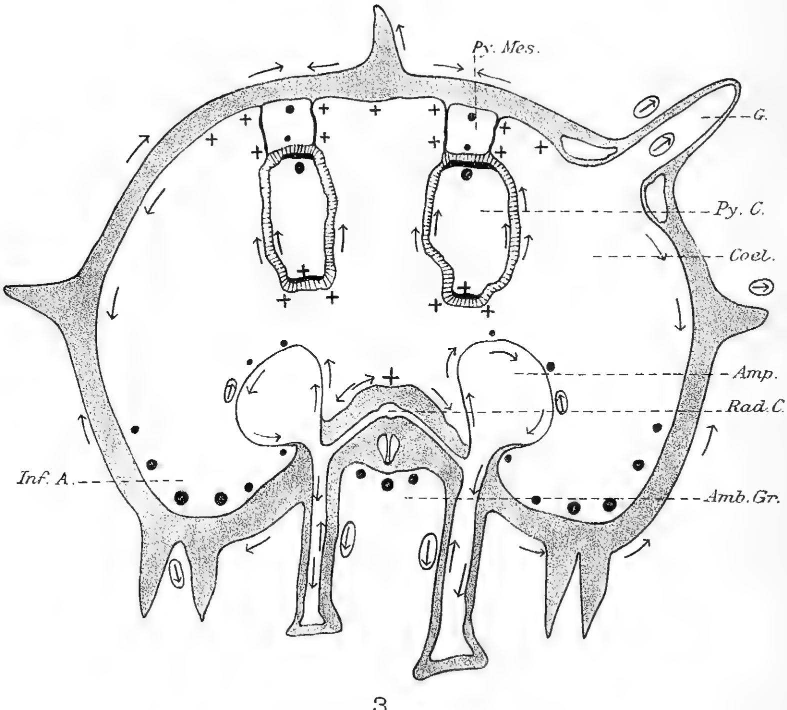
J. F. Gemmill, del.

Huth, Lith. London.

CILIATION OF ASTERIDS.



4.

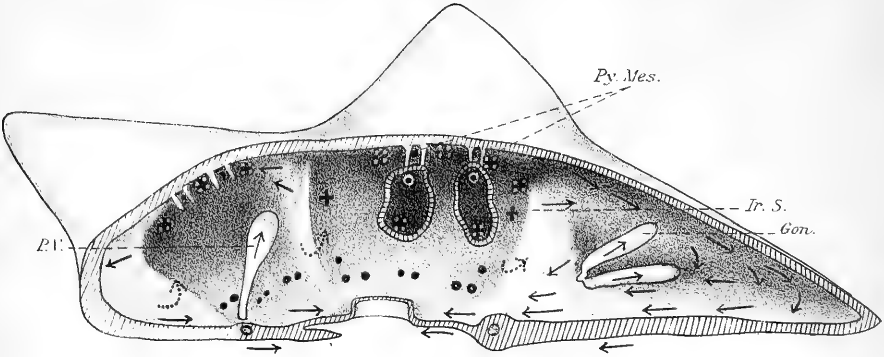


3.

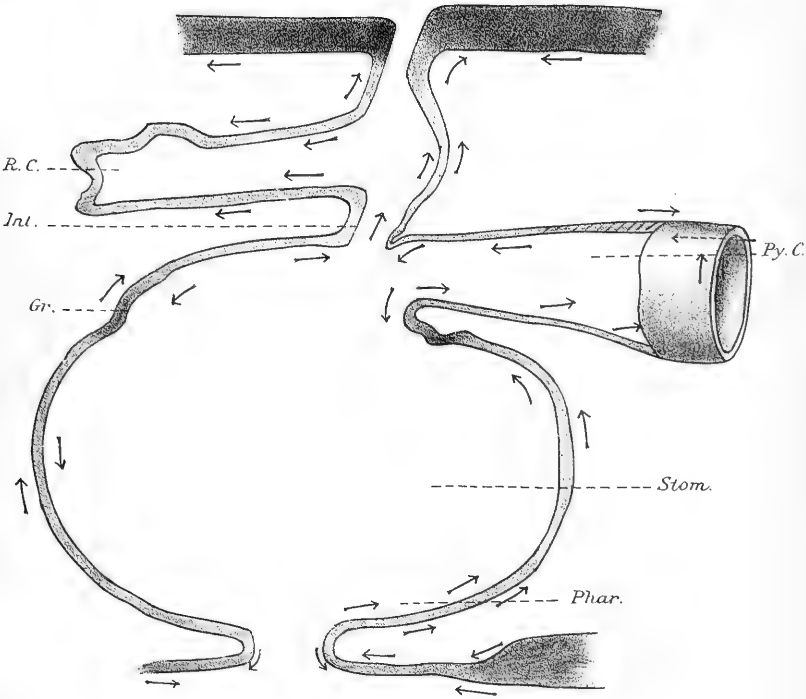
J. F. Gemmill. del.

Huth, Lith. London.

CILIATION OF ASTERIDS.



5.



6.

J. F. Gemmill, del.

Huth. Lith. London

CILIATION OF ASTERIDS.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

PAPERS.

1. On the Ciliation of Asterids, and on the Question of Ciliary Nutrition in Certain Species. By James F. Gemmill, M.A., M.D., D.Sc., F.Z.S.

[Received October 30, 1914: Read February 23, 1915.]

(Plates I.–III.* and Text-figures 1 & 2.)

Index. Page

In studying the development of the common Crossfish, *Asterias rubens* L. (**4**), I was struck by the constancy and functional importance of the ciliation on the various surfaces (epidermal, endodermal, and enterocœlic) of the larva. The larval ciliation being continued at metamorphosis into that of the starfish, it

* For explanation of the Plates see pp. 18–19.

seemed of interest to investigate the ciliary activities of the adult, especially as considerable attention has been paid of late to the role of ciliation * in other animals, with results of much importance alike as regards physiology and structure.

Of the species available in the Firth of Clyde, *Asterias rubens* L., *Solaster papposus* L., *Porania pulvillus* O. F. M., and *Astropecten irregularis* (Pennant), were selected for particular examination, as belonging to families showing very great divergence in form or larval history.

In the course of the investigation, data were obtained indicating that *Porania* secures a portion of its food-supply by ciliary activity. This fact is of the greatest significance as showing how nutritional continuity could have been maintained in the progress of Asterid evolution, during the transition from a bilateral, ciliary-feeding, pelagic ancestor, through an attached stage allowing the gradual acquirement of radial symmetry, to present-day starfishes which obtain their food-supply wholly or mainly by capture through the agency of the sucker-feet.

I. Ciliary Currents.

1. Methods and Orientation.

The direction of ciliary action on the different surfaces was studied by pinning out fresh living preparations from healthy specimens, in sea-water with fine carmine particles in suspension, and then examining under strong reflected light with the help of a Swift-Stevenson binocular microscope. Occasionally, lamp-black or dead *Echinus* sperm was used instead of carmine. In the case of the ampullæ and sucker-feet the corpuscles of the water-vascular fluid served, under bright illumination, to demonstrate the currents, but the results thus obtained were confirmed by the use of carmine injections.

As regards orientation, the specimens are to be considered as lying on a horizontal surface with the aboral side uppermost. In the text:—

Superior, *upwards*, etc., refer to the aboral, and *inferior*, *downwards*, etc., to the oral aspect or direction.

Centripetal means horizontally towards, and *centrifugal* horizontally away from, the vertical or mouth-anal axis.

Laterally inwards and *laterally outwards* indicate currents at right angles to the vertical mid-radial plane of an arm.

Perpendicular refers to currents rising directly from, *i. e.* perpendicular to, a surface or margin.

Opposite currents starting along a line and passing directly outwards from it are described as *shedding away from* the line in question.

* *Cf.* Carlgren, O., Biol. Centralblatt, vol. xxv. 1905, pp. 308–322 (Actinians, Madreporarians). Orton, J. H., Jour. Mar. Biol. Assn. U.K. vol. ix. 1912, pp. 444–478 (Ascidians, Molluscs); vol. x. 1913, pp. 19–49 (*Amphioxus*, Ascidians, Molluscs); vol. x. 1914, pp. 283–311 (Brachiopods, Polychætes, etc.).

2. External Surface.

Area.	*Description of Current.*
Bottom of ambulacral grooves ...	Centripetal in all; strongest in *Porania* and *Astropecten*, weakest in *Asterias*.
Margins of ambulacral grooves on and between the bases of the ambulacral spines.	Laterally outwards in *Asterias* and *Solaster*; laterally inwards and with marked centripetal tendency in *Porania*; laterally inwards in *Astropecten*, especially in the grooves between the groups of spines.
Lateral aspect of rays	On the whole aboralwards in *Asterias* and *Solaster*; perpendicular * at marginal edge in *Porania*, and sometimes also in *Solaster*; in *Astropecten* running strongly downwards, *i. e.* towards oral aspect of the ray, in the grooves between the large marginal plates.
Aboral aspect of rays	Shedding faintly away from mid-radial line in *Asterias**; aboralwards with centripetal tendency in *Solaster* and *Porania*; in *Astropecten* centrifugal along middle line and slanting laterally outwards to either side.
Interradial surfaces (oral aspect).	Centrifugal, *i. e.* away from mouth, in *Asterias* and *Solaster*; centripetal, *i. e.* towards mouth, in *Porania* and *Astropecten*. Sometimes in young specimens of the former, and usually in old specimens, there is a small area near the oral angle of each interradius with centrifugal ciliation.
Interradial surfaces (lateral aspect).	Aboralwards in *Asterias* and *Solaster*; oralwards in *Astropecten*.
Interradial surfaces (aboral aspect).	Confused in *Asterias*; centripetal towards anus in *Solaster* and *Porania*; centrifugal in *Astropecten*.
Actinal intermediate areas	These areas are well marked only in *Porania* and there the ciliation is centripetal, *i. e.* towards the mouth.
Aboral aspect of disc	Confused in *Asterias*; centripetal towards ana opening in *Porania*; somewhat confused in *Solaster*, but with slight centripetal tendency towards anal opening; centrifugal in *Astropecten*.
Buccal membrane	Entirely centripetal in *Astropecten*; centripetal except for narrow centrifugal zone at margin of mouth in *Porania*, as also in *Solaster*, but with weaker centripetal ciliation in the latter; centrifugal all over in *Asterias*.
Madreporite	Centrifugal in *Astropecten*; from periphery towards centre of madreporic surface in *Asterias* and contrariwise in *Solaster* and *Porania*.
Gills	From base to summit somewhat spirally.
Spines	From attached to free ends often spirally. The large spines (denticles) projecting oralwards from the interradial angles of *Solaster* are ciliated towards the base on the lower, and towards the apex on the upper aspect. In

* Currents somewhat variable.

Area.	*Description of Current.*
	Porania and *Astropecten* the entire ciliation on these spines is from base towards apex. As a rule, gills and spines set on any surface which causes a definite current are ciliated so as to promote this current for some distance up from their bases.
Sucker-feet..............................	From attached to free ends spirally, but showing irregularities in *Asterias*; ciliation absent or extremely weak in *Solaster*, *Porania*, and *Astropecten*.
Pedicellariæ	Irregular, but, on the whole, from attached to free ends.
Paxillary spinelets of *Astropecten*.	Weak from base to apex.

General.—There can be little doubt but that all over the surface of the body the ciliary currents subserve local respiratory purposes, a function of much importance in connection with the great superficial nerve-tracts, inasmuch as these tracts cannot readily receive adequate oxygenation from the perihæmal fluid bathing their deep surfaces.

Since the currents along the ambulacral grooves are centripetal (p. 2) fresh water is always being brought along them towards the nerve-ring and centre of the disc. This circumstance may well be of importance during periods when the starfish is stationary, as in feeding, or is wholly or partly buried in sand (*Astropecten*).

Text-figure 1.

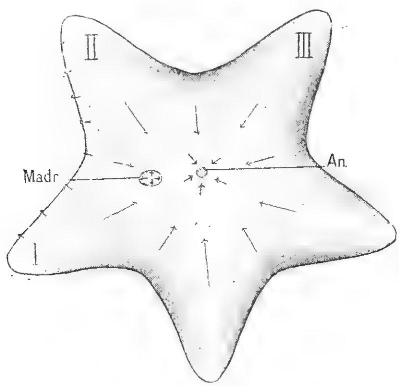


Diagram illustrating the arrangement of the aboral ciliary currents in *Porania*.

An., anus; *Madr.*, madreporite.

We may note that occasionally a number of the papules, instead of showing the usual everted or protruding condition, are found to be introverted (*Porania*). At such times, the spiral ciliation of their epidermal surface keeps this surface bathed with changing water, so that the respiratory function does not completely cease.

The ciliation on all attached or projecting parts (spines and spinelets, pedicellariæ, sucker-feet, gills) is, on the whole, from the attached to the free extremities, an arrangement promoting the removal of débris. In *Porania* and *Solaster*, particularly in the smaller-sized specimens, the skin on the aboral aspect between the gills and spines is ciliated so as to collect particles towards the anus, and throw them up therefrom in a perpendicular stream, from under which the starfish is continually walking away in the ordinary course of its movements. This somewhat remarkable arrangement is illustrated for *Porania* in the accompanying text-figure. In *Asterias*, the skin is too thickly covered with gills, spines, and pedicellariæ to exhibit such an arrangement of currents, but the various structures named serve as the starting-cones of minor ascending currents everywhere on the aboral surface of the disc.

The aboral ciliation of *Astropecten* follows entirely different lines, and is possibly related to ciliary feeding (p. 14). The ciliation on the oral aspect of *Porania* is of direct importance in connection with the last-named function (p. 10).

3 (*a*). Lining of Perivisceral Cavity: Somatopleure.

Area.	*Description of Current.*
Floor of rays in middle line	In *Asterias* centrifugal with irregularities; in *Solaster* centripetal with irregularities; in *Porania* centripetal *; in *Astropecten* very faintly centripetal *.
Floor of rays close to either side of middle line. —	Laterally inwards or outwards to or from middle line *; in *Porania* chiefly inwards; in *Astropecten* chiefly outwards.
Floor of rays over ampullæ of sucker-feet.	From base to summit of ampullæ with centripetal tendency, except in *Astropecten* where the tendency is centrifugal.
Infero-lateral angles of rays	Strongly centripetal, providing the chief oralward streams.
Buccal membrane....................	Centripetal.
Interbrachial septa	Centripetal along inferior angles; centrifugal along superior angles; mixed on sides; tendency * towards circular movement, over the free edges of the septa, in a dextral or watch-hand direction as viewed aborally.
Aboral wall of ray (median portion between the radial cæca).	Strongly centrifugal.
Aboral wall of ray (portions lateral to radial cæca).	Strongly centrifugal and slanting laterally outwards, and then oralwards.
Aboral wall of ray (portions looking into the epigastric cœlomic pockets).	Centripetal in *Asterias* and *Porania* *; mixed in *Solaster* and *Astropecten*.
Lateral wall of ray	Oralwards.

* Currents somewhat variable.

Area.	*Description of Current.*
Aboral wall of disc	Centrifugal interradially, and for the most part radially as well, but sometimes, especially in *Asterias*, centripetal or mixed along the continuations of the epigastric cœlomic pockets.
Aboral gastric ligaments...........	Aboralwards.
Oral gastric ligaments	Mixed, chiefly centrifugal.

3 (*b*). Lining of Perivisceral Cavity: Splanchnopleure.

Pharyngeal portion of stomach ...	Aboralwards in all.
Gastric portion of stomach.........	Aboralwards in all.
Pyloric sac............................	Aboralwards in all.
Stalks of radial cæca (except surfaces looking into epigastric cœlomic pockets).	Centrifugal in all.
Surfaces of radial cæca looking into epigastric cœlomic pockets.	In *Asterias* and *Porania* centripetal *; in *Solaster* mixed centrifugal and centripetal.
Oral edges of radial cæca	Centrifugal in all.
Sides of radial cæca	Aboralwards in all.
Aboral edges of radial cæca and outer aspects of epigastric mesenteries.	Centrifugal in all.
Rectal cæca	Centrifugal with spiral currents and mixing, and in some cases a tendency towards circulation in a dextral direction as viewed aborally.
Region of separation between stomachal and pyloric regions of gastric cavity.	* Slight tendency towards circulation in a dextral direction as viewed aborally.
Gonads and Polian vesicles	In general from attached to free extremities, but sometimes spiral or mixed.

General.—Here the primary fact is that the ciliation produces constant and complete mixing of the cœlomic fluid in the interior of the disc and arms. Great centripetal currents flow along the infero-lateral angles of the arms and, reaching the splanchnopleure of the gut-wall, are swept aboralwards and are next driven centrifugally outwards towards the arm-tips by the cilia on the aboral body-wall and on the radial and rectal cæca. There appears to be a certain amount of circular movement on the part of the cœlomic fluid in the dextral or watch-hand direction as viewed aborally. Continual changing of the fluid inside the gills also occurs.

4. Endodermal Lining.

Area.	*Description of Current.*
Pharyngeal portion of gastric cavity.	Aboralwards in all; in *Asterias* a slight oralward current could sometimes be made out in the middle line of one or other of the interradii, particularly of the anal interradius.

* Currents somewhat variable.

Area.	*Description of Current.*
Stomachal portion of gastric cavity.	Chiefly aboralwards, and strongest along the major radial furrows, but many of the inter-radial furrows and some of the minor radial furrows show oralward ciliation.
Circular groove between stomachal and pyloric-sac portions of gastric cavity.	Slight tendency to circular movement * in a sinistral direction as viewed aborally.
Pyloric sac, radial grooves	Strongly aboralward or centripetal, *i. e.*, towards the intestinal opening near centre of roof of sac. Note that in *Solaster* each of these grooves (probably through secondary sealing of its edges) forms a canal which opens centrally near the commencement of the intestine, and peripherally near the place of origin of a pair of radial cæca.
Pyloric sac, interradial areas	Diffusely centrifugal, *i. e.*, away from intestinal opening.
Pyloric sac, rosette of minor grooves round opening of intestine.	Centripetal, *i. e.*, towards entrance to intestine.
Stalks of pyloric cæca	Entrance to each pair of cæca is centripetally ciliated all round *.
Roof-grooves of pyloric cæca	Strongly centripetal.
Floor-grooves of pyloric cæca	Strongly centrifugal.
Folded sides of pyloric cæca	Aboralwards, *i. e.*, from floor-groove to roof-groove.
Intestine	From pyloric sac towards rectal sac.
Rectal cæca	Centrifugal, *i. e.*, into recesses of cæca.
Rectum	Not ascertained.

General.—The major result of the endodermal ciliation is to effect sweeping from mouth to anus, but we have also to recognise certain secondary results ensuring: (*a*) mixing and delay within the main gastric cavity, and (*b*) circulation within the cæcal outgrowths. As factors under (*a*), note the oralward ciliation of many of the folds and grooves in the stomachal portion of the gastric cavity, the oralward ciliation of the large interradial areas in the roof of the pyloric sac, and the circular movement (clockwise as viewed from the oral aspect) recognisable near the groove separating the stomachal and pyloric-sac portions of the gastric cavity. The aboralward ciliation of the pharyngeal portion of the gastric cavity will prevent particles from passing out of the gastric cavity during the mixing process. As regards the radial cæca, experiment shows that carmine grains are swept with great rapidity centrifugally outwards from the gastric cavity along their floor-grooves, the streams getting gradually smaller as the apices are neared, since numerous small side-currents pass aboralwards along the walls of the cæcal folds. The last-named currents join the great centripetal stream which passes along the roof-groove of the cæcum and then along the corresponding radial

* Currents somewhat variable.

groove on the roof of the pyloric sac. The circulation within the pyloric cæca seems to depend entirely on ciliary action, contractions of the walls of the cæca either not occurring or being exceedingly slight and irregular.

As regards the rectal cæca, all the ciliary currents appear to be centrifugal, that is, outwards into the lobules. The return currents from the cæca must therefore be passive so far as ciliation is concerned. However, as is indicated below (p. 12), the rectal cæca of *Porania* show rhythmic contractility, while those of *Solaster* and *Asterias*, and probably of other starfishes, are also contractile. The rectal cæca may therefore be emptied or the fluid within them kept from stagnation by the muscular action of their walls.

5. Minor Cavities.

Area.	*Description of Current.*
Dorsal sac	Definitely, but not strongly ciliated. In a particular case (*Solaster papposus*) the current passed sinistrally across the roof, and dextrally* across the floor of the sac.
Axial sinus (general lining)........	On the whole aboralwards, and therefore tending to sweep particles towards the madreporite (see **4**, p. 246).
Pore-canal system of madreporite.	Weakly aboralwards.
Interior of stone-canal	Strongly oralwards (see **4**, p. 269).
Surface of stone-canal looking into axial sinus.	Somewhat indefinite, strongest on the grooves between the calcareous plates of the canal-wall, and following the lines of these grooves, but on the whole with an aboral tendency.
Perihæmal spaces (aboral, oral, circular, and radial sinuses).	Ciliation feeble, flickering, strongest on surface of hæmal tissue; no definite direction of resulting currents noted.
Lining of sucker-feet	Upwards into arm along inner side, *i.e.*, side nearest middle line of arm; downwards towards sucker along outer side, *i. e.*, side furthest away from middle line of arm. Similar currents are found within the ampullæ, *i. e.*, upwards on inner aspect of ampullary wall, laterally outwards within dome of ampulla, and downwards towards sucker on outer wall of ampulla.
Peribranchial spaces and spaces of body-wall.	No ciliary activity made out.

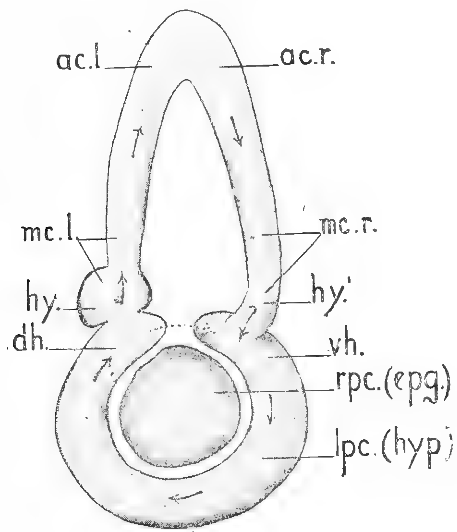
General.—The aboralward ciliation of the lining of the axial sinus is of importance, since by its means particles may be swept from the axial sinus into the stone-canal or the pore-canals (see **4**, p. 270). The fact that the perihæmal spaces are ciliated does not seem to have been previously ascertained. The absence of ciliation from the lining of the peribranchial spaces is a point of considerable interest.

* Clockwise as viewed aborally.

6. Relation of Larval to Adult Ciliation.

While it is true that the larval ciliation passes into that of the adult, the changes in shape and structure which take place at metamorphosis are so profound that in the end only a few details of correspondence between the two systems can be made out. Taking *Asterias rubens* as the type, we note that the oralward ciliation of the circumoral field (food-gathering area, **4**, p. 240) in the larva is probably related to the oralward ciliation of the ambulacral grooves in starfish generally and in Crinoids. In further correspondence, we find that the whole or greater part of the buccal membrane in *Astropecten*, *Porania*, and *Solaster* is ciliated towards the mouth. Perhaps the outwardly lashing cilia of the peristomal band (**4**, p. 239) on the lower lip of the larva may have supplied the basis of the similarly acting cilia at the actino-stomial margin of *Porania*.

Text-figure 2.



Illustrating the circular movement of the cœlomic fluid in the late larva and in the perivisceral cavity of the adult.

ac.l., *ac.r.*, left and right anterior cœloms; *mc.l.*, *mc.r.*, left and right middle cœloms; *dh.*, *vh.*, dorsal and ventral horns of the left posterior cœlom; *hy.*, *hy.'*, hydrocœle, and right hydrocœlic region; *lpc.* (*hyp.*), left posterior or hypogastric cœlom; *rpc.* (*epg.*), right posterior or epigastric cœlom.

Within the perivisceral cavity of the adult, the slight circular dextral movement of the contained fluid appears to be represented in the late larva by a circuit which includes the left posterior cœlom, as well as the left and right anterior and middle cœlomic regions (see **4**, p. 245). The left posterior cœlom gives rise to the main part of the adult perivisceral cavity, and in the late larva the circulation of the fluid is from the ventral round to the dorsal horn of the cœlom in question, then through the left and right middle and anterior cœlomic regions back to the ventral horn. At metamorphosis, the dorsal and ventral horns become united and are closed off from the other cœlomic regions named, which for the most part become obliterated, the left middle one, however, giving rise to the hydrocœle. The circuit thus becomes limited to the perivisceral cœlom and the flow is naturally dextral as viewed from the aboral aspect. These points are illustrated in the appended text-figure.

The ciliation of the perihæmal sinuses in the adult is in agreement with the fact of their direct enterocœlic origin.

As regards endoderm, the greater part of the œsophagus of the larva is retained at metamorphosis, and gives rise to the pharyngeal portion of the adult gastric cavity. The larval œsophagus is ciliated towards the stomach, and we note that the pharyngeal portion of the adult gastric cavity is similarly ciliated. Within the stomach of the early larva, food-particles are churned round dextrally as viewed from its anterior extremity (**4**, p. 240). Something similar occurs within the gastric cavity of the adult (p. 7). In late larvæ, when the stomach has reached full size, oralward currents appear over a large part of its fundus. These are probably represented in the adult by the oralward and centrifugal currents, which one finds on the interradial portions of the stomachal and pyloric sac-regions of the gastric cavity.

II. Ciliation and Feeding.

In Asterids a large part of the actinal epiderm is derived phylogenetically and also in many cases ontogenetically (*Solaster* **2**, *Asterias* **4**) from the preoral lobe and from the region which in the feeding types of larvæ (*Asterias*) surrounds the larval mouth and includes the circumoral or food-gathering area (**4**, p. 240). No doubt the bilateral ancestor of Echinoderms obtained its nutriment through ciliary action, as is still done by all feeding Echinoderm larvæ and by the Crinoids. The oral or centripetal currents which one finds in the ambulacral grooves of starfishes are probably of ancestral origin. Recently, certain observations raised the question in my mind whether particular starfishes do not still obtain a portion of their nutriment through ciliary action.

PORANIA PULVILLUS. (Pl. I. fig. 1.)

The observations in question were concerned in the first place with the pin-cushion starfish, *Porania pulvillus* (O. F. M.), their starting-point being the fact that in investigating the actinal ciliation in this starfish with the help of suspended carmine particles, I found that there were periods during which extremely active ingestion of the particles through the mouth into the stomach occurred. The following structural or functional peculiarities in *Porania* next claimed attention. Taken as a complex they seem direct adaptations for ciliary nutrition :—

1. The cilia all over the actinal surface (in ambulacral grooves, round bases of spines bordering these grooves, on actinal intermediate areas, on buccal membrane, and on denticles) act in such a way that streams of particles are continually converging on the mouth-opening.

2. The general shape of the starfish with its large flat intermediate areas, ensures that there is an extensive circumoral ciliated field, adapted for food-gathering purposes.

3. The endodermal ciliation sweeps particles which have entered the mouth into the recesses of the digestive system. We note, in this connection, the aboralward ciliation of the pharyngeal and radial stomachal regions, the centrifugal ciliation of the floor-grooves of the radial cæca, the centripetal ciliation of the roof-grooves of these cæca and of the radial grooves in the roof of the pyloric sac, the aboralward ciliation of the intestine, and the centrifugal ciliation within the interradial cæca.

4. Every specimen of *Porania* that I have watched long enough has shown periods, sometimes lasting several hours, during which at sub-regular intervals the anus opens and a considerable quantity of clear fluid (two to four grammes) is forcibly expelled therefrom. In a particular specimen this occurred, on an average, at intervals of eleven, in another of twenty-five, and in another of forty minutes. Simultaneous observation by means of a suitably adjusted microscope showed that shortly after each expulsion of water from the anus there began a period of active ingestion of carmine particles by the mouth and that this period ceased just prior to the next expulsion.

5. Mucus is secreted by the epiderm of the oral surface and also by the gastric endoderm. To judge by what happens with carmine particles, this mucus is capable of entangling small food-particles, and of so causing the formation of rafts or ropes of nutritive material which travel slowly into the recesses of the digestive cavity.

6. On killing a specimen which had lived for some time in water with an admixture of carmine particles and had exhibited the phenomena described under 5 above, I found carmine particles in the gastric cavity and in the radial cæca. Again, in the case of living specimens which had been "fed" on carmine, abundance of the particles appeared in the fluid expelled from time to time by the anus. In preparations of the living tissues one can demonstrate the readiness with which particles are swept into and out of the radial cæca, collected round the entrance to the intestine, and even (though this occurs less easily) carried along the intestine into the rectal cæca.

7. The interradial or rectal cæca of *Porania* are exceptionally

large, and are present uniformly in all the interradii. They have distinctly muscular walls which contract and expand rhythmically at short intervals, sometimes with such activity as to suggest the systole of the auricular portion of a heart. As observed in living preparations, the contractions do not usually affect all the cæca, or indeed the whole of a single cæcum, at one time, but probably in nature minor contractions of the cæca or of parts of them are continually occurring, serving to cause changing of the contained fluid. It will be remembered from pp. 7–8 that there is no ciliary provision for outgoing currents from the rectal cæca. Presumably, it is the more or less simultaneous contraction of the whole set that produces the periodical expulsion of water through the anus, which was referred to under 4 (p. 11). Turgidity may provide the stimulus to this act. At any rate, simple pressure by the fingers on the aboral aspect of a distended *Porania* will often, after the lapse of a few seconds, induce a perfectly typical expulsion of fluid by the anus. The body-wall in *Porania* is unusually thick and elastic, and when the anus closes these properties may be of use in causing negative pressure within the different parts of the digestive cavity, and thereby aiding the parts to become filled again with fluid entering by the mouth and loaded with particles collected by the actinal ciliation. The interradial or rectal cæca of *Asterias rubens* and of the majority of starfishes are much smaller and less uniform than those of *Porania*. However, alike in *Asterias rubens*, *A. glacialis*, *Solaster papposus* *, and *S. endeca*, these cæca show contractility, and probably have to do with the passage of material along the food-canal and with the evacuation of fæces.

8. After specimens have been deprived of solid food for a time, the addition to the aquarium of finely-divided nutritive material, *e. g.*, débris from the ovary of a sea-urchin, spermatozoa, etc., is almost invariably followed in the course of a few hours by an increase in the weight of the specimen. This increase is lost a day or two after replacement in clean water, and is, I think, to be explained by the taking for the time being of extra fluid into the digestive cavity along with the suspended food-particles. Specimens kept in a glass vessel, through the wall of which their oral surfaces can be observed with the help of a microscope, will often be found to respond to agitation of the water near them by opening the mouth, partially protruding the pharynx, and actively swallowing food-particles. One must exercise much caution in attempting to feed *Porania* with sperm. Individuals, if left too long (24 hours) in a mixture showing only slight milkiness, may distend themselves with water to an extreme degree, sometimes reaching more than twice their former weight. This is usually followed, in my experience, by loss of vitality leading to death within a week or ten days, the sperm or

* See footnote on p. 15.

its products, or simply the great distention, having a markedly injurious effect.

9. If the oral surface of a *Porania* be sharply irritated, the spines at the interradial angles of the mouth will close in and by interdigitating with each other will cover up the mouth-opening completely. In the same way the whole or any part of an ambulacral groove (see Pl. I. fig. 1 *Amb. Gr.'*) can be entirely shut in by the spines on opposite sides of the groove. We seem to have here a ready means of protecting the mouth from exposure to streams of inacceptable or injurious particles.

10. It may be said that all the details given above are to be explained in terms of endodermal respiration. Probably this kind of respiration occurs in our species, as, indeed, it does in other aquatic animals (7). Certainly in captivity *Porania* exhibits remarkable power of healing after injuries to the body-wall. But were internal respiration the only or the principal function, one would expect this function to be cared for in other starfishes, and particularly in such a starfish as *Asterias rubens*, which feeds in the ordinary way far more greedily and must accordingly exhibit far greater tissue change than *Porania*. Yet inward currents of water through the mouth cannot be observed in *A. rubens*, nor does rhythmic expulsion of water through the anus occur. However, for final evidence on the relation of ciliary action to nutrition we must have recourse to observations on the behaviour of *Porania* and other starfishes under circumstances which preclude them from obtaining food by any other means than the action of ciliary currents. Accordingly the following and similar experiments were instituted.

A starfish after being carefully weighed was placed in a bell-jar, the wide end of which was covered by hair-cloth of fine mesh, while the narrow end was connected to a siphoning tube. Next, the bell-jar was immersed in one of a series of tanks with continuous sea-water circulation, and outward siphon action was started by means of the tube from the bell-jar into another tank set lower in the series. Constant change of water within the bell-jar was thereby assured, and at the same time the entrance into the bell-jar of all objects of any size was effectually prevented. At intervals the starfish was taken out and weighed and the interior of the bell-jar cleaned. The first specimen of *Porania* was put in on Feb. 28, 1914. At the end of four and a half months, the mean of several weighings done within the last week of this period was practically the same as the mean of the weighings done in the first week of the period. Thus nothing at all was lost between the end of February and the middle of July, that is, during the period when microscopic food-particles are most abundant in the tanks. Since July there has been some loss of weight, but the specimen is still healthy (October 18). Several other *Porania* similarly treated have remained healthy for almost as long a period, and the smallest of these increased slightly in weight during the months of May, June, and July. In control experiments, specimens of the common Crossfish, *Asterias rubens*, kept under like conditions, lost weight steadily and died, as a rule, in less than eight weeks. We may note in this connection that the sucker-feet of *Porania* are arranged only biserially, and that they are neither particularly strong nor are they kept actively in use. At the Millport Marine Station the *Porania* are never seen feeding on shell-fish etc., or on their neighbours as other species readily do. Yet for several seasons the *Porania* have remained healthy in the tanks as long (nine months or thereby) as circumstances made it convenient to keep them.

In view of the data given under 1–10 above, it is, I think, impossible to escape from the conclusion that ciliary feeding plays a part in the nutritional economy of *Porania*.

Astropecten irregularis (Pl. I. fig. 2).

It will be seen from the details given on pp. 6–7 that the general arrangement of the cilia in *Astropecten* is suggestive of ciliary nutrition. Strong oralward currents run in the ambulacral furrows, being fed by lateral streams coming from the roof and sides of the disc and rays along the grooves between the transverse rows of ambulacral spines. The interradii are powerfully ciliated towards the mouth along avenues bordered by short, thickly clustered spines. The whole aboral surface underneath the great paxillary umbrella has its ciliation so arranged that particles which manage to get through between the tips of the spinelets into the subpaxillary space can hardly fail to be swept ultimately to the mouth-opening, by way of the interradial or the ambulacral grooves. The denticles, or large spines of the interradial angles, are ciliated from base to apex, and frequently project right into the mouth. If a specimen, after removal of the aboral body-wall and the roof of the stomach, be placed mouth downward in a shallow dish of water with suspended carmine particles, a very active upward eddy of particles through the mouth will soon be found to occur. The tube-feet of *Astropecten* are pointed, and the animal habitually crawls on or burrows in sand. It will, of course, find shell-fish and other animals to feed on there, and, as a matter of fact, I have taken out relatively large shells from the stomachs of dissected specimens. But the sand will also contain abundance of microscopic food-particles. The tiny spinelets which make up the paxillæ are weakly ciliated from the base to apex. The conjecture may be hazarded that this ciliation, while keeping out débris, will not prevent the more active microscopic organisms from getting past the spinelets into the subpaxillary space. Once there they will of necessity be swept towards the mouth, and get the chance of passing into the stomach and being entangled in mucus. An anus being absent, waste water would have to escape through the mouth, as occurs in the feeding starfish-larva (4, p. 240). However, I have not yet kept *Astropecten* alive for long periods under the experimental conditions described above in connection with *Porania*; and as regards the ciliation it must be remembered that, in a burrowing starfish, general and local respiration will best be promoted by currents drawn from the aboral surface and the arm-tips.

SOLASTER PAPPOSUS, and OTHER STARFISHES.

S. papposus has powerful sucker-feet, the bi-serial setting of which is more than compensated for by the increased number of the rays. It feeds readily on almost any kind of animal food, and in general the ciliation on the oral aspect, except in the ambulacral grooves, is away from the mouth. However, these grooves are numerous: an oralward current sets in strongly along each; active ingestion of carmine particles may occasionally be observed to take place; opening of the anus and expulsion of fluid occur repeatedly * at certain times; carmine particles may be present in the fluid expelled, if the specimen has been previously kept in water with this substance in suspension; and, finally, particles of carmine may be found after death in the stomach of a similarly treated specimen. Small Solasters kept under the experimental conditions described in connection with *Porania* lose weight and die off, but not so quickly as similarly-treated specimens of *Asterias rubens*. On the whole, I should judge that while ciliary feeding may, and probably does, occur to some slight extent in the Solasters, it is a side result of other processes which subserve endodermal respiration and emptying of the food-canal.

As regards other starfishes, I have had the opportunity of investigating the ciliation on the oral surfaces of *Asterias rubens*, *A. glacialis*, *A. mülleri*, *Henricia sanguinolenta*, *Asterina gibbosa*, and *Palmipes placenta*. In none of these, however, are there currents towards the mouth except along the ambulacral grooves, and, so far as my experiments have gone, none has approached *Porania* in ability to survive after deprivation of solid food.

Bearing on Phylogeny.

It is generally agreed that the ancestor of Echinoderms was a bilaterally-symmetrical ciliary-feeding pelagic organism, and that radial symmetry was acquired during a stage of fixation.

* In the tanks at the Millport Marine Station, where the Solasters feed freely, the fluid expelled is dark green in colour, and is thrown out with considerable force. In a particular specimen of large size, expulsions were observed to occur at intervals averaging eight minutes during a period of an hour and a quarter, the anus remaining open for from 4 to 6 seconds on each occasion. The first two or three expulsions were powerful, the stream of coloured matter emitted into the water reaching a length of nine inches. Ejection became weaker thereafter, and ceased at the end of the period named. I am indebted for these data to Mr. R. Elmhirst, Superintendent of the Millport Station, and to the Rev. W. Steven, B.A.

The view put forward by Semon (**6**) that the first Echinoderms were *Pentactula*-like forms (whose nearest representatives are now to be found among the *Synaptidæ*) has proved unsatisfactory on many grounds. If we follow the *Pelmatozoon* theory, of which Bather (**1**) is a foremost supporter, we must figure the Proto-echinoderm as a Cystid-like animal. But from the embryological point of view, as was first brought out by MacBride, there are strong objections to deriving the Asterids from any form which was or had been attached by the (larval) right or the (adult) aboral aspect, and in his memoir on the development of *Asterina*, MacBride (**5**, p. 398) put forward the view that the Asteroids and Crinoids separated off from each other as early as the fixed stage of the ancestor.

It seems to me that recent embryological evidence and, in particular, the data from *Asterias rubens* L., strongly support this view, or, at any rate, that part of it which derives the Asterids directly from the fixed ancestor. The larva of *A. rubens* is a feeding bipinnaria, and conforms almost exactly to the conventional *Dipleurula*. It has, as I believe, a primitive circulatory centre (**4**, p. 273) resembling that found in the Enteropneusts and Pterobranchs, the phyla most nearly allied to the Echinoderms. It develops an attaching organ in the middle line anteriorly, fixes itself, bends leftwards, and gradually acquires radial symmetry. During this process, the larval œsophagus, stomach, and intestine are retained, while the changes undergone by the cœlomic cavities are perfectly simple and direct. The attaching stalk, now connected with the oral side of the disc, becomes separated off after the sucker-feet have acquired adhesive and locomotor functions. On the other hand, the only Crinoid larva we are acquainted with (that of *Antedon*) is quite unlike a *Dipleurula*. It does not feed for itself, and the ontogenetic development of its alimentary canal and cœlomic cavities is very different from any course that could have been followed in evolution. In view of these facts, it seems to me that we are compelled to derive the Asterids from the fixed ancestor directly and not through the intermediary of a Pelmatozoic form. But the acquirement of radial symmetry could only take place during an evolutionary period of great, if unknown, duration, and throughout the later portion of this period the attaching stalk must have been connected with the oral aspect, and this aspect must have been turned towards the sea-bottom or the surface of attachment. The difficulty now presents itself that the characteristic Asterid mode of obtaining food seems incompatible with this kind of fixation. MacBride's suggestion (**5**, p. 394) that the evolutionary change took place at parts of the sea-bottom, where currents were continually bringing along objects which might be seized upon by the adhesive tentacles, is of too "ad hoc" a nature to be entirely satisfactory without supplemental data. But if we find that ciliary feeding still occurs in an adult starfish, we have a hint of the manner in which nutritional continuity was maintained. The fixed ancestor fed by ciliary activity during the time when it was becoming, and at first after it had become, an Asterid. It is not necessary that an attached ciliary-feeding organism should have its food-collecting area looking away from the surface of attachment. Given an aboral skeleton, the advantage will be the other way so far as protection from enemies is concerned. The softer oral field could be closely appressed when necessary to the surface of attachment through the agency of the adhesive tentacles, which became evolved into the sucker-foot system. "Easing up" from the surface (cf. *Crania*) would allow ciliary feeding at any time. The tentacles might also begin to capture drifted or moving prey, as MacBride suggested. But in any case gradual perfection of the adhesive function of the tentacles would allow atrophy and separation of the attaching stalk, and, with freedom of movement now possible, opportunities for the capture of the larger kinds of food would be vastly increased and would be utilised sooner or later. Ciliary nutrition would thus be first supplemented and afterwards completely (most Starfish), or partially (*Porania*), replaced. It is worthy of note in this connection that the larval history of *Porania*, so far as it is known, exhibits all the primitive characters referred to above in connection with the development of *Asterias rubens*.

Summary.

A. *Ciliary Action.*—The arrangement of the ciliary currents on the various surfaces of four widely different species of Starfishes has been described in detail. This arrangement is constant for all individuals in each of the species, and, except as regards external surfaces, is practically the same in all the species. Everywhere the arrangement has been shown to be explicable by physiological needs. Ciliation in the perihæmal spaces has been demonstrated.

B. *Ciliary Feeding.*—In the case of *Porania pulvillus* a mechanism for ciliary feeding has been shown to exist, and the results of experiment demonstrate that this kind of feeding actually takes place. As regards *Astropecten*, it is only shown, so far, that the arrangement of the actinal and abactinal cilia makes ciliary feeding possible. In *Solaster papposus* ciliary feeding probably takes place, but in an entirely minor degree. The other Starfishes examined gave negative results. The important bearing of the above results on questions of phylogeny is briefly discussed.

References.

1. Bather, F. A.—Art. "Echinoderma," Encycl. Brit. 11th ed. vol. viii. p. 875.

2. GEMMILL, J. F.—The Development of the Starfish *Solaster endeca* Forbes. Trans. Zool. Soc. London, vol. xx. pp. 1–71, pls. i.–v. (1912).

3. GEMMILL, J. F.—The Larva of the Starfish *Porania pulvillus* (O. F. M.). Report Brit. Assoc. 1913, Section D, p. 511.

4. GEMMILL, J. F.—The Development and Certain Points in the Adult Structure of the Starfish *Asterias rubens* L. Phil. Trans. Roy. Soc. London, 1914, B, pp. 213–294.

5. MACBRIDE, E. W.—The Development of *Asterina gibbosa*. Q. J. M. S. London, vol. xxxviii. pp. 339–411.

6. SEMON, R.—Die Entwickelung der *Synapta digitata* und die Stammesgeschichte der Echinodermen. Jen. Zeitschr. Natw. vol. xxii. pp. 175–302 (1885).

7. STEPHENSON, J.—On Intestinal Respiration in Annelids. Trans. Roy. Soc. Edinb. vol. xlix. pt. 3 (no. 14), pp. 735–829.

EXPLANATION OF THE PLATES.

Lettering and Signs.

Amb.Gr.	Ambulacral groove.
Amb.Gr.'	In fig. 1, portion of an ambulacral groove covered in by interlocking of spines (see p. 13).
Amp.	Ampulla of sucker-foot.
Cœl.	Perivisceral cœlomic cavity.
G.	Gill.
G.'	Three inframarginal gills (abnormal) in the *Porania* shown in fig. 1 (see p. 21).
Gon.	Gonad.
Gr.	Groove separating stomachal from pyloric-sac portions of gastric cavity.
Inf. A. ...	Infero-lateral angle of arm.
Int.	Intestine.
Ir.S.	Interradial septum.
Phar.	Pharyngeal portion of gastric cavity.
P.V.	Polian vesicle.
Py.C.	Pyloric cæcum.
Py.Mes.	Space between the two dorsal mesenteries of a pyloric cæcum.
R.C.	Rectal cæcum.
Rad.C. ...	Radial canal of water-vascular system.
Stom.	Stomachal region of gastric cavity.

● Current centripetal and at right angles to plane of drawing.

+ Current centrifugal and at right angles to plane of drawing.

⟶ Current as arrow points and in plane of drawing.

●⟶ Current as arrow points and in plane of drawing, but with centripetal tendency.

(⟶) Current as arrow points and in plane of drawing, but with spiral tendency.

PLATE I.

Fig. 1. A specimen of *Porania pulvillus* from the oral aspect, with arrows indicating the direction of the ciliary currents. See description on p. 3 and, in connection with feeding, p. 10. This specimen showed three inframarginal gills (*G.'*), and is therefore so far an exception to the rule that in phanerozonate Starfishes the gills should be confined to the supramarginal surface (see p. 21).

2. *Astropecten irregularis*, with arrows indicating the direction of the subpaxillary ciliary currents on the aboral aspect, and also of the currents in the marginal, interradial, and ambulacral grooves. See description on pp. 3, 14.

Plate II.

Fig. 3. Transverse section (diagrammatic) of arm of *Asterias rubens* L., showing direction of ciliary currents on the various ectodermal, enterocœlic, and endodermal surfaces, and also within the cavities of the sucker-feet and ampullæ. For the sake of simplicity, only one sucker-foot is shown on either side of the middle line. Centripetal (p. 2) currents are marked by dots and centrifugal currents by crosses. Ordinary arrows show currents running in the plane of the paper, that is, transversely to the axis of the arms; while arrows with a dot on the shaft indicate that there is in addition a centripetal tendency. Arrows enclosed in an ellipse indicate currents flowing in the direction to which the arrow points, but tending to take a spiral course.

4. Transverse section (diagrammatic) of arm of *Porania*, showing direction of ciliary currents. The same general explanation applies to this figure as to fig. 3.

Plate III.

Fig. 5. Vertical section of *Porania* passing along one of the arms, and somewhat obliquely across another arm to show body-wall after removal of stomach. As in figs. 3 and 4 the arrows indicate currents approximately in the plane of the paper, while the dots show centrifugal and the crosses centripetal currents. The tendency to dextral movement is indicated by the curved arrows on the edge of the interbrachial septa (pp. 6, 9).

6. Vertical section (diagrammatic) through stomach etc. of *Porania* to show direction of ciliary currents on the endodermal and splanchnopleural surfaces. At the actino-stomial margin the ring of buccal membrane with outward ciliation should be noted.

2. Abnormal Gills in the Starfish *Porania pulvillus* O. F. M.

By James F. Gemmill, M.A., M.D., D.Sc., F.Z.S.

[Received October 1, 1914: Read February 23, 1915.]

(Text-figure 1.)

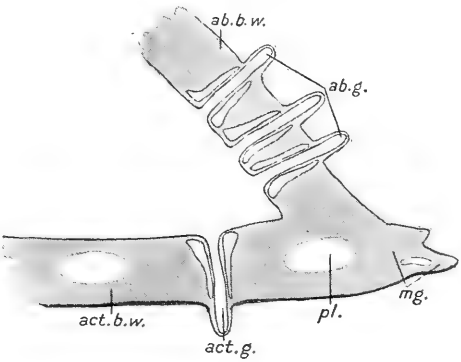
The genus *Porania* belongs to the Gymnasteriidæ, a family of the Phanerozonia (Sladen, **6**, pp. xxxiii, 360). In *P. pulvillus* the disc is large and the arms short, and the actinal and actinal-intermediate areas are flattened, so that they rest more or less closely against any surface to which the starfish is adherent. The margin or boundary between the actinal and abactinal areas forms a sharp angle and is exceptionally well defined owing to (*a*) the contrast in colour between the white actinal and the crimson abactinal surfaces, and (*b*) the presence of spines which project horizontally outwards from the margin and are set on the marginal plates. The actinal intermediate plates are very regular and are arranged in short rows, standing out more or less at right angles to the rays, but sloping slightly towards the mouth. Superficially on the actinal epiderm, ciliated grooves overlie the interspaces between the rows of plates. On the abactinal surface near the margin, the papulæ or gills come close down to the superomarginal plates.

Apart from the superficial grooves above mentioned, the actinal intermediate areas, as a rule, are smooth and destitute of gills, spines, or other growths, except along the margins of the ambulacra, which are bordered by double or triple rows of spines. However, in a preserved specimen from the Millport Marine Station, which I examined for other purposes, there appeared on the actinal surface a set of opaque papillæ arranged with no little regularity, one in each of the grooves above mentioned, a short distance inwards from (*i. e.* to the oral side of) the margin. These papillæ, being soft, were obviously not spinous in character, but, owing to the thickness and opacity of the body-wall, the question whether they were gills could not be satisfactorily decided by inspection, even after the cœlomic cavity was laid open and viewed from inside. Serial sections were accordingly made, and the structures referred to were then found to be perfectly typical papulæ or gills. The accompanying figure illustrates somewhat diagrammatically a section, vertical to the marginal edge, showing one of the infra-marginal and three of the supra-marginal gills.

As Joh. Müller first noted (**5**, p. 163) and as was emphasised later by Sladen (**6**, p. xxiv), starfish which possess well-developed marginal plates have their papulæ or gills limited to that part of the abactinal surface which is bounded by the supero-marginal plates. This provides one of the important distinctions between the Orders Phanerozonia and Cryptozonia, these Orders being called by Sladen, in consequence, the Stenopneusia and Adetopneusia respectively.

That the division in question is not an altogether natural one has been pointed out by various authorities (*e. g.* Jeffrey Bell, **1**, and MacBride, **4**). Further, as I have recently proved (**2**), the larval history of the phanerozonate *Porania* resembles in its essentials that of the typically cryptozonate *Asterias rubens* L. (**3**), both species having a feeding bipinnarial larva which changes into a brachiolaria and becomes attached at metamorphosis. Probably the occasional presence of infra-marginal gills in *Porania* is

Text-figure 1.



Porania pulvillus.

Vertical section through interradial marginal edge, showing the abnormal distribution of gills.

ab.b.w., abactinal body-wall; *ab.g.*, abactinal gills; *act.b.w.*, actinal body-wall; *act.g.*, actinal gill; *pl.*, part of a marginal plate; *mg.*, marginal edge, with spine.

not due directly to atavistic or ancestral causes, but is a parallel manifestation, in an individual belonging to a particular asterid Family, of a tendency or potency which has been fully realised in the various members of numerous other Families.

In any case, the specimen of *Porania* here described * deserves notice, because, although, as is well known, the Linckiidæ (**6**, p. 397) include genera some of which have, and others have not, actinal gills, no instance of abnormal gill-distribution within a particular phanerozonate species appears to have hitherto been recorded.

* Three other specimens of *Porania* with actinal gills have recently been obtained at Millport. Several such gills are present in the specimen illustrated in fig. 1, Pl. I. of the preceding paper.

References.

1. Bell, F. Jeffrey.—National Antarctic Expedition Results: Natural History. Vol. iv. Echinoderma, i. p. 8.
2. Gemmill, J. F.—The Larva of the Starfish *Porania pulvillus* (O. F. M.). Report Brit. Assoc. 1913, Section D, p. 511.
3. Gemmill, J. F.—The Development and Certain Points in the Adult Structure of the Starfish *Asterias rubens* L. Phil. Trans. Roy. Soc. London, 1914. B. pp. 213–294.
4. MacBride, E. W.—Cambridge Natural History, vol. i. p. 461.
5. Müller, Joh.—Ueber den Bau der Echinodermen. Abh. Akad. Wiss. Berlin, 1853 (1854), p. 163.
6. Sladen, W. P.—Report on the Scientific Results of the Voyage of H.M.S. 'Challenger.' Zoology, vol. xxx.

3. Contributions to a Study of the Dragonfly Fauna of Borneo.—Part III. A Collection made on Mount Kina Balu by Mr. J. C. Moulton in September and October 1913. By F. F. Laidlaw, M.A. (Camb.), F.Z.S.

[Received October 1, 1914: Read March 9, 1915.]

(Text-figures 1–5.)

Index.

List of the Species.

ANISOPTERA.

Libellulidæ.

Libellulinæ.

1. *Orthetrum glaucum* (Brauer) *.
2. *O. testaceum* (Burm.).
3. *O. clelia* Selys.
4. *Trithemis aurora* (Burm.).
5. *T. festiva* (Ramb.).
6. *Zygonyx iris* Selys.

Corduliinæ.

7. *Macromia euterpe*, sp. n.
8. *Macromidia fulva*, sp. n.

ZYGOPTERA.

Agrionidæ.

Agrioninæ (=Calopteryginæ *sensu* Selys).

9. *Matronoides cyaneipennis* Foerster.
10. *Vestalis amœna* Selys.
11. *Pseudophæa subnodalis*, sp. n.
12. *P. basalis*, sp. n.
13. *P. subcostalis* Selys.
14. *Devadetta argyroides* (Selys).
15. *Rhinoneura villosipes*, gen. et sp. n.
16. *Rhinocypha moultoni*, sp. n.
17. *Rhinocypha* sp.

Cœnagrioninæ (=Agrioninæ *sensu* Selys).

18. *Cœliccia nemoricola* Laidlaw.
19. *Protosticta kinabaluensis*, sp. n.
20. *Ceriagrion* sp.
21. *Stenagrion dubium* (Laidlaw).

ANISOPTERA

Libellulidæ.

Libellulinæ.

1. Orthetrum glaucum (Brauer).

Orthetrum glaucum Ris, Cat. Coll. Selys, x. pp. 233–234 (1909).

* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules on Nomenclature (Proc. 7th Int. Cong. Boston, 1907, p. 44 (1912)).—Editor.]

2 ♂ ♂ ad. 30.9.13 (Nos. 29, 69, 1914). 1 ♂ juv. 16.9.13 (No. 51, 1914). 1 ♀. 4.9.13, circ. 3000 ft. (No. 73, 1914). 2 ♀ ♀. 16, 30.9.13 (Nos. 3, 35, 1914).

This species has been captured previously on Kina Balu by Everett.

2. Orthetrum testaceum (Burm.).

Orthetrum testaceum testaceum Ris, Cat. Coll. Selys, x. p. 235 (1909).

Orthetrum testaceum, id. Ann. Soc. Entom. Belg. lv. 1911, p. 252.

8 ♂ ♂. 30.9.13 (Nos. 26, 27, 28, 30, 31, 33, 36, 71, 1914).

3. Orthetrum clelia Selys.

Orthetrum pruinosum clelia Ris, Cat. Coll. Selys, x. pp. 239, 242 (1909).

3 ♂ ♂, 1 ♀. 29–30.9.13 (Nos. 9, 34, 40, 67, 1914).

These specimens must, I believe, be referred here. I note, however, that the adult male has the third abdominal segment dusted over with a bluish bloom, as well as the first and second segments.

4. Trithemis aurora (Burm.).

Trithemis aurora Ris, Cat. Coll. Selys, xiv. pp. 775–778, fig. 442 (1912); id. Ann. Soc. Entom. Belg. lv. 1911, p. 254; Laidlaw, Records Indian Mus. viii. (iv.) p. 338 (1914).

1 ♂. 1.10.13 (No. 21, 1914). 1 ♀. 20.9.13 (No. 63, 1914).

5. Trithemis festiva (Ramb.).

Trithemis festiva Ris, Cat. Coll. Selys, xiv. pp. 796, 798, figs. 456, 457 (1912).

2 ♂ ♂. 16.9.13 (No. 18, 1914). 1 ♂. 16.9.13 (No. 50, 1914), immature.

This species has been taken previously on Kina Balu by Everett.

6. Zygonyx iris Selys.

Zygonyx iris Ris, Cat. Coll. Selys, xiv. pp. 820, 823, fig. 478 (1912).

1 ♂. 20.9.13 (No. 64, 1914). 1 ♂. 1.10.13 (No. 10, 1914).

Corduliinæ.

7. Macromia euterpe, sp. n. (Text-figs. 1 & 2.)

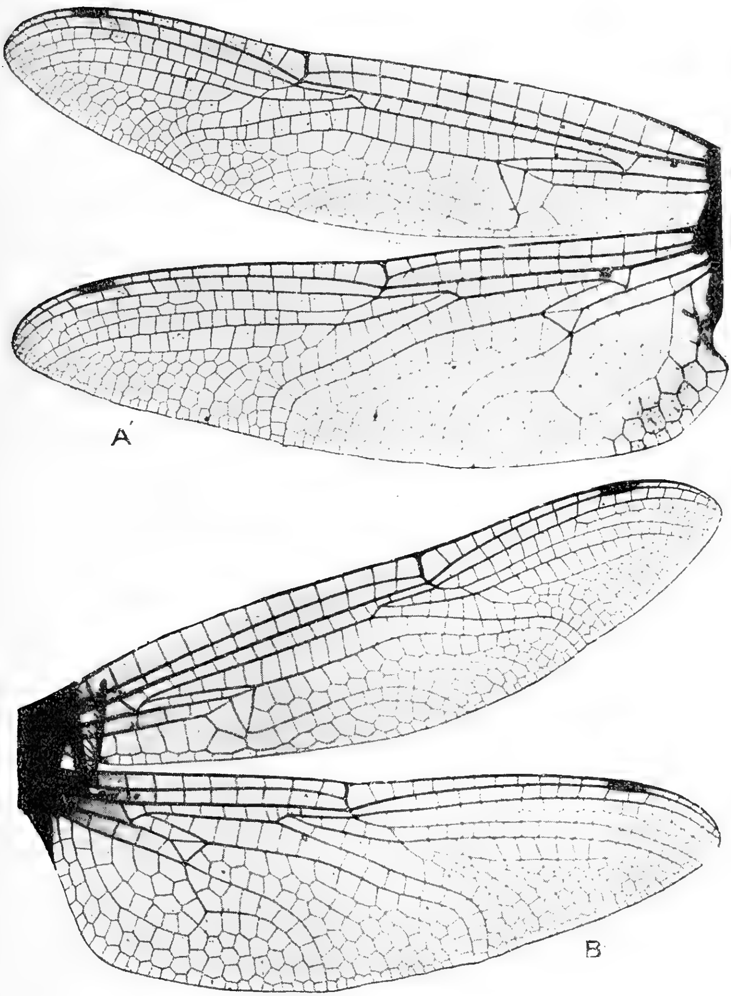
3 ♂ ♂, 2 ♀ ♀. 23.8.13, 10, 11, 12.9.13 (Nos. 7, 13, 39, 56, 58, (1914).

Length of abdomen : ♂ 40+3 mm., ♀ 44 mm.
Length of hind wing. ♂ 43 mm., ♀ 46 mm.
Length of pterostigma: 2·5 mm. or a trifle less.

Venation formula :—

	An.n.	Pn.n.	Suprat.	M.
	$\frac{14}{9}$	$\frac{9}{11}$	$\frac{3}{2}$	$\frac{5}{4}$
Extremes ...	$\frac{(13-15)}{(8-10)}$	$\frac{(7-10)}{(10-12)}$	$\frac{(2-3)}{(1-2)}$	$\frac{(4-5)}{(4-5)}$

Text-figure 1.



Macromia euterpe.

Wings of type male (A) and female (B).

♂. Wings without any trace of colouring, even at the extreme base. Pterostigmata black.

Head: Lower and anterior surfaces entirely russet-brown. Vertex a rich metallic blue.

Prothorax brown.

Thorax: Dorsal surface brown, its upper third with a metallic green reflex. Sides also metallic green, with a brown band of moderate width enclosing the stigma, continuous above with the brown interalar sinus, and below with the brown colouring of the under surface.

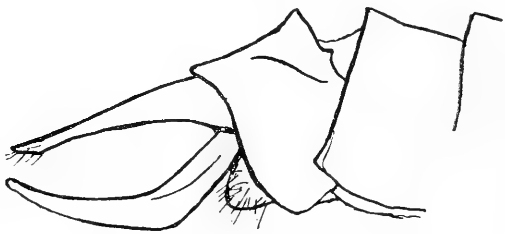
Abdomen: Segments 1, 2, 3 a little dilated, as are 7, 8, 9, the three latter each with a marked dorsal longitudinal keel; 10 with a similar keel, which is raised to form a well-marked projection at the base of the segment. The abdomen is black, save for a square yellow mark at the base of 7 on its dorsal side; this yellow mark covers roughly the first quarter of the segment.

1, 2, 3 have a distinct metallic-green lustre, which fades gradually and disappears almost entirely on 4.

The *legs* are long and entirely black.

Anal appendages (text-fig. 2) black, the lower one longer than the upper pair and distinctly bituberculate at its extremity, and

Text-figure 2.



Anal appendages of *Macromia euterpe*.

with a slight upward curve. The upper pair each carry a very small tooth on their outer margin at the middle of their length. This tooth is so small that it may be spoken of as "obsolescent."

The female in colouring scarcely differs from the male; the bases of the wings have a very faint smoky-yellow tinge.

The abdomen is, on the whole, stouter than in the male, and consequently segments 2, 3 and 7, 8, 9 not so markedly dilated.

The types ♂ ♀ will be deposited in the British Museum. Co-types ♂ ♀ in Sarawak Museum and ♂ in my collection.

In general, this species approaches *M. westwoodi* Selys. I have some doubt as to whether the male from Banka described by Selys in the 2me Addit. au Synops. Cord. is really co-specific with the female which is the type of the species. In any case the male of *M. euterpe* differs from that male in details of venation, in the position of the boss on segment 10, and in the character of the upper anal appendage, which in Selys's specimen is said to possess " une forte dent externe," a description which scarcely applies to the three males of *M. euterpe* now before me. The females for their part differ in their lesser stature, as well as in venation, from the type of *M. westwoodi*, which appears to have been lost.

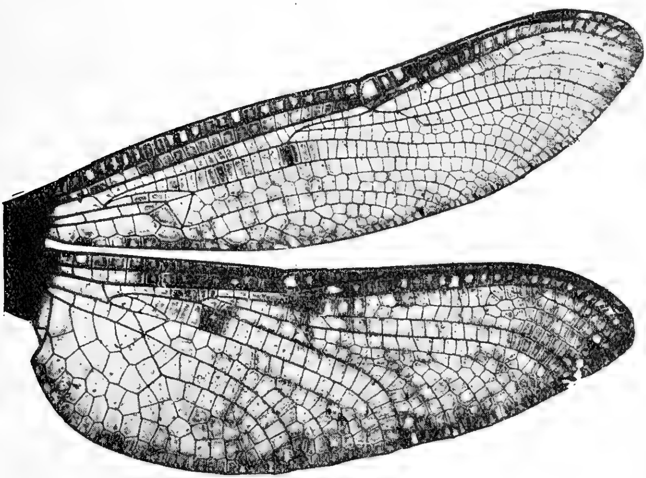
8. Macromidia fulva, sp. n. (Text-fig. 3.)

1 ♂. 11.9.13 (No. 20, 1914), fully adult.

Hind wing 35 mm., abdomen 37 mm., pterostigma 3 mm. Venation formula :—

An.n.	Pn.n.	Cu.a.	Suprat.	A.A.
21—22	12—11	3—3	3—3	
10—12	15—16	3—4	2—2	9—8

Text-figure 3.



Wings of *Macromidia fulva*, ♂.

Anal angle rather more acute, and anal margin of hind wing rather more deeply convex than in the example of *M. rapida* figured by Martin.

Wings with a marked smoky-brown tinge, deeper in costal and postcostal spaces and at extreme base. Pterostigmata grey-brown.

Head : Eyes dark brown ; upper lip yellow-brown ; the rest of the head entirely dull brown, with a slight metallic violet reflex on the frons.

Prothorax dull brown.

Thorax : Dorsal surface dull metallic greenish brown, with an ill-defined antehumeral band of yellow-brown. Sides of the same colour as the antehumeral band, with a broad metallic green-brown band under each wing.

Abdomen generally very dark brown; segments 2–7 each with a ring of lighter brown distally, in 2–4 occupying nearly the hinder half of the segment, and in 2 extending forward laterally nearly to the anterior end. In each case the extreme apex of the segment has a darker ring; 8–10 are uniformly very dark brown.

Legs reddish brown, darker at the articulations and terminal extremities.

Anal appendages uniform dark brown in colour, similar in form to those of *M. rapida*, but the lower appendage is nearly equal in length to the upper pair. The lower margin of each of the latter is more regularly curved than in that species, and there is a small projecting median ventral tooth on each.

Very closely allied to *M. rapida* Martin, the type of the genus, which was captured in Tonkin.

The type-specimen of *M. fulva* is deposited in the British Museum.

ZYGOPTERA.

AGRIONIDÆ.

AGRIONINÆ (=CALOPTERYGINÆ *sensu* Selys).

9. MATRONOIDES CYANEIPENNIS Foerster.

Matronoides cyaneipennis Foerster, Wiener Entom. Zeitung, 1897, iii.; id. Ann. Soc. Entom. Belg. xli. 1897 (sep.), pp. 1–5, fig. ii.; Laidlaw, Journ. Roy. Asiatic Soc. Straits Branch, no. 63, Dec. 1912, p. 95.

14 ♂♂, 5 ♀♀ (Nos. 78–89, 1914), taken between Sept. 4th and Sept. 19th, 1913, mostly on Sept. 11th. Two males were captured at about 3000 ft. above sea-level.

10. VESTALIS AMŒNA Selys.

Vestalis amœna Kirby, Cat. Odon. p. 103 (1890); Karsch, Entom. Nachr. xvii. 1891, no. 16, p. 243; Kruger, Stett. Entom. Zeit. 1898, p. 75; Laidlaw, Proc. Zool. Soc. Lond. 1902, i. p. 87; Williamson, Proc. U.S. Nat. Mus. xxviii. p. 183 (1904); Ris, Ann. Soc. Entom. Belg. lv. 1911, p. 234.

11 ♂♂, 5 ♀♀. One ♂, 3000 ft., 4.9.13; the other specimens 10–11.9.13, no data (Nos. 91–100, 1914).

De Selys has commented on the considerable differences in size existing in a number of specimens he examined from Labuan (3^{me} Addit. Synops. Calopt. p. 475). The extremes noted by him were as follows:—

Abdomen: ♂ 38–50 mm., ♀ 35–34 mm.
Lower wing: ♂ 31–36 mm., ♀ 32–35 mm.

Measurements of the hind wings of Mr. Moulton's specimens indicate possibly that the species presents an example of discontinuous variation. In eight of the males the wing-length is about 37·5 mm., with an extreme range between 37 mm. and 38·5 mm. In all these specimens the length of the abdomen lies somewhere about 48–52 mm.

In the rest of the males the length of the hind wing is decidedly less, about 34 mm., and of the abdomen roughly 44 mm.

Three of the females are large (length of hind wing 37·5 mm., 37·5 mm., 39 mm. respectively); the other two smaller, with a measurement of 35 mm. apiece. The length of abdomen varies broadly as the length of the hind wing. The figures are, of course, too small to admit of any certainty, but suggest a discontinuous variation in both sexes.

The more mature specimens of both sexes, whether large or small, show the smoky shading of the wings, especially near the margins. The younger individuals have the body of an intense emerald-green, in the older a more golden tone prevails.

11. PSEUDOPHÆA SUBNODALIS, sp. n.

13 ♂♂, 1 ♀. 16.9.13, 30.9.13, 1.10.13 (Nos. 11, 14, 15, 23, 24, 52, 60, 70, 72, 75, 1914).

Hind wing: ♂ 27–28 mm., ♀ 27 mm. About 26 An.n.

Abdomen: ♂ 33–35 mm., ♀ 27 mm. About 28 Pn.n.

This species is, I believe, in all probability identical with the "larger examples" spoken of by Selys in his original description of *P. subcostalis.* From examples of both species that I have been able to examine from several localities they differ in certain well-marked and constant characters.

P. subnodalis is distinctly larger. In none of the series is there a black ray in the subcostal space of the fore wing, and on the hind wing the space between R and M_{1+2} is always uncoloured up to the level of the nodus. The auricles on the second abdominal segment are relatively and actually larger than in the allied species.

In the fully adult male the whole body is a rich velvety black, excepting the upper lip and genæ, which are blue in colour and have a porcellanous texture.

Younger males show traces of pale yellow dorsal and lateral markings on the thorax. Both pairs of wings have a distinct brownish tinge, deepest in the costal spaces. The lower wing has its basal third, roughly speaking, hyaline; but the subcostal space in several specimens has a dark ray, its middle third is metallic blue or green, and its distal third is black. As already remarked, the space bounded by R and M_{1+2} is always hyaline up to the nodus; for the rest the inner margin of the metallic-blue colouring is irregular, but advances most nearly to the base of the wing in the space between M_3 and M_4. The outer margin of the colouring is a straight line approximately at right angles to the long axis of the wing.

(?) 1 ♀. 1.10.13 (No. 75, 1914).

Probably belongs to this species, which appears to be the most abundant in the district where the present specimen was captured. Wings with smoky tinge. Head as in the male, but with a small pair of orange spots, one on either side of the ocelli.

Prothorax black, with two small orange spots lying one over the other on either side.

Thorax black, pulverulent below, marked with yellow as follows:—A dorsal band and a band running along either side of the humeral and lateral sutures, the sutures themselves marked with a black line.

Abdomen black, sides of segment 1 yellow, 2, 3, 4 with a yellow lateral band, which is continued on 5, 6, and 7 as a very fine line. Appendages black.

Legs black, the femora marked on their outer sides with yellow.

The type-male and the female described above will be deposited in the British Museum.

12. Pseudophæa basalis, sp. n.

2 ♂ ♂. Kina Balu, 11–18.9.13 (Nos. 49, 65, 1914).

Hind wing 27 mm., abdomen 35 mm. An.n. 22. Pn.n. 29.

Distinguished from its allies especially by the colour-pattern of the hind wings, by the relatively small size of the auricles on the second abdominal segment, and by the well-rounded vesicle of the penis.

In both specimens the whole body and its appendages are of a rich velvety black, excepting the upper lip, the genæ, and a space on either side of the eyes in front, which is porcellanous in texture and dull grey-blue in colour. The thorax is pulverulent below.

The upper pair of wings have a smoky tinge, especially evident on the antenodal costal and subcostal spaces and at the apex of the wings.

The basal four-sevenths of the hinder wing is of a rich metallic green or blue, excepting the antenodal costal and subcostal spaces, the median space, the quadrilateral and the submedian space. These are all very deeply tinged with black. The apical three-sevenths of the wing is entirely black, with metallic reflex. The boundary between the two colours is a straight line at right angles to the long axis of the wing, lying some 10 cells beyond the nodus. The type-male is deposited in the British Museum.

13. Pseudophæa subcostalis Selys.

1 ♂. 20.9.13 (No. 62, 1914).

Hind wing: length 24 mm.

A typical example of the species. The presence or absence of a dark line in the subcostal space of the fore wing seems to be a character dependent on the maturity or otherwise of the individual. I have seen several examples from Baram and from Saribas, and except in this particular their characters are constant. The auricles are relatively a little smaller and less prominent than in *P. subnodalis*, and the space between R and M_{1+2} before the nodus is occupied by opaque metallic-green colour in all the specimens I have seen.

14. DEVADETTA ARGYROIDES (Selys).

Devadetta argyroides Kirby, Cat. Odon. p. 111.

Tetraneura argyroides Martin, Mission Pavie (sep.), p. 17.

Devadetta argyroides Laidlaw, Fascic. Malay. Zool. pt. I, p. 199.

5 ♂♂, 6 ♀♀, taken during September. Two females are noted as having been collected, one at 2800 ft., the other at 3000 ft. altitude. (Nos. 1, 2, 5, 6, 12, 19, 42, 46, 53, 66, 1914.)

RHINONEURA, gen. nov.

A genus belonging to the legion *Libellago*, and closely allied to *Rhinocypha*, to which genus the general characters of the venation indicate near relationship. The wings are long and narrow, both pairs of equal length, pterostigmata large and inflated. Abdomen long and fairly slender, surpassing the wings considerably in length. Segments 3–7 (in the male) each about four times as long as segment 2. Legs long and slender, but not reaching to the end of segment 4 when adpressed.

15. RHINONEURA VILLOSIPES, sp. n. (Text-figs. 4, 5 A.)

1 ♂. 6.9.13 (No. 59, 1914). Kina Balu.

Length of abdomen 35 mm., of hind wing 27 mm., of pterostigma 2·5 mm.; breadth of hind wing 4·5 mm.

The insect resembles in its proportions a *Diphlebia*, but is, of course, smaller than the species of that genus.

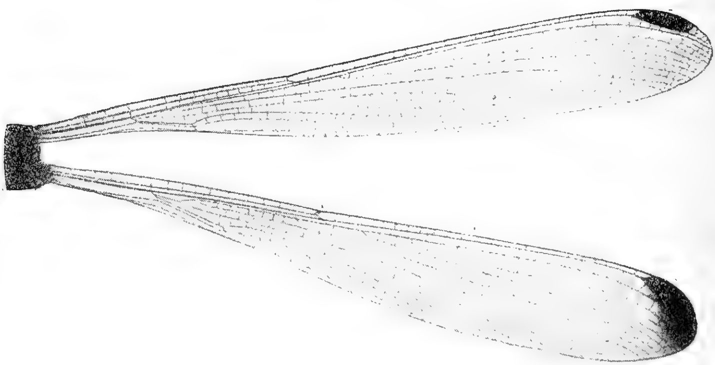
Wings (text-fig. 5 A) very narrow, transparent, with a very faint yellow tinge, except for the extremity of the hind wing, which becomes smoky brown at its apex from the level of the middle of the pterostigma. The latter is large, brownish black, with its costal and anal borders convex. Quadrilateral long and narrow, in the fore wing divided by 3 cross-nerves, in the hind wing by 4. "Sectors of the arculus" separated at their origin. 13–14 antenodal costal nerves; of these only two, viz. the first and third, are continuous with the nerves of the postcostal space, and the third lies at the level of the arculus, except in the right hind wing, where an extra (?) non-continuous antenodal lies before the level of the arculus; $\frac{26\text{–}29}{23\text{–}25}$ postnodals. The cells of the wings show none of the antero-posterior elongation characteristic of certain species of *Rhinocypha*. The nodus is distinctly proximal to a point midway between the base of the wing and the pterostigma.

Head: Lower surface black, extremities of lower lip yellow. Upper lip yellow with a fine vertical median black line; genæ yellow; the rest of the upper surface black.

Prothorax black, a pair of minute yellow dots on the anterior lobe, and on either side three irregular yellow marks.

Thorax dorsally black, with a narrow irregular antehumeral band of an orange-yellow colour, broken up into three parts on either side: of these the uppermost part curves outwards and downwards to join the yellow of the lateral surface. There is a small black mark at the top of the second suture. Under surface black.

Text-figure 4.



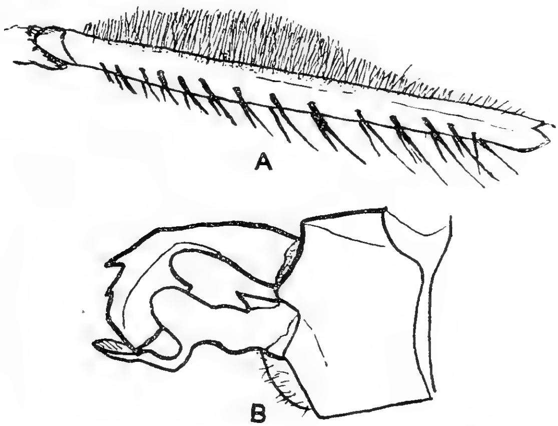
Wings of *Rhinoneura villosipes*, ♂.

Legs black, anterior surface of trochanters brown. The legs are long and slender. The third pair of femora carries on the dorsal surface of each a remarkable "fur" composed of very numerous short hairs, the longest of which are scarcely equal in length to the normal cilia of the anterior margins (text-fig. 5 A). The tibiæ are not dilated. The femora of the second pair of legs show a trace of "fur" similar to that of the third pair, but by no means so well developed.

The *abdomen* is entirely black, save for the dorsal surfaces of segments 1, 2, 3, 4, which are marked with brick-red, with black terminal rings. Segment 2 has a small black ⊥-shaped mark running back from its anterior margin. In 3 the narrow black apical ring encloses a pair of small, circular, red points. The red colour of 4 extends about four-fifths of the length of the segment, running to a fine point apically as it disappears.

Anal appendages black, the upper pair longer than segment 10, cylindrical, sharply incurved at their middles, crossing each other near their apices where their inner sides are a little flattened. Lower pair very short, conical, parallel, and slightly curved upwards.

Text-figure 5.



A. Femur of *Rhinoneura villosipes*, ♂, showing hairs.
B. Anal appendages of *Protosticta kinabaluensis*, ♂.

This very remarkable insect suggests several interesting problems. Its wings, as will be seen from text-figure 4, have all the characters which mark the small group of genera to which it belongs, and these characters in all the other genera are associated with a short depressed abdomen. The wings show a specialization approaching the condition found in the Cœnagrioninæ, unexcelled in any other group of Agrioninæ, and the question arises as to whether the specialization of the wings preceded the development of a depressed short abdomen, or whether this latter condition came into existence earlier. Or, put differently, is the long and comparatively slender abdomen of *Rhinoneura* a primitive condition lost in allied genera; or does it mark a departure in the evolution of the form which will approximate physically still nearer to the slender-bodied Cœnagrioninæ?

One would like to know something of the meaning of the "fur" on the hindermost pair of femora, but unfortunately speculation on this point is useless.

16. Rhinocypha moultoni, sp. n.

4 ♂♂, 2 ♀♀. 11.9.13, 16.9.13, 1.10.13 (Nos. 16, 22, 25, 57, 68, 1914).

Length of abdomen, ♂ 18 mm., ♀ 17·5 mm.; of hind wing, ♂ 22 mm., ♂ 24·5 mm.

Male. Wings without markings, with a faint yellow tinge over the whole. Pterostigma black, a little inflated, covering 4+ cells, 2 mm. long. An.n. 14, Pn.n. 20, on fore wing. Quadrilateral on all wings divided into 3 cells. One row of cells only between Cu_2 and anal margin of wing. Cu_2 begins to be irregular 3 cells beyond level of quadrilateral.

Head: Labium yellow, mandibles black; labrum black, with a pair of large yellow spots. Anteclypeus black; postclypeus black, with a large yellow mark at its summit. Frons black, with a pair of large yellow spots between the antennæ. Base of antennæ and a minute spot on either side of the ocelli, genæ, and margin of frons along the eye up to the level of the ocelli yellow, as is a pair of small spots on the occiput.

Prothorax black, its anterior margin yellow; a lateral spot and a mark at the base of the first pair of legs of the same colour.

Thorax black, a tawny orange antehumeral stripe, incomplete above, and the spots at the base of both pairs of wings of the same colour, as is a broad lateral band extending from the base of the second pair of legs to the metepimeron. In addition there is a pale yellow line covering the upper half of the humeral suture. Under surface black, with yellow at the base of the limbs.

Abdomen *: The dorsal markings are brick-red, the lateral yellow. Ground-colour black.

1 has a basal antero-lateral spot, dorsal surface entirely black.

2–9 have antero-dorsal marks, broader towards the bases of the segments, separated by the mid-dorsal carina, diminishing progressively in size from 3 to 9—in 2 and 9 occupying about one-half of the total length of the segment, in 3 to 8 more than one-half.

2–8 have antero-lateral marks, confluent with the dorsal marks, but diminishing more rapidly in size.

2–6 have postero-lateral spots, in 2 confluent with the antero-lateral, in the remainder distinct.

Legs black, coxæ, trochanters, and a mark on the anterior surface of the femur yellow.

Anal appendages black, the upper pair twice as long as segment 10, curved inwards to meet at their extremities; lower pair about as long as 10, conical and straight.

Female. Colouring of the head, prothorax, thorax, and legs as in the male, but the yellow or orange is less vivid. Abdomen entirely without the dorsal series of marks; antero-lateral marks extend from segments 2 to 7; postero-lateral spots from 1 to 9, but very small on the last three. Wings with a deeper tinge of yellow than in the male.

This species is very nearly allied to an unnamed species noted

* In describing the colouring of the abdomen I employ a modification of the terms suggested recently by Mr. Kennedy (Proc. U.S. Nat. Mus. xlvi. p. 114, 1913).

by me as occurring on Mt. Batu Lawi (Journ. R. Asiat. Soc. Str. Br. no. 63, p. 95). It is distinguished from the latter readily by the yellow mark on the summit of the postclypeus and by its broader pterostigma, as well as by other characters.

17. Rhinocypha sp.

1 ♂ juv. 20.9.13 (No. 41, 1914).

Probably a young example of *Rhinocypha biseriata* Selys, a well-known Bornean insect.

Foerster has described (Ann. Soc. Entom. Belge, xli. 1897, p. 210) *Rhinocypha stygia* from Kina Balu. This is the only species not included in Mr. Moulton's collection of which I can find a record.

Cœnagrioninæ (=Agrioninæ *sensu* Selys).

18. Cœliccia nemoricola Laidlaw.

Cœliccia nemoricola Laidlaw, Journ. R. Asiat. Soc. Str. Br. no. 63, p. 95 (Dec. 1912).

? = *C. membranipes* (Ramb.).

6 ♂ ♂, 2 ♀ ♀, Sept. 1913 (43, 45, 48, 54, 55, 1914). One ♀ from 3000 ft.

I have carefully compared this series with the co-type of my *C. nemoricola* and cannot distinguish them. Dr. Ris has also kindly examined an example of each series with the same result. All the Kina Balu specimens show a very distinct antehumeral band of a blue colour which is evidently much faded in the Batu Lawi individuals, and, moreover, the last two abdominal segments in the present series are blue above, whilst in the types of *C. nemoricola* no blue colour was evident.

The two female specimens I cannot distinguish from the description of the female of *C. membranipes* (Ramb.), to which *C. nemoricola* is certainly very closely allied. In the latter species the upper anal appendages are black and not blue. The measurements given for it (*loc. cit.*) are incorrect, and should read: Abdomen 46 mm., hind wing 28 mm. These are the proportions of the specimens from Kina Balu, all of which appear to be less fully mature and less completely dried up than are the types.

The type of *C. nemoricola* and examples of both sexes of the present series are to be deposited in the British Museum.

19. Protosticta kinabaluensis, sp. n. (Text-fig. 5 B.)

1 ♂. 5.9.13 (1914, 38) (No. 17).

Length of abdomen 34 mm., of hind wing 22 mm.

13 antenodals in fore wing. CuN lies halfway between base of wing and level of An_1. The rudiment of Cu_2 lies rather nearer to An_2 than to An_1. Pterostigma rather long, covering more than one complete cell, its costal margin shorter than the anal, its proximal side more oblique than the distal. The veins surrounding it thickened. Venation generally that characteristic

of the genus. Wings hyaline with green and lilac iridescence, R_3 rises from nodus, M_3 distal.

Head: Upper surface entirely black with a feeble bronze reflex, except for a pale band on the anteclypeus and for the third joint of the antennæ which is light brownish yellow.

Prothorax: Middle lobe primrose-yellow, anterior and posterior lobes green-bronze.

Thorax: Dorsal surface entirely green-bronze; lateral surface of the same colour with a fairly broad primrose-yellow band; the metepimeron likewise primrose-yellow, as are the under surfaces.

Abdomen dull bronze-black, the under surface paler, and segments 3–8 each with a primrose-yellow apical triangular mark on the ventral side.

Legs yellow, posterior surface of tibia dark brown as is the tibio-femoral articulation. Tarsi becoming darker.

Anal appendages longer than segment 10. Upper pair bronze-black, lower pair rather paler. The upper appendages are each curved strongly downwards, ending in a flattened leaf-shaped lobe, its apex directed downwards, carrying well-developed spines on its margin.

The lower pair are each stout and club-shaped, with a strong internal tooth near the base. Towards their outer extremities each carries a curious slender projection curving at first downwards and then backwards, flattened laterally at its apex (text-fig. 5 B). These appendages present a very striking appearance, and are quite unlike those of the only other male of the genus in which the appendages have been figured (*P. foersteri* Laidlaw, in Fascic. Malayensis, Odonata, pt. 2, sep., p. 9, fig. 2 A, B).

It seems to me perfectly reasonable to suppose that this specimen belongs to a species distinct from *P. versicolor* Laidlaw, a species of which only the female is known.

At present five species belonging to the genus have been described. Two of these are recorded from the Celebes, i. e. *P. simplicinervis* Selys and *P. gracilis* Kirby. These are both large species and each has a wing-measurement of about 30 mm. The three remaining species (*P. foersteri*, *P. versicolor*, and *P. kinabaluensis*) described by me are smaller, with a wing-measurement of less than 25 mm.

P. foersteri, from the Malay Peninsula, has its anal appendages quite different in appearance from the present species. *P. versicolor* is distinguishable by its remarkable colouring.

20. Ceriagrion sp.

1 ♂, segments 6–10 of abdomen missing (No. 70, 1914).

Belongs probably to an undescribed species.

At first sight it would pass for *C. erubescens* Selys. However, the origin of A* is distinctly proximal to CuN; the dorsum of the thorax is of a rich, warm, brown colour, with a coppery reflex.

STENAGRION, gen. nov.

Wings petiolated to the level of A*. Quadrilateral long. M_3 rises from subnodus, Rs a little distal. Tarsal claws toothed. Body very slender; male with simple upper anal appendages, female with simple posterior prothoracic margin, no ventral spine on eighth abdominal segment. Postocular spots present.

This genus would appear to be in series with *Pseudagrion*, *Stenobasis* (=*Archibasis*), and *Teinobasis*. It differs from them all by the simple character of the anal appendages of the male and in the relative length of the upper margin of its quadrilateral, in which respect it resembles *Amphicnemis*.

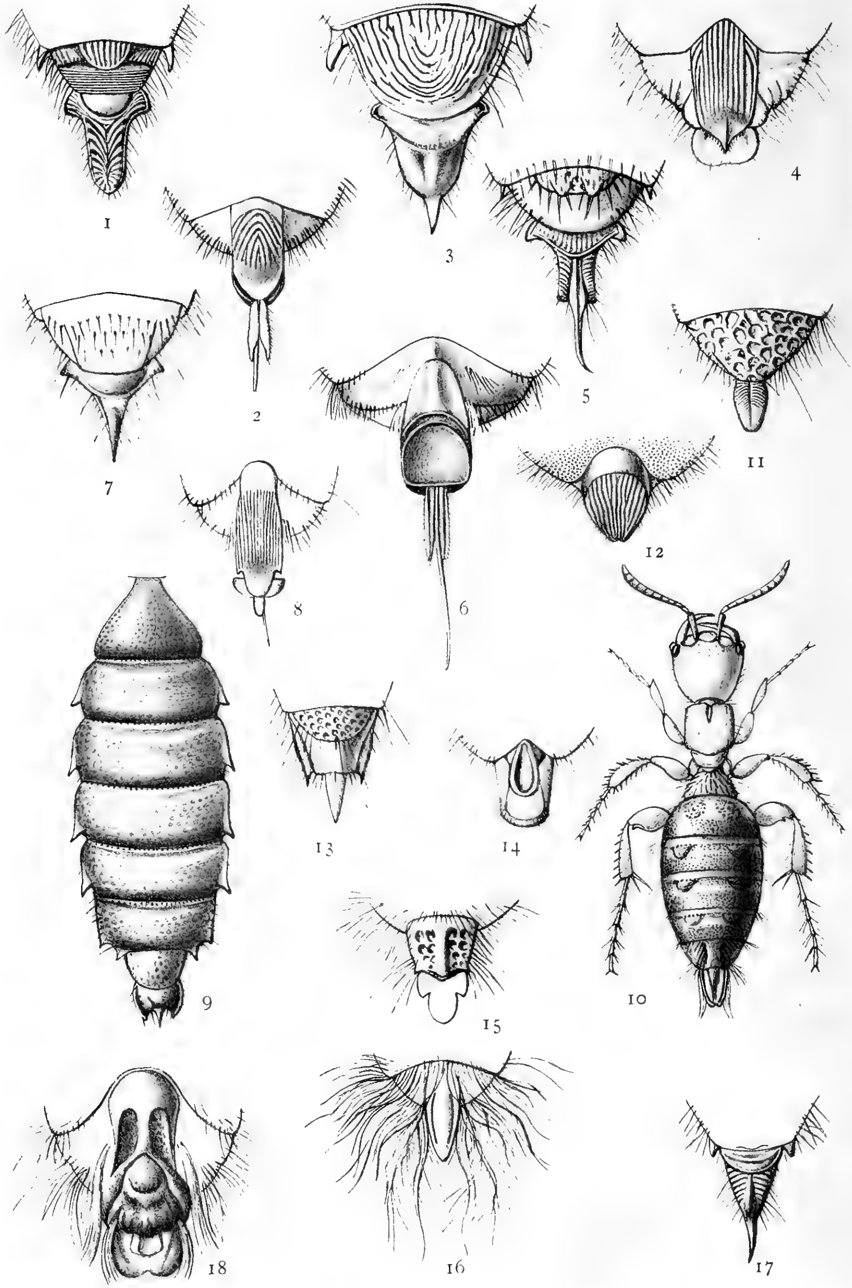
21. STENAGRION DUBIUM (Laidlaw).

Pseudagrion? dubium Laidlaw, Journ. R. Asiat. Soc. Str. Br. no. 63, 1912, p. 97, pl. fig. 5.

1 ♂, 2 ♀ ♀. 6, 9, 16.9.13 (Nos. 17, 47, 73, 1914).

These specimens undoubtedly belong to the species described by me as *Pseudagrion? dubium* (loc. cit.).

They show that there is a well-defined pair of postocular spots, nearly obliterated in the type-specimen; and in addition, on the dorsum of the thorax on either side of the middle line lies a broad blue band, interrupted at its middle by a transverse black line. These markings are present in both sexes, but in the type-specimen, which is a very mature individual, they can scarcely be distinguished.



Horace Knight, del.

London Stereoscopic Co., imp.

EXOSKELETAL STRUCTURE OF AUSTRALIAN FOSSORIAL WASPS.

4. Descriptions of New Fossorial Wasps from Australia. By Rowland E. Turner, F.Z.S., F.E.S.

[Received November 20, 1914: Read February 23, 1915.]

Plate I.*)

Index.

The species described in this paper were mostly collected by me on a recent expedition to Australia; a few have been received from the Queensland and West Australian Museums.

Family Thynnidæ.

Zaspilothynnus unipunctatus, sp. n. (Pl. I. figs. 1, 2.)

♂. Niger; clypeo linea angusta apicali utrinque, maculaque mediana albo-flavidulis; alis subhyalinis, venis fuscis; mandibulis macula basali flava; femoribus anticis intermediisque apice, posticis omnino, tibiis tarsisque ferrugineis.

♀. Nigra; mandibulis pygidioque fusco-ferrugineis; segmento dorsali primo oblique striato, secundo circa decies transverse striato; pygidio elongato-ovato, longitudinaliter striato.

Long., ♂ 15 mm.; ♀ 10 mm.

* For explanation of the Plate see p. 69.

♂. Clypeus strongly convex at the base, obliquely depressed towards the apex, closely punctured, the apical margin broadly truncate. Head closely punctured, the interantennal prominence very broad, feebly rounded at the apex, divided by a longitudinal carina which is continued to the base of the clypeus. Thorax closely punctured; the anterior angles of the pronotum not produced; median segment as long as broad, rounded, with two parallel longitudinal grooves on the posterior slope. Abdomen elongate, closely and shallowly punctured, the segments very slightly constricted at the base; seventh dorsal segment longitudinally striated, produced at the apex into a flat subtriangular lamella. Hypopygium linguiform, without an apical spine, obliquely striated above, the basal angles produced into blunt teeth. Sixth ventral segment with a spine on each side at the apical angles. Claspers truncate at the apex, with a fringe of long hairs. Second abscissa of the radius a little shorter than the third, second recurrent nervure received just beyond one-third from the base of the third cubital cell. Pubescence on the head and dorsulum pale fulvous, whitish elsewhere.

♀. Clypeus punctured-rugose, without a carina. Head shining, with a few scattered punctures, subrectangular, nearly half as broad again as long, rounded at the posterior angles, the front coarsely punctured. Pronotum broader than the head, nearly twice as broad as long, opaque and shallowly punctured; the anterior margin very shallowly emarginate, with a few large setigerous punctures. Scutellum and median segment shining, sparsely and finely punctured; the scutellum broader than long, broadly rounded at the apex, dorsal surface of the median segment shorter than the scutellum. Abdomen shining, sparsely punctured; first dorsal segment closely obliquely striated; second with about ten transverse carinæ gradually decreasing in height from the apex to the base, the basal ones low and not very distinct. Fifth ventral segment longitudinally striated; pygidial area elongate-ovate, longitudinally striated, the striæ converging at the base. Intermediate tibiæ dilated, basal joint of intermediate tarsi moderately broadened.

Hab. Yallingup, S.W. Australia; October to December. ♂ ♀ in cop.

This is nearest to *Z. dilatatus* Sm., from which the male differs in the sculpture and colour of the clypeus, in the distinctly coarser puncturation, and in the position of the second recurrent nervure, which is received further from the base of the cell than in *dilatatus*. The female differs conspicuously from *dilatatus* in the sculpture of the first dorsal segment and in the shape of the pygidium; in the former character it approaches *carbonarius* Sm., but the pygidium is not constricted at the base in either this species or *dilatatus*. It is remarkable that although *dilatatus* is one of the commonest species about Perth in December, I did not take it at Yallingup, whereas I secured a good series of males of the present species, though not many females. This species has not yet been taken at Perth. Mr. Giles took *dilatatus* on *Leptospermum* blossom, which the present species does not seem to frequent, most of my specimens having been taken on the wing, or resting on Eucalyptus leaves.

There is no tubercle at the base of the second ventral segment of the male as there is in *dilatatus*, and the mesopleuræ of the female do not show a small dorsal surface as in that species.

ZASPILOTHYNNUS DILATATUS Sm., subsp. SPICULIFER, nov.

A pair received by me from Southern Cross, W. Australia.

The male differs from Perth specimens in having a short but distinct apical spine on the hypopygium, and black legs.

♀. Nigra, mandibulis fusco-ferrugineis; segmento dorsali primo punctato, secundo transverse circa 12-carinato; tibiis intermediis incrassatis.

Long. 12 mm.

♀. Head subrectangular, more than half as broad again as long; shining, sparsely punctured. Pronotum broader than the head, sparsely and finely punctured, the anterior margin very shallowly emarginate, with a row of large punctures, from each of which springs a long hair. Mesopleuræ showing a very small dorsal surface on each side at the basal angles of the scutellum. First dorsal segment punctured, with a transverse groove before the recurved apical margin; second dorsal segment with about twelve transverse carinæ, all low, except the two nearest the apex, the basal carinæ very low and indistinct. Pygidium not constricted at the base, obliquely truncate posteriorly, with arched carinæ at the base and on the basal portion of the surface of the truncation which is broadly ovate. Fifth ventral segment obliquely striated.

Hab. Southern Cross, W. Australia. ♂ ♀ in cop.

This is in both sexes very near *Z. dilatatus* Sm., but the male differs in the presence of an apical spine on the hypopygium and in the colour of the legs; the female in the sculpture of the basal dorsal segment and of the fifth ventral segment, in *dilatatus* the former is finely transversely striated, with punctures between the striæ, the latter longitudinally striated instead of obliquely as in the present form, in which also the striæ on the first dorsal segment are obsolete leaving only the punctures.

This species is remarkable in showing a small dorsal surface of the mesopleuræ on each side at the base of the scutellum. This point is one of the chief characters of the subfamily Rhagigasterinæ, in which, however, it is much more strongly developed.

ZASPILOTHYNNUS RUGICOLLIS, sp. n. (Pl. I. figs. 3, 4.)

♂. Niger; rugosus; albopilosus; abdomine punctato; pronoto angulis anticis acute producto; alis subhyalinis, venis nigris.

♀. Rufo-ferruginea; abdomine nigro; segmento dorsali primo transverse rugoso, apice transverse carinato, segmento dorsali secundo transverse decem carinato, area pygidiali longitudinaliter striato; antennis nigris.

Long., ♂ 18 mm.; ♀ 11 mm.

♂. Head broad, distinctly broader than the pronotum; clypeus convex, narrowly truncate at the apex. Eyes separated at the base of the antennæ by a distance equal to nearly three times the length of the scape; the interantennal prominence very broad, strongly recurved at the sides, almost transverse at the apex and divided by a low longitudinal carina. Head and thorax coarsely rugose; the anterior angles of the pronotum acutely produced; scutellum almost flat. Median segment broader than long, strongly sloped, and closely punctured, the sides clothed with long white pubescence. Abdomen elongate, shallowly punctured, the segments slightly constricted at the base; sixth ventral segment with a spine on each side at the apical angles; seventh dorsal segment not produced into a lamella, coarsely striated, the striæ rounded towards the apex. Hypopygium triangular, with a strong apical spine, the basal angles produced into broad rounded teeth. Second abscissa of the radius about equal to the third, second recurrent nervure received at two-fifths from the base of the third cubital cell. Hind tibiæ spinose.

♀. Clypeus convex, without a carina; head subrectangular, rounded at the posterior angles, nearly half as broad again as long, distinctly convex, with fine scattered punctures. Pronotum twice as broad as long, sparsely punctured, the anterior margin straight, with a transverse row of large punctures each bearing a long hair. Scutellum much broader than long; median segment broad, no longer than the scutellum, the two combined no longer than the pronotum. Abdomen finely and closely punctured; first dorsal segment transversely rugose, with an apical transverse carina; second dorsal segment with ten transverse carinæ, the two apical carinæ stronger and further apart than the others. Sixth dorsal segment about twice as long as broad, the sides parallel till near the apex, when they converge sharply, the apex produced into a point, the ventral plate extending beyond the dorsal and broadly rounded. Fifth ventral segment coarsely longitudinally striated. The pygidium is not constricted at the base.

Hab. Yallingup, S.W. Australia; November. Capel River, S.W. Australia. ♂ ♀ in cop.

This species differs from most of the genus, in the male sex by the absence of the flat lamella on the seventh dorsal segment, and in the female by the shape of the pygidium which is not narrowed at the base. The hind and intermediate tibiæ of the female are much broadened and strongly spinose, but the basal joint of the intermediate tarsi is not broadened. In both sexes the species is closely related to *Z. nigripes* Guér., differing in the male by the larger head, coarser sculpture, and acute angles of the pronotum; in the female by the colour of the median segment and the different shape of the pygidium.

Pogonothynnus fulvohirtus, sp. n. (Pl. I. figs. 5, 6.)

♂. Niger, albopilosus; thorace supra fulvohirto; mandibulis, clypeo, lineaque pone oculos flavis; alis hyalinis, leviter infuscatis, venis fuscis.

♀. Nigra; mandibulis fusco-ferrugineis; flagello fusco; pedibus obscure fusco-ferrugineis; segmento dorsali secundo transverse sex-carinato; segmento sexto contracto, apice late truncato.

Long., ♂ 20 mm.; ♀ 12 mm.

♂. Clypeus moderately convex, very broadly truncate at the apex; antennæ as long as the head, thorax, and median segment combined, the interantennal prominence rounded at the apex and connected by a carina with the base of the clypeus. Head rugosely punctured, thinly covered above with fulvous pubescence; thorax closely and more finely punctured, the dorsal surface thickly covered with long fulvous pubescence. Median segment covered with long whitish pubescence, rounded, broader than long. Abdomen shallowly punctured, the sides almost parallel, except at the extremities; sixth ventral segment with a short spine on each side at the apical angles; hypopygium broad at the base, with a strong tooth on each side at the basal angles, thence the sides converge sharply and are produced into a process longer than broad, the sides of which diverge slightly towards the apex, which is truncate at the base of the long and slightly recurved apical spine. Second and third abscissæ of the radius almost equal, second recurrent nervure received at one-fourth from the base of the third cubital cell.

♀. Clypeus without a carina; head shining, with scattered punctures, nearly twice as broad as long, very strongly rounded posteriorly. Thorax shining, with scattered punctures; the pronotum nearly twice as broad as long, widely emarginate anteriorly, with a row of punctures on the anterior margin, from each of which springs a long hair; scutellum broader than long. Median segment very short, not more than half as long as the scutellum. First dorsal segment strongly punctured at the base, with one or two indistinct transverse striæ before the strongly raised apical margin; second dorsal segment with six strong transverse carinæ, third and fourth segments very sparsely punctured. Pygidium contracted at the base, then obliquely truncate, the surface of the truncation ovate, the dorsal plate covering only two-thirds of the surface of the truncation and broadly truncate at the apex, two arched carinæ at the base of the truncation. Fifth ventral segment coarsely obliquely striated. Intermediate tibiæ very stout; basal joint of intermediate tarsi moderately broadened.

Hab. Yallingup, S.W. Australia; October to December.

This is near *P. morosus* Sm., from which the male differs in the colour of the pubescence on the head and thorax and the slightly narrower process of the hypopygium. In both species the seventh dorsal segment is produced into a flat rugulose lamella. The female of *morosus* is unknown, but the female of the closely allied *walkeri* Turn. differs in the deeply emarginate apex of the dorsal plate of the pygidium. These three species are very closely allied and probably do not occur together. The only other species of *Pogonothynnus* which I took at Yallingup was *fenestratus* Sm., of which I obtained two males and a female. In one male the process of the hypopygium is narrower than in Perth specimens, in the other much broader, showing that too much importance must not be attached to small variations in the shape of the hypopygium.

Campylothynnus lundyæ, sp. n. (Pl. I. figs. 17, 18.)

♂. Flavus; mandibulis apice, antennis, vertice fascia lata inter oculos, antice per ocellos posticos ad basin antennarum producta, fascia sub-ocello antico, pronoto fascia angusta transversa, mesonoto fasciis tribus longitudinalibus, scutello segmentoque mediano fascia angusta longitudinali, mesosterno, segmentis dorsalibus ventralibusque linea longitudinali mediana, tibiis supra, tarsisque intermediis posticisque nigris; alis hyalinis, venis nigris.

♀. Flava; mandibulis, fronte inter oculos; segmentis dorsalibus primo secundoque fascia transversa apicali, tertio, quarto quintoque linea apicali in media dilatata, maculaque basali utrinque, pygidio, femoribus supra, tarsisque posticis nigris.

Long., ♂ 23 mm.; ♀ 14 mm.

♂. Closely punctured, more finely on the abdomen than on the thorax. Interantennal prominence very broadly rounded at the apex, connected by a short carina with the base of the clypeus, which is very broadly truncate at the apex. Pronotum rather strongly produced at the anterior angles but not forming tubercles. Apex of the scutellum raised above the level of the postscutellum. Abdomen elongate, the sides nearly parallel; seventh dorsal segment not flattened or produced into a lamella; hypopygium with a spine on each side at the basal angles, thence narrowly produced with converging sides and ending in a long apical spine. The second transverse cubital nervure is nearer to the second than to the first recurrent nervure.

♀. Head shining, broader than long, very sparsely punctured, with a short longitudinal frontal sulcus, three large punctures apparently indicating the position of the ocelli. Thorax very sparsely punctured; pronotum twice as broad as long, with a row of deep punctures along the anterior margin; dorsal surface of the median segment no longer than the scutellum. First dorsal segment with a transverse carina at the apex, with a broad groove before the carina; second dorsal segment with three strong carinæ, which are separated by a very broad furrow from the apical carina. Pygidium shining at the base, constricted and marked with several arched carinæ at the base of the oblique posterior truncation, the surface of which is elongate ovate; the ventral plate slightly broadened and rounded beyond the apex of the dorsal plate. Fifth ventral segment coarsely longitudinally striated. Intermediate tibiæ swollen, basal joint of intermediate tarsi not broadened. A tuft of golden hairs on each side of the pygidium.

Hab. Cunderdin, W. Australia, 80 miles east of Perth (*Mrs. Lundy*). December to January. ♂ ♀ in cop.

Closely allied to *C. assimilis* Sm., from which the male differs in the shape of the interantennal prominence, which is pointed in *assimilis*, in the more prominent angles of the pronotum and in the narrower hypopygium, as well as in the much greater extent of the yellow colour. On the abdomen the colour is light orange rather than yellow.

The female differs from *assimilis* (described by Smith as *flavo-fasciatus*) in the greater extent of the yellow colour, in the much greater width of the furrow before the apical carina of the second dorsal segment, and in the same difference on the first dorsal segment. The form of the pygidium is almost identical in the two species. *C. assimilis* occurs at Perth and also at Southern Cross, Cunderdin being about halfway between the two localities, so that this is not likely to be merely a subspecies.

Elidothynnus fumatipennis, sp. n.

♂. Niger; mandibulis, apice excepto, clypeo, margine interiore oculorum angustissime usque ad basin antennarum, lineaque pone oculos flavis; alis fuscis, apice subhyalinis.

♀. Nigra, albopilosa; capite nitido, pygidio pilis longissimis instructo; mandibulis fusco-ferrugineis.

Long., ♂ 26 mm.; ♀ 12 mm.

♂. Clypeus broadly truncate at the apex; interantennal prominence almost pointed at the apex, connected by a carina with the base of the clypeus; head and thorax closely punctured, scutellum and abdomen rather more sparsely punctured, median segment very closely and finely punctured. Prothorax produced into acute angles at the sides; median segment short and broad, thinly clothed with white pubescence; sides of the abdomen almost parallel. Seventh dorsal segment with curved striæ, not produced into a lamella; hypopygium triangular, with an apical spine, the basal angles produced into strong blunt teeth. Second abscissa of the radius as long as the third, second and first recurrent nervures received at almost equal distances from the second transverse cubital nervure.

♀. Head fully half as broad again as long, very slightly convex, with a few large punctures on the front, the remainder of the head shining, with a few scattered punctures. Thorax and median segment sparsely punctured and thinly clothed with long white hairs; the pronotum nearly twice as broad as long, very slightly narrowed posteriorly; scutellum broad, no longer than the dorsal surface of the median segment. Basal half of the first abdominal segment raised above the apical portion and deeply emarginate in the middle posteriorly, sparsely punctured at the base and thinly clothed with long white hairs, delicately transversely aciculate on the depressed apical portion. Second dorsal segment with three strong transverse carinæ at the base, the apical half transversely striated; third and fourth dorsal segments closely punctured and clothed with long pubescence at the base, smooth at the apex; fifth dorsal segment closely punctured. Fifth ventral segment coarsely longitudinally striated. Pygidium strongly compressed at the base, the surface of the apical truncation narrowly elongate ovate, a dense tuft of pale fulvous hairs springing from each side near the base.

Hab. Cunderdin, W. Australia (*Mrs. Lundy*). December and January. ♂ ♀ in cop.

This is very near *E. tuberculifrons* Sm., but may be distinguished in the male by the large size, the fuscous wings, the acute angles on the sides of the prothorax, and the broader hypopygium; in the female by the much sparser puncturation of the head and thorax, and the straight instead of arched division between the punctured and smooth areas on the third dorsal segment.

THYNNOIDES FUSCOCOSTALIS Turn.

Thynnoides fuscocostalis Turn. Ann. & Mag. Nat. Hist. (8) x. p. 540 (1912), ♂ ♀.

Further specimens of this species show that the female often has the legs ferruginous.

BELOTHYNNUS NOVELLUS, sp. n.

♂. Niger; mandibulis basi, clypeo margine apicali, maculaque utrinque, lineaque obliqua utrinque inter antennas flavis; femoribus, tibiis tarsisque ferrugineis; alis subhyalinis, venis fuscis; segmento ventrali primo apice tuberculato.

♀. Ferruginea; abdomine nigro; segmento dorsali primo transverse sex-carinato; pygidio contracto, longitudinaliter striato, basi utrinque fasciculato.

Long., ♂ 18 mm.; ♀ 14 mm.

♂. Clypeus obliquely depressed from near the base, broadly truncate at the apex; the interantennal prominence broadly rounded at the apex; antennæ slightly narrowed at the apex, a little longer than the thorax and median segment combined. Head, thorax, and median segment very finely and closely punctured; anterior margin of the pronotum very shallowly and widely emarginate. Abdomen elongate, the sides nearly parallel, more sparsely punctured than the thorax, the segments slightly constricted at the base; seventh dorsal segment rugose at the apex; first ventral segment with a strong longitudinal carina, produced into a tubercle at the apex; hypopygium with a blunt tooth on each side at the base, thence produced in an elongate triangular form to the base of the apical spine. Third abscissa of the radius a little longer than the second, first recurrent nervure received nearer to the second transverse cubital nervure than the second, which is received beyond one-third from the base of the third cubital cell.

♀. Clypeus very short, transverse, without a carina. Head rather large, more than half as broad again as long, with a distinct frontal sulcus, subopaque, with a few scattered punctures, strongly rounded at the posterior angles. Thorax and median segment sparsely punctured; the pronotum nearly twice as broad as long, rectangular, with a row of large punctures along the anterior margin; scutellum very broad, as long as the dorsal surface of the median segment. Abdomen very finely and closely punctured; the first dorsal segment with a shallow transverse groove before the apical margin; second dorsal segment with six strong transverse carinæ; fifth ventral segment longitudinally rugose. Pygidium elongate, nearly four times as long as broad, the sides nearly parallel, rounded at the apex, finely longitudinally striated, smooth at the apex. Intermediate tibiæ moderately swollen; basal joint of intermediate tarsi spinose, but not broadened.

Hab. Brisbane (*Hacker*). September. From the Queensland Museum.

This is nearer to *B. binghami* Turn. than to any other species, but is quite distinct. The hypopygium is broader than in *impetuosus* Sm.

LOPHOCHEILUS MAMILLATUS Turn.

Thynnus (*Lophocheilus*) *mamillatus* Turn. Proc. Linn. Soc. N.S.W. xxxiii. p. 171 (1908), ♂.

♀. Nigra: mandibulis, pedibus, segmento ventrali quinto, pygidioque ferrugineis; antennis fuscis; segmento dorsali secundo transverse sex-carinato.

Long. 9–11 mm.

♀. Clypeus without a carina, transverse at the apex; head twice as broad as long, rounded at the posterior angles, smooth and shining, with a short but distinct frontal sulcus, a few scattered punctures on the front. Thorax shining, with a few small scattered punctures; pronotum half as broad again as long, with a row of deep punctures along the anterior margin; dorsal surface of the median segment shorter than the scutellum, with large scattered punctures. First dorsal segment very sparsely punctured, with a deep transverse groove before the raised apical margin; second segment with six transverse carinæ, a deep, broad, transverse groove before the apical carina; third and fourth segments very minutely punctured, with sparse large punctures intermingled; fifth dorsal segment more coarsely punctured in the middle, almost smooth at the base and apex. Fifth ventral segment longitudinally rugose-striate. Sixth dorsal segment longitudinally striated, smooth at the extreme apex, about three times as long as the basal and twice as long as the apical breadth, broadly rounded at the apex, the sides divergent from the base.

Hab. Yallingup, S.W. Australia; November and December. ♂ ♀ in cop. Fremantle (type ♂).

The nearest species to this is *L. læviceps* Sm., the male of which has a similar tubercle at the base of the second ventral segment, but in that species the apical segments are black in both sexes and the hypopygium of the male and pygidium of the female are different in shape.

Lophocheilus læviceps Sm.

Thynnus læviceps Sm. Cat. Hym. B. M. vii. p. 44 (1859), ♀.

♂. Niger, albopilosus; alis hyalinis, venis nigris, segmento ventrali secundo basi tuberculato, clypeo apice transverse albo-lineato.

♀. Nigra; mandibulis pygidioque apice fusco-ferrugineis; segmento dorsali secundo irregulariter septem-carinato.

Long., ♂ 20 mm.; ♀ 11 mm.

♂. Clypeus closely punctured, with a longitudinal carina at the base, truncate rather narrowly at the apex; interantennal prominence broad, bilobed at the apex. Head and thorax closely and rather finely punctured. Median segment very minutely punctured with large sparse punctures intermixed, thinly clothed with long white hairs. Abdomen finely and shallowly punctured, the segments slightly constricted at the base; seventh dorsal segment broadly subtruncate at the apex, irregularly longitudinally rugose-striate. First ventral segment with a strong longitudinal carina, deeply separated from the second, which has a strong tubercle at the base. Hypopygium strongly prominent at the basal angles, thence triangular to the base of the strong apical spine. Second abscissa of the radius nearly half as long again as the third; first and second recurrent nervures received at about the same distance from the second transverse cubital nervure.

♀. Head about half as broad again as long, very strongly rounded at the posterior angles, smooth and shining, with a distinct frontal sulcus. Thorax shining; a row of large punctures along the anterior margin of the pronotum, which is nearly twice as broad as long. Median segment coarsely punctured, nearly as long as the scutellum. Abdomen shining, with a few scattered punctures; first dorsal segment with a deep transverse groove before the raised apical margin; second dorsal segment with about seven transverse carinæ, the two at the apex and the basal one high and regular, those intermediate lower and broken. Fifth ventral segment rugose. Pygidium more than twice as long as broad, the sides parallel, rounded at the apex, longitudinally striated, smooth at the apex.

Hab. Yallingup, S.W. Australia; December. ♂ ♀ in cop.

This is nearest to *L. mamillatus* Turn., as noticed under that species. Smith described the female only from a specimen collected on the west coast of Australia.

Lophocheilus rubrocaudatus, sp. n. (Pl. I. figs. 7, 8.)

♂. Niger, fulvopilosus; mandibulis, clypeo margine apicali, maculaque parva utrinque inter antennas flavis; segmentis abdominalibus sexto septimoque, femoribus intermediis apice, posticis dimidio apicali, tibiis tarsisque rufo-ferrugineis; alis hyalinis, venis fuscis, stigmate ferrugineo.

♀. Nigra; segmentis quinto sextoque rufo-ferrugineis; mandibulis, antennis, tibiis tarsisque ferrugineis; segmento dorsali secundo transverse septem-carinato.

Long., ♂ 14–16 mm.; ♀ 10–12 mm.

♂. Clypeus closely punctured, with a distinct longitudinal carina, rather narrowly truncate at the apex; interantennal carina almost transverse, not very strongly developed. Head, thorax, and median segment finely and closely punctured; the pubescence on the head and dorsal surface of the thorax fulvous, on the pleuræ and median segment whitish. Abdomen shining and more sparsely punctured, feebly fusiform, the segments constricted at the base, seventh dorsal segment with strong curved striæ. Hypopygium elongate triangular, produced into an apical spine, the basal angles produced, forming rounded teeth. Second abscissa of the radius a little longer than the third; first and second recurrent nervures received at an almost equal distance from the second transverse cubital nervure.

♀. Clypeus without a carina, transverse at the apex. Head nearly twice as broad as long, very strongly rounded at the posterior angles, shining, with a few scattered punctures and a short shallow frontal sulcus. Pronotum much narrower than the head, nearly twice as broad as long, very finely and closely punctured, with a row of large setigerous punctures along the anterior margin. Median segment sparsely punctured, the dorsal surface as long as the scutellum. First dorsal segment coarsely but sparsely punctured, with a deep transverse groove before the raised apical margin; second dorsal segment with seven transverse carinæ, the two apical carinæ higher than the rest and with a broader and deeper groove between them; third and fourth dorsal segments microscopically punctured, with larger punctures intermingled; fifth dorsal segment smooth at the base, punctured at the apex. Fifth ventral segment longitudinally rugose-striate. Sixth dorsal segment oblique, the sides parallel, rounded at the apex, nearly three times as long as broad, longitudinally striated, smooth at the apex.

Hab. Yallingup, S.W. Australia; September to November. ♂ ♀ in cop.

The fore coxæ of the male are slightly concave.

This may be distinguished from *L. mamillatus* Turn., which occurs in the same district, and is very similar in size and colour of the abdomen, by the absence of a tubercle at the base of the second ventral segment, by the yellow clypeus and mandibles and ferruginous legs in the male, and by the red colour of the fifth dorsal segment, the presence of seven (instead of six) carinæ on the second dorsal segment, the longer and narrower pygidium, and the puncturation of the thorax in the female.

Encopothynnus, gen. nov.

♂. Pronotum widely emarginate anteriorly; abdominal segments strongly constricted at the base; ventral segments 3–6 with a spine on each side at the apical angles, dorsal segments 2–5 with a spine on each side at the apical angles; hypopygium very broad, broader than long, the sides parallel, the apical margin narrowly emarginate near the middle on each side of the short apical spine; maxillæ strongly bearded.

♀. Clypeus convex, without a carina; pronotum much longer than broad, with a median sulcus; second abdominal segment without carinæ, the sculpture not differing from the other segments; fifth dorsal segment with a longitudinal carina; sixth segment compressed laterally, the dorsal plate obliquely depressed, very narrow, slightly broadened to the apex.

This genus is somewhat allied to *Doratithynnus*, but may be distinguished by the spines on the dorsal segments of the male, and by the undifferentiated second dorsal segment of the female. In most of the allied genera, such as *Tmesothynnus* and *Acanthothynnus*, the maxillæ of the male are strongly bearded.

Type of the genus, *E. spinulosus*.

Encopothynnus spinulosus, sp. n. (Pl. I. figs. 9, 10.)

♂. Rufo-ferruginea; sterno, postscutello, segmento mediano, coxis, trochanteribus, femoribus, tarsis intermediis et posticis, tibiis intermediis supra posticisque totis, mandibulis macula basali alba, antennisque nigris; clypeo margine anteriore, pronoto linea angusta transversa antice, tegulis basi, postscutelloque linea angusta transversa albis; alis hyalinis, venis fuscis.

♀. Nigra; capite, prothorace, scutello pygidioque rufo-ferrugineis; tibiis tarsisque fusco-ferrugineis.

Long., ♂ 8–10 mm.; ♀ 3–7 mm.

♂. Clypeus broad, very slightly convex, not much produced, and narrowly truncate at the apex. Antennæ of almost even thickness throughout, short, shorter than the thorax and median segment combined; interantennal prominence obsolete. Head and thorax sparsely but not finely punctured; pronotum as broad as the head, widely emarginate anteriorly; median segment rounded, finely and closely punctured. Abdomen narrower than the thorax, the segments strongly constricted at the base, the sides not parallel, the third segment the broadest; dorsal segments 2–5 with a small spine on each side at the apical angles, those on segments 2–4 white; ventral segments 3–6 with a spine on each side at the apical angles; all the segments coarsely punctured; seventh dorsal segment rather broadly truncate at the apex. Hypopygium much broader than long, the sides parallel, rounded at the apical angles, the apical margin strongly but rather narrowly emarginate on each side of the short apical spine. Second abscissa of the radius about twice as long as the third; second recurrent nervure received at about one-tenth from the base of the third cubital cell.

♀. Head smooth and shining, as long as the greatest breadth, nearly twice as broad in front as on the hind margin; mandibles falcate. Pronotum nearly half as long again as broad, the sides almost parallel, a sulcus from the anterior margin reaching beyond the middle, smooth and shining, with a row of large punctures on the anterior margin, from each of which springs a long hair. Scutellum small, strongly narrowed to the apex; dorsal surface of the median segment twice as long as the scutellum, sparsely punctured. Abdominal segments very minutely and closely punctured; a small, narrow, raised area on each side at the base of the five basal dorsal segments; fifth segment longitudinally carinated in the middle; sixth segment compressed laterally, the dorsal surface oblique, very narrow, slightly broadened towards the apex. Fifth ventral segment sparsely punctured.

Hab. Kalamunda, Darling Ranges, S.W. Australia, 850 ft.; February to April. ♂ ♀ in cop.

Taken in considerable numbers on Eucalyptus blossom.

GYMNOTHYNNUS CARISSIMUS, sp. n.

♂. Niger; mandibulis, apice excepto, clypeo linea longitudinali nigra, linea obliqua utrinque inter antennas, pronoto margine anteriore et posteriore, mesopleuris maculis duabus, mesonoto linea longitudinali, scutello macula mediana, maculaque utrinque angulis anticis, postscutello linea transversa, segmentisque dorsalibus 1–6, ventralibusque 2–5 fascia interrupta apicali albido-flavis; femoribus, tibiis tarsisque ferrugineis; alis hyalinis, venis nigris, stigmate pallide ferrugineo.

♀. Nigra; tibiis tarsisque bruneo-testaceis; segmentis abdominalibus apice lateribusque luteo-testaceis, pygidio pallide ferrugineo; pronoto plano; segmento dorsali secundo basi transverse bicarinato.

Long., ♂ 9–11 mm.; ♀ 4–6 mm.

♂. Clypeus produced and rather narrowly truncate at the apex; interantennal prominence broad; antennæ scarcely as long as the thorax and median segment combined, tapering slightly towards the apex. Pronotum short, the anterior margin almost straight; head and thorax finely and closely punctured, opaque; scutellum shining and very strongly convex; median segment rounded, finely and closely punctured. Abdominal segments moderately constricted at the base, shining and very sparsely punctured; seventh dorsal segment very broadly truncate at the apex; hypopygium truncate at the apex, with a strong apical spine. Second abscissa of the radius more than half as long again as the third; first recurrent nervure received beyond two-thirds from the base of the second cubital cell, second at about one-eighth from the base of the third cubital cell.

♀. Head as long as the greatest breadth, strongly narrowed posteriorly; a broad, shallow depression on each side, with a shallow frontal sulcus, smooth. Pronotum smooth, opaque, a little longer than broad, slightly narrowed posteriorly; scutellum transverse, broader than long; dorsal surface of the median segment no longer than the scutellum, shining, with a few scattered punctures. First dorsal segment broadly depressed at the apex, the raised basal portion strongly bilobed; second dorsal segment with two strong transverse carinæ near the base, the apical margin also raised; third and fourth segments narrowly depressed at the apex. Pygidium very narrow, the dorsal plate sharply narrowed into a point at the apex, the ventral plate notched at the apex; a tuft of pale golden hairs on each side.

Hab. Kalamunda, Darling Ranges, S.W. Australia; March and April. Perth; February. ♂ ♀ in cop.

This is related to *G. lesoeufi* Turn., especially in the male sex, but the shape of the head and thorax and the sculpture of the abdomen of the female are very different. The flattened pronotum of the female seems to be characteristic of this genus.

GYMNOTHYNNUS (?) MUCRONATUS, sp. n. (Pl. I. figs. 15, 16.)

♂. Niger: mandibulis, clypeo margine apicali, pronoto margine anteriore, tegulis basi, scutello macula mediana, postscutelloque linea transversa pallide flavis; alis hyalinis, venis nigris, stigmate fusco-ferrugineo; hypopygio trilobato, loba apicali elongata, mucronata.

♀. Fusco-nigra; segmentis abdominalibus apice late luteo-testaceis; pygidio pallide ferrugineo, crinito; segmento dorsali secundo haud transverse carinato, dimidio apicali valde depresso.

Long., ♂ 7 mm.; ♀ 5 mm.

♂. Clypeus produced and narrowly truncate at the apex; interantennal prominence obsolete; antennæ shorter than the thorax and median segment combined, of almost even thickness throughout; head closely punctured, the clypeus smooth and flattened. Thorax rather closely punctured; median segment smooth and shining at the base. Abdomen fusiform, the segments strongly constricted at the base, smooth and shining, the two apical segments closely punctured. The head, sides of the abdomen and thorax clothed with long whitish hairs. Hypopygium trilobed, the lateral lobes not very strongly developed, the median lobe much longer than the lateral, nearly twice as long as broad and rounded at the apex, without an apical spine. Second abscissa of the radius more than half as long again as the third;

first recurrent nervure received just beyond two-thirds from the base of the second cubital cell, second at about one-tenth from the base of the third cubital cell.

♀. Head shining, very sparsely punctured, a little longer than the greatest breadth, narrowed posteriorly, not convex, without a frontal sulcus. Thorax much narrower than the head; the pronotum longer than broad, slightly narrowed posteriorly, with a median sulcus on the anterior half, slightly raised posteriorly and subtuberculate; scutellum very small, subtriangular; dorsal surface of the median segment shorter than the scutellum. Dorsal segments of the abdomen very broadly depressed at the apex, the raised basal portion bilobed, second segment without transverse carinæ. Pygidium arched, narrow, lanceolate, the sides densely clothed with long pale fulvous hairs, which also cover the fifth ventral segment.

Hab. Cunderdin, W. Australia; February to March (*Mrs. Lundy*). ♂ ♀ in cop.

This little species is not very near typical *Gymnothynnus*, and can only be placed provisionally in the genus. The form of the male hypopygium is singular; and though the sculpture of the abdomen and form of the pygidium of the female are very near *G. trianguliceps* Turn., the form of the head and pronotum differ very greatly. That species and *lesoeufi* Turn. are most nearly related to the present species, and none of them is very near typical *Gymnothynnus*. *G. carissimus*, described above, seems to form a link connecting them with the typical species.

ASPIDOTHYNNUS FOSSULATUS, sp. n.

♂. Niger; mandibulis, apice excepto, clypeo linea marginali utrinque, macula minuta utrinque inter basin antennarum, pronoto margine anteriore in medio interrupto, tegulis, scutello linea abbreviata longitudinali, postscutello linea transversa, mesopleuris macula parva sub alis, segmentisque dorsalibus 2–4 macula transversa utrinque flavidulis; pronoto margine posteriore late luteo; femoribus anticis dimidio apicali, tibiis anticis tarsisque ferrugineis; alis hyalinis, venis fuscis.

♀. Fusco-ferruginea; thorace, segmentisque dorsalibus tertio quartoque dimidio apicali nigris; capite utrinque concave depresso; segmento dorsali secundo transverse quadricarinato, pronoto angulis anticis tuberculatis.

Long., ♂ 10 mm.; ♀ 6 mm.

♂. Clypeus convex, longer than broad, with a longitudinal carina, rather broadly truncate at the apex, the anterior angles rounded; interantennal prominence very feebly developed; antennæ about as long as the thorax and median segment combined, of almost even thickness throughout. Head long and narrow, closely and finely punctured, thorax more finely and sparsely punctured; anterior margin of the pronotum straight; scutellum strongly convex. Abdomen elongate fusiform, the segments strongly constricted at the base; seventh dorsal segment broadly truncate at the apex; hypopygium short, very broadly rounded at the apex, with a slender apical spine. Second abscissa of the radius a little longer than the third; second recurrent nervure received by the third cubital cell at a distance from the base equal to one-quarter of the length of the second transverse cubital nervure.

♀. Clypeus convex, but not carinate. Head a little longer than broad, subrectangular, shining, with a few scattered punctures, with a strong longitudinal median ridge, on each side of which is a large concave depression. Pronotum broader than long, very slightly narrowed posteriorly, sparsely and finely punctured, the anterior angles distinctly tuberculate; scutellum broader than long, broadly rounded at the apex; dorsal surface of the median segment very short, not so long as the scutellum, the posterior slope oblique. First dorsal segment with the apical half depressed, the apex of the raised basal half strongly emarginate; second dorsal segment with four well marked transverse carinæ; segments 3–5 smooth at the base, sparsely but rather deeply punctured at the apex. Pygidium very narrowly elongate ovate, compressed into a narrow carina at the base. Tibiæ thickened, the basal joint of the intermediate tarsi slender, not broadened. Tarsal ungues simple, not bidentate.

Hab. Yallingup, S.W. Australia; ♂ ♀ in cop., January 6th, 1914. Busselton, S.W. Australia; 11 ♂ ♂, January 24–27, 1914.

This is the first female of the group to be described.

The male is very near *A. combustus* Sm., but in that species the abdomen is ferruginous. I am inclined to think that *fossulatus* may prove to be only a local form of *combustus*, but it is quite possible that the female may show stronger differences. *A. combustus* is from Adelaide, though the type appears to have been taken on the west coast.

Asthenothynnus vicarius, sp. n.

♂. Niger; mandibulis basi, macula obliqua utrinque inter antennas, linea late interrupta pone oculos, vertice macula utrinque, pronoto margine anteriore et posteriore, tegulis basi, mesopleuris maculis duabus parvis, mesonoto macula quadrata, scutello macula mediana, postscutello linea transversa, segmentisque dorsalibus 2–6 macula obliqua utrinque flavis; femoribus, tibiis tarsisque ferrugineis; alis hyalinis, venis fuscis, stigmate bruneo-testaceo; hypopygio linguiforme.

♀. Fusca; pedibus bruneis, tarsis testaceis; segmentis dorsalibus primo, tertio quartoque apice testaceis; segmento secundo bruneo-testaceo, sexto ferrugineo.

Long., ♂ 5–7 mm.; ♀ 3–4 mm.

♂. Clypeus convex, with a low carina from the base not reaching the apex, strongly produced in the middle and narrowly truncate at the apex. Antennæ shorter than the thorax and median segment combined, of almost even thickness throughout, the interantennal prominence pointed at the apex. Head closely punctured; thorax shining, very sparsely punctured. Median segment rounded, shining, very minutely punctured, smooth at the base. Abdomen fusiform, flattened, the third segment the broadest; hypopygium narrowly linguiform, without an apical spine. Second abscissa of the radius equal to the third; first recurrent nervure received at two-thirds from the base of the second cubital cell second just before one-quarter from the base of the third cubital cell.

♀. Head shining, with a few scattered punctures, without a frontal sulcus, nearly twice as broad anteriorly as long, narrowed posteriorly and rounded at the posterior angles, much broader than the thorax. Pronotum narrow, without a median sulcus, a little broader anteriorly than long, slightly narrowed posteriorly, finely punctured; scutellum very small and narrow; dorsal surface of the median segment scarcely as long as the scutellum, shining and sparsely punctured, the posterior truncation oblique. First dorsal segment broadly depressed at the apex, the raised portion broadly emarginate posteriorly; second segment with two strongly raised transverse carinæ in addition to the less strongly raised apical margin; segments 3–5 with a raised area on each side strongly curved. Pygidium lanceolate. Basal joint of intermediate tarsi slender, not spinose.

Hab. Yallingup, S.W. Australia; November. ♂ ♀ in cop.

Allied to *A. pygmæus* Turn. both in the shape of the clypeus and hypopygium. These species are not very near typical *Asthenothynnus*, but seem to form a link between that genus and *Zeleboria*. The female of *pygmæus* is unknown. The male of the present species is less strongly punctured than *pygmæus*, has a longer clypeus and a shorter third cubital cell, in addition to colour differences. *A. deductor* Turn. is also closely allied.

Asthenothynnus lilliputianus, sp. n.

♂. Niger; mandibulis basi, clypeo margine apicali angustissime, linea obliqua utrinque inter antennas, pronoto marginibus late interruptis, postscutello linea transversa, segmentisque dorsalibus secundo, tertio quartoque macula utrinque albido-flavis; alis hyalinis, venis nigris, stigmate bruneo-ferrugineo; hypopygio anguste linguiforme.

♀. Nigra; segmento dorsali secundo ferrugineo, transverse bicarinato, margine apicali insuper reflexo; pygidio pallide ferrugineo; segmentis dorsalibus apice anguste testaceis.

Long., ♂ 4–5 mm.; ♀ 3 mm.

♂. Clypeus produced and narrowly truncate at the apex; interantennal prominence not much developed, almost transverse at the apex; antennæ scarcely as long as the thorax and median segment combined, the apical joints very feebly arcuate beneath. Head and thorax very finely and closely punctured. Median segment rounded, shining, very minutely punctured. Abdomen flattened fusiform, shining; the dorsal segments very narrowly depressed at the apex. Hypopygium narrowly linguiform, without an apical spine. Second abscissa of the radius a little longer than the third; first recurrent nervure received at about two-thirds from the base of the second cubital cell, second at about one-quarter from the base of the third cubital cell.

♀. Head smooth and shining, much broader anteriorly than long, narrowed posteriorly, slightly convex; thorax much narrower than the head; the pronotum a little broader anteriorly than long, slightly narrowed posteriorly, with a longitudinal depression on each side reaching from near the anterior angles to more than halfway to the posterior margin; scutellum narrow; dorsal surface of the median segment a little longer than the scutellum, sparsely punctured. First dorsal segment broadly depressed at the apex, the raised basal portion widely emarginate posteriorly; second dorsal segment with two strong transverse carinæ near the base, the apical margin also raised; third and fourth segments narrowly depressed on the apical margin. Pygidium narrow, the sides almost parallel.

Hab. Yallingup, S.W. Australia; November. ♂ ♀ in cop.

Allied to *A. vicarius* described above, but may easily be distinguished by the black legs of the male and the lateral depressions on the pronotum of the female.

Asthenothynnus pleuralis, sp. n.

♂. Niger; mandibulis macula basali, clypeo margine apicali, linea obliqua utrinque inter antennas, pronoto margine anteriore et posteriore, mesonoto macula apicali, scutello linea longitudinali, postscutello linea transversa, mesopleuris maculis duabus, segmento mediano macula apicali utrinque, segmentisque dorsalibus 1–5 macula transversa laterali utrinque albido-flavis; vertice macula utrinque fusco-ferruginea; alis hyalinis, venis nigris; hypopygio rotundato, spina minuta apicali.

♀. Fusca: segmento dorsali secundo, pygidio, tarsisque bruneo-ferrugineis; pronoto late longitudinaliter sulcato, segmento dorsali secundo transverse quadri-carinato.

Long., ♂ 9–10 mm.; ♀ 4–5 mm.

♂. Clypeus produced and narrowly truncate at the apex; interantennal prominence very feebly developed; antennæ scarcely longer than the thorax and median segment combined, tapering slightly towards the apex; head and thorax finely and very closely punctured; scutellum strongly convex, subcarinate longitudinally in the middle; median segment short, much broader than long. Abdomen flattened, shining and almost smooth, the two apical segments rather coarsely punctured. Hypopygium broadly rounded, as broad at the base as long, with a short apical spine. Second abscissa of the radius longer than the third; first recurrent nervure received at two-thirds from the base of the second cubital cell, second at about one-sixth from the base of the third cubital cell.

♀. Head smooth and shining, slightly convex, a little longer than the greatest breadth, slightly narrowed posteriorly, with a short frontal sulcus. Thorax much narrower than the head; the pronotum nearly as long as broad, the sides almost parallel, with a very broad and deep longitudinal groove dividing the segment; scutellum narrow, longer than broad, pointed at the base; dorsal surface of median segment as long as the scutellum. Dorsal segments of the abdomen narrowly depressed at the apex, second segment with four transverse carinæ. Pygidium lanceolate, very narrow.

Hab. Yallingup, S.W. Australia; November. Kalamunda, S.W. Australia; February to April. ♂ ♀ in cop. The female is the type.

The male is extremely near *A. beatrix* Turn., and is only distinguished from that species by the rather shorter antennæ, the more convex and subcarinate scutellum, and by the somewhat different yellow markings, which however are subject to considerable variation. The female, on the other hand, is easily distinguished from that of *beatrix* by the broad groove on the pronotum and the longer and narrower head.

The males in this genus and in *Zeleboria* are often extremely near each other, and the species are not always easy to divide in that sex.

Agriomyia suspiciosa Sm.

Thynnus suspiciosus Sm. Descr. n. sp. Hymen. p. 161 (1879), ♂.
Thynnus tæniolatus Frogg. Trans. Roy. Soc. S. Australia, xvi. p. 71 (1893), ♂.

I have seen the type of *tæniolatus* in the South Australian Museum.

Neozeleboria alexandri, sp. n.

♂. Niger; abdomine ferrugineo, segmento primo dimidio basali nigro; femoribus, tibiis, tarsisque ferrugineis; vertice macula utrinque fusco-ferruginea; mandibulis, clypeo margine apicali late, tegulis, scutello macula magna mediana, postscutelloque fascia transversa flavis; alis hyalinis, venis nigris.

♀. Nigra; pedibus ferrugineis, coxis nigris; mandibulis basi, clypeo, antennisque subtus fusco-ferrugineis; capite utrinque late excavato; segmento dorsali secundo transverse quadricarinato.

Long., ♂ 13–16 mm.; ♀ 7 mm.

♂. Clypeus produced and rather broadly truncate at the apex; interantennal prominence bilobed; antennæ as long as the head, thorax and median segment combined, the apical joints slightly arcuate beneath. Head and mesonotum finely granulate and clothed sparsely with long fulvous pubescence, pleuræ thickly clothed with grey pubescence; scutellum and median segment very closely punctured. Abdomen elongate, shallowly punctured; seventh dorsal segment truncate at the apex. Hypopygium gradually narrowed to the apex, where it is narrowly truncate, with a strong apical spine. Second abscissa of the radius longer than the third; first recurrent nervure received at two-thirds from the base of the second cubital cell, second at one-fifth from the base of the third cubital cell. A tuft of pale hairs on each side at the base of the hypopygium.

♀. Clypeus without a carina. Head shining, sparsely punctured, broader anteriorly than long, narrowed posteriorly, the hind margin not as broad as the head is long; a rather deep and large depression on each side of the head between the eyes and the base of the antennæ; the head somewhat compressed at the sides. Thorax much narrower than the head; pronotum closely punctured, half as broad again anteriorly as long, narrowed posteriorly, with a longitudinal sulcus; scutellum sparsely punctured, narrowed towards the apex. Median segment very finely and closely punctured, the dorsal surface a little longer than the scutellum. First dorsal segment with a broad transverse groove before the apex, second with four strong transverse carinæ; the other segments shining, very sparsely punctured. Pygidium constricted at the base, the surface of the posterior truncation ovate. Tarsi slender.

Hab. Cunderdin, W. Australia (*Mrs. Lundy*); July and August.

The male is rather near *volatilis* Sm., but the sculpture is coarser, the details of neuration rather different, and the scutellum has a yellow spot. The females of the two species are very distinct.

PSAMMOTHYNNUS RUBRICANS, sp. n.

♂. Niger; clypeo margine apicali, mandibulis basi, pronoto margine anteriore linea transversa utrinque, scutello postscutelloque macula parva mediana flavis; pronoto margine posteriore late tegulisque luteis; segmentis abdominalibus primo apice secundoque fusco-ferrugineis, secundo tertioque macula obliqua laterali flavidula; femoribus, tibiis tarsisque ferrugineis.

Long. 8·5 mm.

♂. Clypeus convex, broadly rounded at the apex, with a carina from the base not reaching the apex. Head, thorax, and median segment closely punctured, the head more coarsely, the median segment very finely; interantennal prominence almost pointed at the apex; the five apical joints of the flagellum arcuate beneath. Abdomen fusiform, shining, sparsely and very shallowly punctured; hypopygium small, emarginate at the apex, with a small spine on each side at the angles of the emargination; some long curved hairs springing from beneath the seventh dorsal segment. Third abscissa of the radius slightly longer than the second; the third cubital cell receiving the second recurrent nervure at a distance from the base equal to about one-fourth of the length of the second transverse cubital nervure.

Hab. Yallingup, S.W. Australia; September.

In addition to colour, the rounded apex of the clypeus separates this from other species of the genus.

PHYMATOTHYNNUS TONSORIUS, sp. n. (Pl. I. figs. 11, 12.)

♂. Niger, fulvopilosus; mandibulis, apice excepto, clypeo margine anteriore, pronoto fascia arcuata et margine anteriore anguste, tegulis, postscutelloque macula parva flavis; femoribus, tibiis tarsisque ferrugineis; clypeo apice bidentato; hypopygio linguiforme.

♀. Fusco-ferruginea: mandibulis, flagello, femoribus, tibiis tarsisque bruneo-testaceis; scutello compresso, subtuberculato; segmento mediano obliquo, angulis anticis subtuberculatis.

Long., ♂ 13–17 mm.; ♀ 8–9 mm.

♂. Clypeus not much produced, strongly bidentate on the middle of the apical margin; the interantennal prominence only represented by tubercles at the base of the antennæ; apical joints of the antennæ strongly arcuate beneath. Head, thorax, and median segment opaque, closely and rather finely punctured; pubescence fulvous on the head and thorax, whitish on the median segment and sides of the abdomen. First abdominal segment slender, broadened from the base, longer than the second, with a sulcus from the base reaching beyond the middle; abdomen shining, sparsely and very shallowly punctured, flattened, elongate; the seventh dorsal segment and the apex of the sixth rugose. Hypopygium linguiform, without spines. Wings hyaline, faintly tinged with yellow; second and third abscissæ of the radius about equal; second recurrent nervure further than the first from the second transverse cubital nervure.

♀. Clypeus with a carina; the front deeply emarginate anteriorly and subtuberculate at the base of the antennæ, with a short frontal sulcus. Head shining, with scattered punctures, nearly twice as broad as long, strongly rounded posteriorly. Thorax and median segment very finely punctured; the pronotum more than half as broad again as long, depressed at the anterior angles, the anterior margin distinctly carinate between the depressions; scutellum strongly compressed and subtuberculate. Median segment oblique, the anterior angles subtuberculate. Abdomen finely and closely punctured; first dorsal segment narrowly depressed at the apex; second transversely rugulose between two transverse carinæ, the apical margin raised, with a deep groove before it. Pygidium entire, almost vertical, broadly ovate, longitudinally rugulose. Fifth ventral segment punctured rugose.

Hab. Yallingup, S.W. Australia; September to November. ♂ ♀ in cop.

This is related to *P. nitidus* Sm., but the male may be easily distinguished by the colouring and the bidentate clypeus; the female by the compressed and subtuberculate scutellum, the somewhat similar tubercle in *nitidus* being on the base of the median segment. These two species form a group rather distinct from *P. monilicornis*, the type of the genus.

The male of this species was attracted at Yallingup in large numbers to hair lotion, the chief ingredient of which was oil of bergamot.

PHYMATOTHYNNUS PYGIDIOPHORUS, sp. n. (Pl. I. figs. 13, 14.)

♂. Niger, albopilosus; alis hyalinis, venis nigris; hypopygio truncato, angulis apicalibus brevissime dentatis, spina apicali magna, incrassata.

♀. Nigra, antennis pygidioque fusco-ferrugineis; capite thoraceque nonnunquam ferrugineis; segmento dorsali sexto basi constricto, lateribus marginato.

Long., ♂ 10 mm.; ♀ 5–6 mm.

♂. Clypeus with a carina, produced and narrowly truncate at the apex; interantennal prominence strongly developed, broadly rounded at the apex; antennæ with the apical joints strongly arcuate beneath. Head rather broad, coarsely rugose. Thorax deeply but not very closely punctured; the pronotum with the anterior angles slightly prominent; median segment rounded, finely and closely punctured. Abdomen shining, the punctures almost obsolete, subfusiform, the first segment slender at the base; seventh dorsal segment punctured-rugose. Hypopygium broad, with parallel sides, short, broadly truncate at the apex, the apical angles produced into short, delicate spines, the apical spine very stout and long. Second abscissa of the radius distinctly longer than the third; first recurrent nervure received nearly half as far again as the second from the second transverse cubital nervure, the second recurrent received at about one-fifth from the base of the third cubital cell.

♀. Head subrectangular, half as broad again as long, rounded at the posterior angles, rather closely punctured, the clypeus without a carina, the front with a short sulcus and produced into small tubercles at the base of the antennæ. Pronotum a little longer than broad, sparsely punctured. Scutellum broader than long, no longer than the dorsal surface of the median segment. Abdomen closely and finely punctured; first dorsal segment with a transverse groove before the apical margin; second transversely rugulose between two transverse carinæ, a broad transverse groove before the raised apical margin. Pygidium narrowed at the base, the sides margined from the base by divergent carinæ, broadly rounded at the apex.

Hab. Yallingup, S.W. Australia; September to November. ♂ ♀ in cop.

The male is rather near *P. monilicornis* Sm., but the hypopygium is much larger and broader; the female, however, differs in the shape of the head and most notably in the shape of the pygidium, which, unlike typical *Phymatothynnus*, is narrowed at the base and margined.

TACHYNOMYIA MACULIVENTRIS, sp. n.

♂. Niger, albopilosus; mandibulis, apice excepto, clypeo margine apicali et in medio, macula parva utrinque inter antennas, pronoto fascia arcuata, scutello postscutelloque macula parva mediana, segmentis dorsalibus 2–6 macula magna laterali utrinque, ventralibusque 2–6 fascia lata vix interrupta flavis; femoribus, tibiis, tarsis, segmentoque ventrali septimo ferrugineis; alis hyalinis, venis nigris; segmento ventrali primo acute tuberculato.

♂. Head finely rugose; thorax and median segment very closely punctured; abdomen shining, shallowly punctured. Clypeus without a carina; interantennal prominence bilobed; anterior margin of the pronotum broadly arched. First ventral segment with an acute tubercle at the apex, deeply separated from the second segment. Sides of the hypopygium parallel on the basal half, then strongly convergent to the base of the apical spine. The three apical joints of the maxillary palpi are longer than the others, but not very elongate. Second recurrent nervure received at about one-seventh from the base of the third cubital cell.

Hab. Cunderdin, W. Australia; September to October (*Mrs. Lundy*).

This species is easily distinguished from all others of the genus by the yellow markings of the abdomen, and the tubercle on the first ventral segment. The form of the hypopygium is very similar to that of *T. abdominalis* Guér.

EIRONE ALBOCLYPEATA, sp. n.

♂. Niger; clypeo macula apicali triangulari lineaque marginali utrinque, pronotoque margine anteriore linea transversa utrinque albis; alis hyalinis, iridescentibus, venis nigris.

♀. Rufo-ferruginea, nitida; abdomine nigro, segmento sexto ferrugineo; scutello latitudine duplo latiore.

Long., ♂ 8·5 mm.; ♀ 5·5 mm.

♂. Clypeus with a depressed, oblique, triangular truncation at the apex. Head rather broad, not convex, closely and rather strongly punctured; the four apical joints of the flagellum arcuate beneath. Thorax more finely punctured than the head; median segment rounded. Abdomen shining, closely and finely punctured; seventh dorsal segment with larger punctures, broadly rounded at the apex. Hypopygium rounded, ciliated.

♀. Head subrectangular, as broad as long, smooth and shining. Pronotum longer than broad, emarginate posteriorly; scutellum about twice as long as broad, more than half as long as the pronotum; thorax and median segment smooth and shining, with a few scattered punctures. Median segment longer than the pronotum, much longer than broad, gradually broadened from the base. Abdomen elongate, subcylindrical, shining, sparsely and finely punctured, with a few larger elongate punctures. Pygidium with a broad median carina.

Hab. Yallingup, S.W. Australia; November. ♂ ♀ in cop.

The male is nearest to *E. vitripennis* Sm., but in that species the head is rather strongly convex posteriorly and much less strongly punctured. The female has the head broader than in *vitripennis*, the scutellum longer, and the whole insect more polished and less strongly punctured; there is also no longitudinal impressed mark on the dorsal segments.

Eirone rufodorsata, sp. n.

♂. Niger; clypeo postscutelloque luteis; pronoto, mesonoto, scutello tegulisque ferrugineis; alis hyalinis, venis nigris.

Long. 9 mm.

♂. Clypeus almost flat, with a carina, the apical margin transverse; head and thorax finely and closely punctured; the front between the antennæ widely emarginate. Pronotum less closely punctured than the mesonotum, narrower than the head, the anterior margin transverse and slightly raised; scutellum narrowly rounded at the apex; median segment rounded, very finely punctured. Abdomen shining, shallowly punctured; hypopygium rounded and ciliated. Third abscissa of the radius a little longer than the second; first recurrent nervure received at the middle of the second cubital cell, second at about one-third from the base of the third cubital cell.

Hab. Herberton, N. Queensland (*Dodd*).

The colouring is quite different from that of any other species of the genus.

Eirone ferrugineicornis Turn.

Eirone ferrugineicornis Turn. Proc. Zool. Soc. London, p. 265 (1910), ♂.

The type came from Hermannsburg in Central Australia. I took five males at Kalamunda, in the hills behind Perth, in February.

Family Scoliidæ.

Subfamily Anthoboscinæ.

Anthobosca clypeata Sm.

Dimorphoptera clypeata Sm. Trans. Ent. Soc. London, p. 240 (1868), ♀.

Anthobosca clypeata Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 522 (1907).

This appears to be a most variable species as to colour. The type, said by Smith to come from Champion Bay, though it is labelled "Swan River," has the second, third, and fourth dorsal and second and third ventral segments broadly banded with ferruginous; specimens from the Warren River, S.W. Australia, are without the bands on the fourth dorsal and third ventral segments, but are undoubtedly of the same species. In the Australian Museum are specimens from Albany, W. A., collected by Masters, in which the thorax is richly variegated with yellow, and a form from Cunderdin in the West Australian Museum has the markings on the abdomen also yellow. Not having been able to compare these last two forms, I cannot be sure that they belong to the same species, though the neuration agrees, both recurrent nervures being received by the second cubital cell. With the Warren River females in the South Australian Museum is a male closely resembling *A. crassicornis* Sm., but differing in having the abdomen black, with the two apical segments ferruginous, and the antennæ distinctly shorter and stouter than in the type. The latter difference must, I think, be specific, so that *crassicornis* cannot be the male of *clypeata*, though it must belong to a nearly related species.

Anthobosca fastuosa Sm.

Dimorphoptera fastuosa Sm. Trans. Ent. Soc. London, 1868, p. 240, ♀.

Anthobosca fastuosa Turn. Proc. Linn. Soc. N. S. W. xxxii. p. 521 (1907), ♀.

The type from Champion Bay has the three apical segments of the abdomen black. A specimen in Mr. Froggatt's collection from Southern Cross, W. A., has these segments ochraceous, so that the abdomen is all of one colour, giving the specimen a very strong resemblance to the female of *Scolia* (*Trielis*) *flavidula* Sm. This is probably only a colour variety, though it may possibly prove to be distinct.

Family Psammocharidæ.

Calopompilus xanthochrous, sp. n.

♀. Niger; mandibulis apice, femoribus, tibiis tarsisque ferrugineis; alis flavis, fusco bivittatis, margine apicali insuper infuscatis.

Long. 7–10 mm.

♀. Mandibles bidentate; clypeus short, very broadly truncate at the apex; antennæ slender, second joint of the flagellum a little longer than the third, shorter than the third and first combined; ocelli very close together, the posterior pair more than twice as far from the eyes as from each other. Scutellum a little longer than the length of the transverse groove at the base, broadly subtruncate at the apex. Median segment as long as broad, with a longitudinal sulcus from the base to the apex. Head opaque, thorax subopaque, abdomen shining; hind tibiæ feebly serrate, not spinose. Second abscissa of the radius shorter than the third, second cubital cell narrow; first recurrent nervure received close to the middle of the second cubital cell, second at one-third from the base of the third cubital cell. Cubitus of the hind wing originating just beyond the transverse median nervure.

Hab. Mt. Wellington, Tasmania, 2300 ft.; January to March.

Nearly allied to *C. aliciæ* Turn. from the same locality, the colouring of the wings and the position of the cubitus of the hind wing being the same in both species. In *aliciæ* the antennæ are much shorter and stouter, the scutellum shorter and broader, the two basal abdominal segments more or less ferruginous, the third abscissa of the radius much shorter, being only about half as long as the second, and the hind tibiæ more distinctly serrate and slightly spinose.

From the position of the cubitus of the hind wing these two species would, according to Ashmead's table, fall into the genus *Hemipogonius* Sauss.; but this character is certainly not of generic importance, and I am inclined to think that Ashmead's name *Calopompilus* should sink. The comb of the fore tarsi is entirely absent in *aliciæ* and *xanthochrous*, though a few very minute spines are visible with the lens. But among Australian species many intermediate forms are to be found, and I doubt if *Calopompilus* or *Hemipogonius* can be clearly separated from *Cryptocheilus*.

Calopompilus connectens, sp. n.

♀. Nigra; mandibulis, clypeo apice, antennis, articulis duobus apicalibus exceptis, femoribus, tibiis, tarsisque ferrugineis; alis flavo-hyalinis, fusco-bivittatis, margine apicali insuper infuscatis.

Long. 8 mm.

♀. Antennæ slender, the proportion of the joints as in *xanthochrous*, from which the species differs in the shorter scutellum, the absence of a sulcus on the median segment, the position of the first recurrent nervure, which is received distinctly before the middle of the second cubital cell, the shorter third abscissa of the radius, which is only equal to the second, and the colour of the antennæ, mandibles, and clypeus.

Hab. Mt. Wellington, Tasmania, 2300 ft.; January.

The hind tibiæ in this species are almost smooth, the serration being very feeble.

CALOPOMPILUS AUROPILOSELLUS, sp. n.

♀. Nigra, aureo-sericea; mandibulis, clypeo apice, scapo subtus, flagello basi, tegulis, ano, pedibusque ferrugineis; alis flavis, nigro-trifasciatis.

♂. Feminæ similis; flagello nigro.

Long., ♀ 13 mm.; ♂ 11 mm.

♀. Clypeus broad and short, broadly subtruncate at the apex; labrum slightly exposed, subtruncate at the apex. Antennæ rather short and stout; second joint of the flagellum about as long as the first and third combined, third a little longer than the fourth. Eyes almost parallel on the inner margin; ocelli in a small triangle, the posterior pair twice as far from the eyes as from each other. Scutellum broadly subtruncate at the apex; median segment with a deep median sulcus. Abdomen subopaque, the second ventral segment with a distinct transverse groove near the base; pygidium broad. The whole insect more or less densely clothed with golden pubescence, most closely on the posterior margin of the pronotum, the pleuræ, the median segment, and the apical angles of the dorsal segments. Hind tibiæ spinose, distinctly serrate on the outer side. Second abscissa of the radius about equal to the third; first recurrent nervure received at two-fifths from the base of the second cubital cell, second at three-fifths from the base of the third cubital cell. Cubitus of the hind wing interstitial with the transverse median nervure. The black bands on the fore wing are broad and completely cross the wing, the first on the basal nervure, the second from the base of the radial cell, the third is apical; the two latter converge towards the lower margin.

Hab. Mt. Wellington, Tasmania, 2200 ft.; January to March.

The male differs in having the flagellum wholly black, the margins of the abdominal segments pale ferruginous; the second joint of the flagellum a little shorter than the third.

The colour of the wings is similar to that of *C. molestus* Sm., but the antennæ are shorter and stouter, the hind tibiæ more distinctly serrate, the position of the recurrent nervures very different, also the colour of the pubescence. The antennæ are not quite so stout and short as in *pictipennis* Sm.

CALOPOMPILUS PROTERVUS, sp. n.

♀. Nigra, albopubescens; segmentis dorsalibus fascia apicali interrupta albopilosa; alis fuscis, cellula radiali macula apicali, cellulaque discoidali secunda striga basali flavis; segmentis analibus lateribus valde compressis; tibiis posticis basi albo-maculatis.

Long. 19 mm.

♀. Clypeus broadly subtruncate at the apex; the labrum exposed, narrowly and shallowly emarginate at the apex, a long seta springing from each of the angles of the emargination.

Antennæ fairly stout, but not short; second joint of the flagellum as long as the first and third combined, the third fully half as long again as the fourth. Eyes slightly diverging towards the clypeus; posterior ocelli a little further from the eyes than from each other. Thorax subopaque, finely aciculate; scutellum triangular, very narrowly rounded at the apex. Median segment short, opaque, with a deep median sulcus. Abdomen subopaque; first dorsal segment as broad as the second, the three apical segments strongly compressed laterally, the dorsal surface of the sixth segment almost linear; second ventral segment with a distinct, but not very strong, transverse groove near the base. Hind tibiæ spinose, the spines short; calcaria white, black at the extreme apex. Second abscissa of the radius distinctly longer than the third; first recurrent nervure received at three-fifths from the base of the second cubital cell, second at two-fifths from the base of the third cubital cell. Cubitus of the hind wing originating just before the transverse median nervure, almost interstitial.

Hab. Kalamunda, S.W. Australia, April.

This is somewhat allied to *C. lunatus* Sm., but is easily distinguished by the different proportions of the joints of the flagellum, by the difference in the yellow marks on the fore wings, by the more triangular scutellum, and most conspicuously by the strongly compressed anal segments.

Family Bethylidæ.

Sierola leeuwinensis, sp. n.

♀. Nigra, antennis pedibusque testaceo-ferrugineis; alis hyalinis; venis ferrugineis, basi testaceis; capite magno, latitudine duplo latiore.

Long. 3 mm.

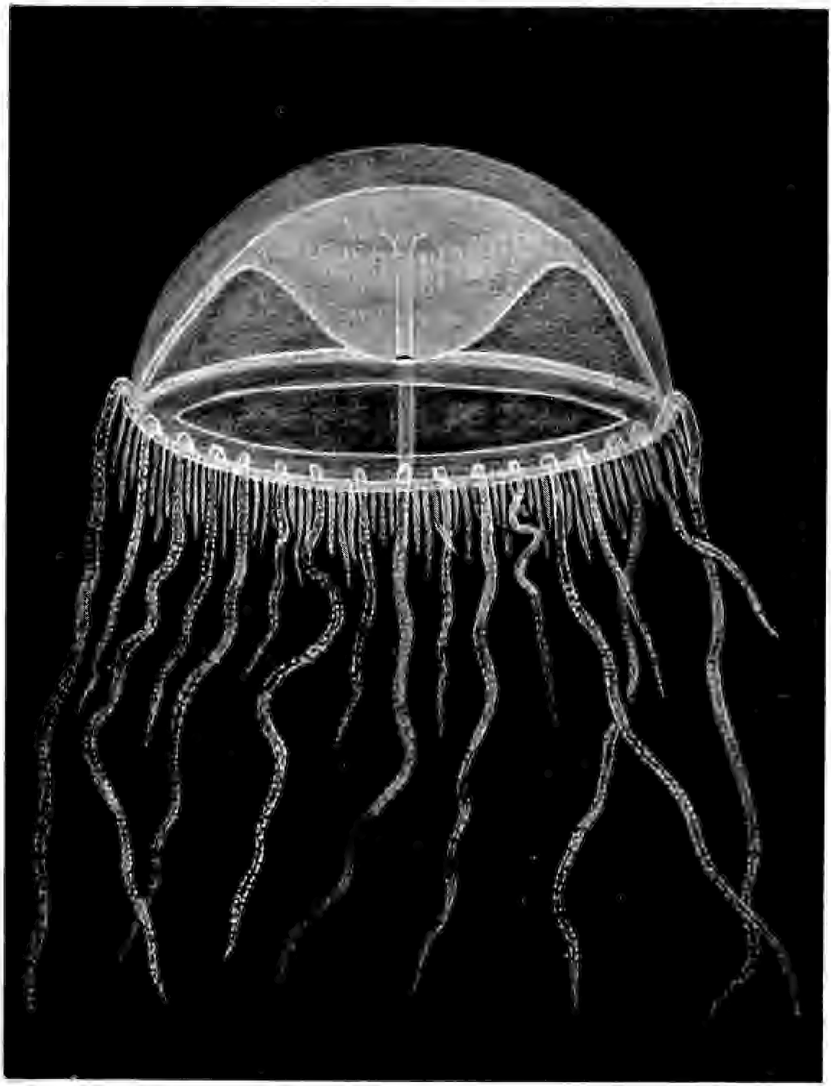
♀. Head very large, flat, twice as long as broad, longer than the antennæ. Eyes large, oval, separated from the posterior margin of the head by a distance at least equal to their own length; ocelli situated close to the posterior margin of the head, far behind the eyes. Head, thorax, and median segment coriaceous, abdomen smooth and shining; the pronotum broader than long, a little narrowed anteriorly; mesonotum short, with a distinct longitudinal furrow on each side; a distinct transverse groove at the base of the scutellum; median segment margined at the sides, with an obscure median carina. Fore wing with a prostigma and a closed discoidal and radial cell as in other species of the genus.

Hab. Yallingup, S.W. Australia; December.

This is distinct from the two Australian species described by Ashmead, having a carina on the median segment and a furrow on each side of the mesonotum.

EXPLANATION OF THE PLATE.

Fig. 1.	*Zaspilothynnus unipunctatus* Turn.	♂.	Apex of abdomen.	Dorsal view.	
2.	,, ,, ,,	♀.	,,	,,	,,
3.	*Zaspilothynnus rugicollis* Turn.	♂.	,,	,,	,,
4.	,, ,, ,,	♀.	,,	,,	,,
5.	*Pogonothynnus fulvohirtus* Turn.	♂.	,,	,,	,,
6.	,, ,, ,,	♀.	,,	,,	,,
7.	*Lophocheilus rubrocaudatus* Turn.	♂.	,,	,,	,,
8.	,, ,, ,,	♀.	,,	,,	,,
9.	*Encopothynnus spinulosus* Turn.	♂.	Abdomen.	Dorsal view.	
10.	,, ,, ,,	♀.			
11.	*Phymatothynnus tonsorius* Turn.	♂.	Apex of abdomen.	Dorsal view.	
12.	,, ,, ,,	♀.	,,	,,	,,
13.	*Phymatothynnus pygidiophorus* Turn.	♂.	,,	,,	,,
14.	,, ,, ,,	♀.	,,	,,	,,
15.	*Gymnothynnus* (?) *mucronatus* Turn.	♂.	,,	,,	,,
16.	,, ,, ,,	♀.	,,	,,	,,
17.	*Campylothynnus lundyæ* Turn.	♂.	,,	,,	,,
18.	,, ,, ,,	♀.	,,	,,	,,



G. Arnold, del.

Bale & Danielsson, Ltd. imp.

LIMNOCNIDA RHODESIAE, × about 8.

5. On a Freshwater Medusa from the Limpopo River System, with a Note on a Parasitic Infusorian.

By G. ARNOLD, M.Sc., A.R.C.S., Curator of the Rhodesia Museum, Bulawayo, and C. L. BOULENGER, M.A., D.Sc., F.Z.S., Zoological Department, The University of Birmingham.

[Received December 1, 1914: Read March 9, 1915.]

(Plate I.* and Text-figures 1 & 2.)

INDEX.

The medusæ which form the subject of this communication were obtained by one of the authors during January 1913 in the Norquane River, a minor tributary flowing through the Inziza and Umzingwane Rivers to the Limpopo. They were identified as belonging to the genus *Limnocnida*, and the new fact in the distribution of this form was recorded in a letter to 'Nature' in April of the same year (**17**).

A number of specimens were sent to England, and proved to belong to the same species, *Limnocnida rhodesiæ* Boulenger, as those collected during 1908 by Mr. R. H. Thomas in the Hunyani River, a southern tributary of the Middle Zambesi.

Limnocnida rhodesiæ was described in 1912 (**14**) from somewhat scanty and poorly preserved material, so that, in addition to their interest from the zoo-geographical point of view, the Norquane River specimens afford an opportunity of adding to our knowledge of this species.

Species of the genus *Limnocnida* have now been recorded from the five principal river-systems of Africa, as well as from India. The type species, *L. tanganicæ*, discovered by Böhm (**1**) in Lake Tanganyika in 1883 and described by Günther ten years later (**2, 3**), has been found to occur also in the Victoria Nyanza (**6–8**) as well as in the River Niger (**9, 10**). *L. rhodesiæ* is now known to inhabit Rhodesia both in the Zambesi and Limpopo river-systems; and the Indian species has been described under the name of *L. indica* (**15**) from tributaries of the Kistna River in the Satara district of the Bombay Presidency.

The Norquane River is situated in the Bembesi district of Southern Rhodesia, about 30 miles W.N.W. of Bulawayo. This stream usually contains water throughout the year, but the visible flow is interrupted during the dry season by sandy bars, whereby the course is broken up into a succession of pools.

* For explanation of the Plate see p. 76.

About a mile above its junction with another small stream, the Nongqua or Noonka, the Norquane River is broken by a large granite bar which during the rains forms a small waterfall. No jellyfishes were seen above this bar, but down to the junction of the two streams all the pools contained them. The vegetation of the latter consists of water-lilies and Potamogetons together with a submerged plant (not identified) which forms thick carpets on the bottom. The remainder of the fauna comprises the usual aquatic insect larvæ, freshwater crabs, mussels, and two small species of fish.

The jelly-fish in the living state vary in size from about 6–16 mm. in diameter, the depth of the umbrella varying correspondingly from 3–6·5 mm. when in the uncontracted condition. They are very transparent; the tentacles are, however, of a milky white colour and more opaque, whilst the umbrella-edge and the base of the manubrium are of a pale yellowish-white and also slightly opaque. When, therefore, the animal is viewed from above, at a distance of two feet or so, only a central patch is seen separated by a transparent area from an external opaque ring.

The medusæ move fairly rapidly, at the rate of 12–14 inches per minute; the tentacles usually take part in the wave of contraction whereby locomotion is effected, but are sometimes kept extended during the whole phase. The manubrium, or stomach, appears to aid in locomotion, being emptied and refilled with water at each contraction.

The deeper and larger pools contained far greater numbers of these creatures than the shallow ones: this is no doubt largely due to the difference in temperature between these bodies of water, the temperature being of course higher in the smaller and shallower pools. Careful observation made it clear that the jelly-fish prefer the cooler waters. This was especially seen in the fact that during the hotter hours of the day, *i. e.* from about 11 A.M. to 4 P.M., very few medusæ were to be seen near the surface; they remained at a level of about two feet below the same, where the water was appreciably cooler. In the early morning and in the evening they were as plentiful at the surface as at deeper levels.

It was noticed that the fish in the stream did not attempt to feed on the medusæ—indeed, some of the smaller fish were seen to swim out of the way of an advancing medusa; it is probable, therefore, that their stinging powers render them unpalatable.

Although carefully sought for, no traces of a hydroid stage were found.

Plate I. shows the appearance of the living animal; after fixation the natural shape of the medusa is not easily appreciated, preserved specimens presenting the flattened umbrella and widely open mouth so generally associated with the genus *Limnocnida*.

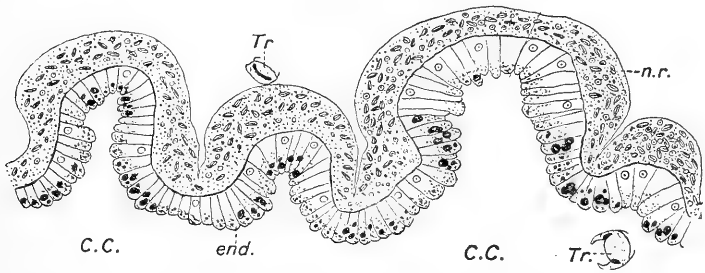
The specimens received in England had been fixed with various reagents, chiefly corrosive sublimate and osmic acid: all, unfortunately, had the umbrella-edge, the tentacles, and the manubrium much contracted, so that the largest specimens measured no more than 6·5 mm. in diameter, exclusive of the tentacles.

Umbrella.—In all the preserved specimens from the Norquane River, the umbrella is disk-shaped and considerably flattened at the top; it is about $3\frac{1}{2}$ times as broad as high.

Manubrium and Mouth.—The manubrium is also much contracted in all the individuals, and the mouth appears as a wide circular aperture. Observations on the living animal showed, however, that the mouth could be completely closed. In this connection it will be recalled that one of the Zambesi specimens of *L. rhodesiæ* was described as possessing an almost conical manubrium and a nearly completely closed mouth. Gravely and Agharkar (**16**) have shown that *L. indica* is also capable of closing the mouth, small specimens doing so more frequently than large ones.

Gonads.—The gonads are poorly developed in all the individuals; so far as could be ascertained the majority belong to the male sex. The Norquane specimens were collected about the same time of the year as the originally described specimens of *L. rhodesiæ*; these also had the gonads poorly developed except in one instance, where a fairly well-formed ovary occurred.

Text-figure 1.



Longitudinal horizontal section through part of the nettle-ring of *Limnocnida rhodesiæ*, × about 150.

c.c., circular canal; *end.*, endoderm; *n.r.*, nettle-ring; *Tr.*, parasitic *Trichodina.*

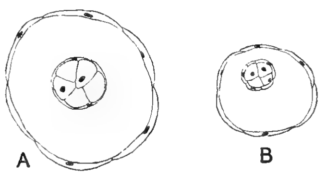
Tentacles.—In structure and arrangement the tentacles are precisely similar to those of the Zambesi specimens. The number of these organs varied in the different individuals from about 85 to 110; owing to the state of contraction of the umbrella-edge they appear very closely crowded together, and are therefore somewhat difficult to count with any accuracy. As in the other species the tentacles are arranged in series, according to size—the perradial, interradial, and adradial being the largest. The larger tentacles have long narrow bases attached to the exumbrella surface of the bell and devoid of nematocyst batteries; the smaller ones are more cylindrical in shape and are only attached to the umbrella for a short distance. The nematocysts are similar to those of *L. tanganicæ*.

Nettle-Ring.—As in the type specimens of *L. rhodesiæ*, the nettle-ring is comparatively narrow and thickened and folded round the bases of the tentacles in such a way as to form structures resembling the tentacle-bulbs which occur in so many craspedote medusæ. These "tentacle-bulbs" are particularly conspicuous in the specimens from the Norquane River: this is probably due, in part, to the great contraction of the umbrella-margin, which is thus thrown into folds.

As the structure of the nettle-ring and other organs of the umbrella-edge forms the chief distinguishing character between *L. rhodesiæ* and *L. tanganicæ*, it seemed important to ascertain by means of sections whether the peculiar appearance of the tentacle-bases in the former species is due entirely to this folding of the nettle-ring whilst the medusa is in a contracted condition. A series of sections was cut in a longitudinal horizontal direction through the umbrella-margin, and such sections show quite clearly that, although the nettle-ring is a continuous structure, it is considerably thickened at the base of each tentacle, these thickenings forming the characteristic basal swellings which resemble the tentacle-bulbs of other medusæ.

In its histological structure the nettle-ring of *L. rhodesiæ* is precisely similar to that of *L. tanganicæ* as described by one of the authors in a previous communication (**12**).

Text-figure 2.



Sense-organs of *Limnocnida rhodesiæ* (A) and *L. tanganicæ* (B) viewed under the same magnification. × 170.

Sense-Organs.—The sense-organs are only slightly less numerous than the tentacles: for instance, in the case of an individual with 96 tentacles, 84 of these organs were counted. This is due to the very definite relation between the arrangement of the sense-organs and that of the tentacles in this species; a pair of the former being situated at the base of each of the larger tentacles near the velar margin of the nettle-ring, whilst a single sense-organ occurs in a similar position at the base of each of the other tentacles with the exception of the smallest, which are without these organs.

In the description of the Hunyani River specimens of *L. rhodesiæ* (**14**), mention was made of the fact that the sense-organs of this species appeared to be somewhat larger than those of *L. tanganicæ.* This statement is correct also with regard to the specimens from the Norquane River. A number of the sense-organs from different individuals of *L. rhodesiæ* were measured with care, and the average diameter found to be 135 μ; examination of preparations of *L. tanganicæ* showed the diameter of the sense-organs of this species to average 70 μ and not to exceed 90 μ (at least in the few specimens at our disposal). The latter measurements were taken from some medusæ collected by Dr. Cunnington in Lake Tanganyika in 1905.

There seems to be no definite statement as to the size of the sense-organs in any of the numerous descriptions of the Tanganyika medusa. Günther (**3**), however, figures two of these organs $\times$ 1000, which by calculation gives the diameter as 60 μ, this agrees fairly well with the measurements given above.

Parasitic Infusorians.—Annandale (**15**) recorded the occurrence of numerous examples of *Trichodina pediculus* Ehrenberg on the manubrium of specimens of *L. indica.*

A peritrichous infusorian belonging to the same genus was found in great abundance on many of the specimens of *L. rhodesiæ* from the Norquane River, occurring not only on the manubrium but also on the velum, the tentacles, and the surface of the umbrella, sometimes in such numbers as to give the whole medusa a spotted appearance when viewed under a lens or a low power of the microscope. Sections of a medusa showed a number of these infusorians inside the circular canal which runs peripherally along the umbrella-margin; they showed no signs of having been acted on by digestive juices, and were as well preserved and stained in the same way as those occurring on the umbrella surface: this suggests that *Trichodina* is able to lead an endoparasitic existence within the gastrovascular system of the medusæ.

The occurrence of *Trichodina* on both the Indian and Rhodesian species of *Limnocnida* led us to examine some preparations of *L. tanganicæ.* These revealed the fact that this species also is infested with this infusorian, which in warmer countries therefore turns out to be a fairly constant associate of freshwater jellyfish, and must play much the same rôle with regard to these organisms as it does in the case of the species of *Hydra* in this country.

Bibliography.

1. MARTENS, E. VON, and BÖHM, R.—"Ueber eine Qualle im Tanganyika See, mit Bemerkungen." Sitzgsb. naturf. Fr. Berlin, 1883, p. 179.

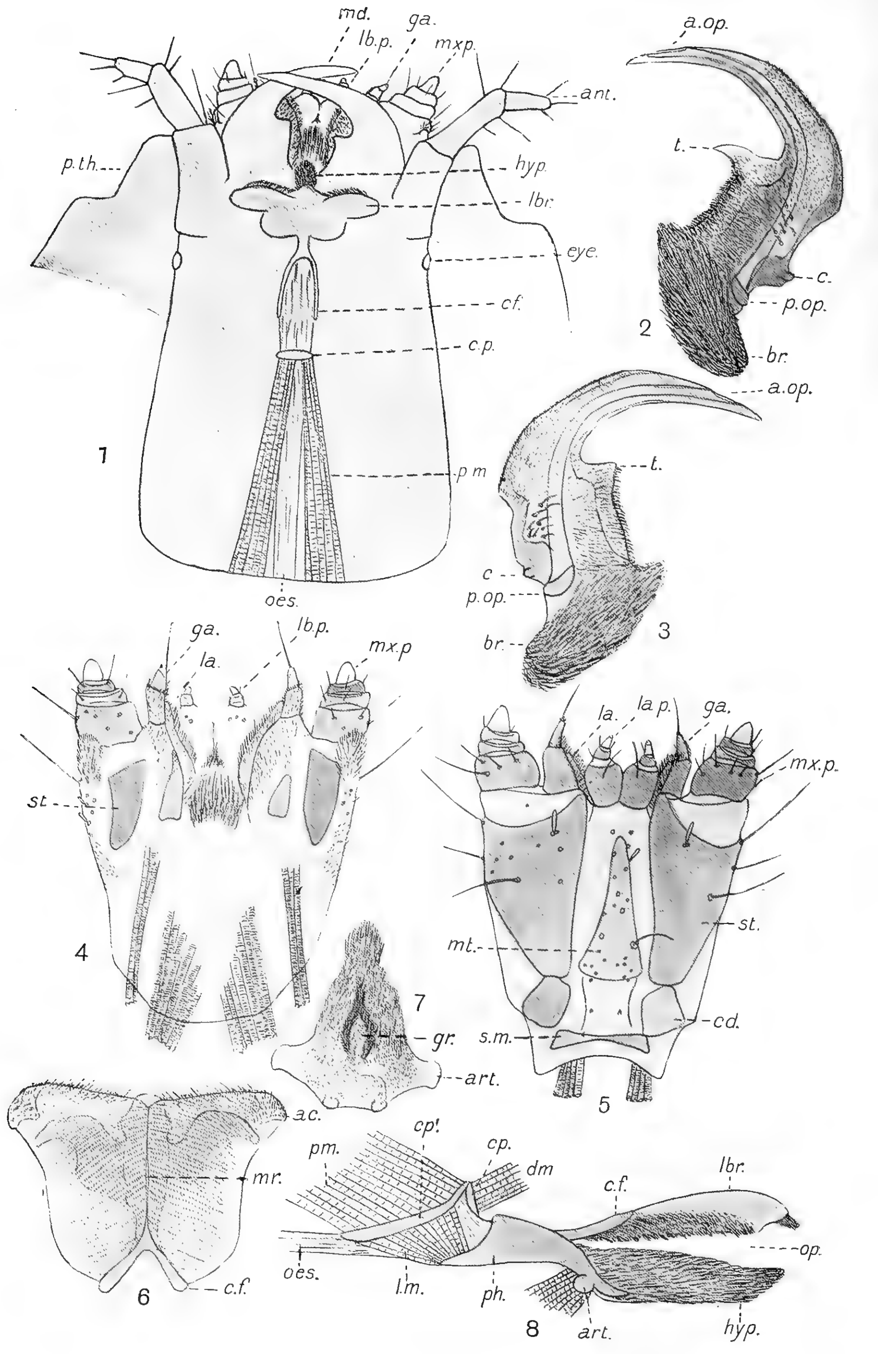
2. GÜNTHER, R. T.—"Preliminary Account of the Fresh-water Medusa of Lake Tanganyika." Ann. Mag. Nat. Hist. ser. 6, vol. xi. 1893, p. 269.

3. ——. "A further Contribution to the Anatomy of *Limnocnida tanganyicæ.*" Quart. Journ. Micr. Sci. vol. xxxvi. 1894, p. 271.

4. Guerne, J. de.—"A propos d'une Méduse observée par le Dr. Tautain dans le Niger à Bamakou (Soudan français)." Bull. Soc. Zool. de France, vol. xviii. 1893, p. 225. Translation in Ann. Mag. Nat. Hist. ser. 6, vol. xiv. 1894, p 29.
5. Moore, J. E. S.—The Tanganyika Problem. London, 1903, p. 298.
6. Lankester, E. R.—"Exhibition of Specimens of Medusæ from the Victoria Nyanza." Proc. Zool. Soc. 1903, ii, p. 340.
7. Gravier, C.—"Sur la Méduse du Victoria Nyanza et faune des grands lacs africains." Bull. Mus. Hist. Nat. Paris, vol. ix. 1903, p. 347.
8. ——. "Sur la Méduse du Victoria Nyanza." CR. Acad. Sci. Paris, vol. cxxxvii. 1903, p. 867.
9. Browne, E. T.—"On the Freshwater Medusa, *Limnocnida tanganicæ*, and its Occurrence in the River Niger." Ann. Mag. Nat. Hist. ser. 7, vol. xvii. 1906, p. 304.
10. ——. "On the Freshwater Medusa, *Limnocnida tanganicæ*. discovered in the River Niger by the late J. S. Budgett." The Work of John Samuel Budgett, Cambridge, 1907, p. 471.
11. Günther, R. T.—"Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–5: Report on *Limnocnida tanganicæ*, with a Note on the Sub-species from the Victoria Nyanza." Proc. Zool. Soc. London, 1907, p. 643.
12. Boulenger, C. L.—"On some Points in the Anatomy and Bud-Formation of *Limnocnida tanganicæ*." Quart. Journ. Micr. Sci. vol. lvii. 1911, p. 83.
13. Annandale, N.—"The Occurrence of a Freshwater Medusa (*Limnocnida*) in Indian Streams." Nature, vol. lxxxvii. 1911, p. 144.
14. Boulenger, C. L.—"On a Freshwater Medusa from Rhodesia." Quart. Journ. Micr. Sci. vol. lvii. 1912, p. 427.
15. Annandale, N.—"Preliminary Description of a Freshwater Medusa from the Bombay Presidency." Rec. Indian Mus. vol. vii. 1912, p. 253.
16. Gravely, F. H., and Agharkar, S. P.—"Notes on the Habits and Distribution of *Limnocnida indica* Annandale." Rec. Indian Mus. vol. vii. 1912, p. 399.
17. Arnold, G.—"Jellyfish of the Norquane River." Nature, vol. xci. 1913, p. 111.

EXPLANATION OF THE PLATE.

Limnocnida rhodesiæ. Specimen from the Norquane River, Southern Rhodesia. × about 8.



K. Haddon. del.

University Press Cambridge.

STRUCTURE OF LAMPYRIS NOCTILUCA.

6. On the Methods of Feeding and the Mouth-parts of the Larva of the Glow-worm (*Lampyris noctiluca*). By Kathleen Haddon, Zoological Laboratory, Cambridge *.

[Received June 26, 1914: Read February 23, 1915.]

(Plate I.†)

INDEX.

In many insects of widely separated groups digestion takes place partly outside the body, digestive fluids being exuded from the mouth upon or into the food, which is then sucked up in a liquid form. The mouth-parts are in some cases specially formed in connection with this habit, while in other cases there appear to be no peculiar modifications.

One type of modification seen in a few forms is that in which the mandibles are either grooved or pierced by a fine tube, and in which the groove or tube is the channel of egress for the digestive fluid, although there seems to be no clear evidence of this, except perhaps in the case of the Dytiscid larvæ: such modification is apparently found only in insects which feed chiefly or entirely upon the juices of their prey.

The glow-worm larva is one of those forms in which the mandibles are pierced by a fine tube, and as it feeds upon snails and slugs and leaves no residue, excepting the slime of its prey, Mr. F. Balfour-Browne suggested that I should study the mouth-parts to ascertain whether the food was eaten or sucked up.

A certain amount of spirit-material was available for dissection, but we were fortunate in obtaining a number of nearly full-grown living specimens at Wicken Fen in May.

Specimens required for section-cutting were first softened for about forty-eight hours in Perenyi's fluid, dehydrated, cleared in cedar-wood oil, and embedded in paraffin in the usual way. The sections were cut 8 μ thick and stained on the slide, first with eosin in ninety per cent. alcohol, then with picro-nigrosin in water.

External Features and Habits.

The larvæ were kept in an inverted bell-jar nearly filled with moist earth, and supplied with some moss. They were caught on May 14th, and for about a week were fairly active and ready to eat; but subsequently they became torpid, refused their food, and finally began to pupate—by June 1st all had pupated.

* Communicated by Frank Balfour-Browne, M.A. (Oxon. et Cantab.), F.R.S.E., F.Z.S.

† For explanation of the Plate see p. 82.

The habits of these larvæ have already been described by Newport * and later writers, but their accounts do not entirely agree. Newport describes the bite of the larva as causing great pain to the snails on which they feed; whereas Fabre †, in a popular article on the subject, says that the snail is anæsthetised by the bite. It may be of interest, therefore, to record my own observations, which were carried out with a Zeiss binocular, the larvæ being placed with some moss in a shallow glass dish and supplied with small snails.

The larvæ crawl about, feeling their way with their maxillary palps, which are kept constantly in motion, the head being fully extended, so that the whole of it protrudes beyond the prothorax; whereas when the animal is at rest only the mouth-parts are visible. The snail apparently is found quite by chance, and if hungry the larva at once fastens on its prey. The mandibles are worked laterally, and bending its head down it cuts its way into the snail, which promptly withdraws into its shell, the larva following. If left undisturbed the larva feeds continuously, and is frequently joined by others, until the snail is finished; but if it is pulled off at once, the snail pursues its way apparently uninjured. Wishing to see more clearly the method of procedure, I supplied small slugs as food instead of snails, so that there could be no retreat into a shell. The larva bit the slug on the visceral hump, but apparently could not get a sufficient hold, as the slug with a twist of its body slipped away leaving a mass of mucus over the head of its enemy. The larva at once desisted from its attack and tried to free itself from the slime by working its jaws and rubbing them with its front legs. These methods failing, it curled up and cleaned itself with the adhesive organs in the terminal portion of its abdomen, repeating the process long after there were any signs of slime on the head, probably to cleanse the hairy bases of the mouth-parts.

In the next attempt to feed the larvæ with slugs the attack was more fortunate, the larva striking right into the pulmonary cavity of its victim; but either the food was not to its taste or else it was not hungry, as it shortly let go, and the slug, which had previously been lethargic, glided off apparently undisturbed.

These observations show that—in these cases, at any rate—there was no anæsthetising.

When feeding, the larvæ keep their jaws constantly moving, and thus their mouth is bathed in the juices from the snail. Newport ‡ also observed some dark-coloured liquid, which flowed from the mouth of the larva at the time of its attack and apparently acted as a poison, for the snail was much more affected by the bite of a larva than by a mechanical injury, such as piercing with a needle. He apparently failed to notice that the mandibles

* G. Newport, "On the Natural History of the Glow-worm," Journal of the Proc. of the Linnean Society, Zoology, vol. i. 1857, p. 40.

† Fabre, "The Glow-worm," Century Magazine, November 1913.

‡ *Loc. cit.* p. 58.

of the larvæ are pierced by canals which communicate with the mouth, a fact described by Meinert * some time later. This observer suggested that the juices of the snail were sucked up through these tubes, the thick hairs which surround the mouth acting as a kind of absorbing sponge. More recently R. Vogel † has described these tubular mandibles, and he further asserts that he has seen the dark-coloured liquid mentioned by Newport flowing from them. As no salivary glands are to be found in this animal, he believes that the secretion originates in the mid-gut, as is said to be the case with the larva of *Dytiscus* and in *Carabus*.

Mouth-parts.

As stated above, the head of the *Lampyris* larva can be retracted within the prothorax, and in this position only the tips of the mouth-parts are visible. As the preserved specimens are usually in this position, the dorsal portion of the prothorax has to be cut away to expose the head (Pl. I. fig. 1). Only the mandibles are strongly chitinised; the first and second maxillæ are fleshy, their basal parts being distinguishable only by the sclerites (figs. 4 & 5). The labrum and hypopharynx are strengthened by chitin and covered with hairs.

Mandibles.

The mandibles (figs. 2, 3) are strong and much curved, and except at the distal end are covered with small hairs. There is a secondary tooth (*t.*) on the inner margin, which is sharply pointed on the right mandible and as a rule stouter and blunt on the left; in some cases, however, the left resembles the right.

The base of each mandible on the dorsal side is occupied by a thick brush of hairs, pointing towards the tip of the mandible. Along the inner edge, between the secondary tooth and the basal brush, there are longer and stiffer hairs than over the rest of the surface.

Along the outer border, and near the base, is a condyle (*c.*) for articulation with the labrum. Just inside this on the dorsal side is the posterior opening (*p.op.*) of the canal which pierces the mandibles; the anterior opening (*a.op.*) of this canal is on the outer margin of the mandible slightly to the side of the apex. Directly in front of the condyle is a group of short stout bristles.

Maxillæ and Labium.

These appendages (figs. 4 & 5) are fused posteriorly into a fleshy pad, and it is only ventrally that their component parts can be distinguished by means of the sclerites. Distally, however, the various parts of the appendages may easily be identified.

* F. Meinert, "Gjennemborede Kindbakke hos Lampyris og Dribus-Laverne," Ent. Tidskrift, vii. 1886.

† R. Vogel, "Beiträge zur Anatomie und Biologie der Larve von *Lampyris noctiluca*," Zool. Anz. xxxix. 1912, p. 515.

The maxillæ have on their ventral aspect a small square plate (*cd.*) representing the cardo, and a larger more elongated stipes (*st.*), which bears a few long bristles and some short flattened hairs. Externally is a stout four-jointed palp (*mx.p.*) with a few hairs, and internally a two-jointed palp-like galea (*ga.*) and a flat lacinia (*la.*), both covered profusely with hairs, the inner margin of the lacinia bearing a row of stiff bristles. Dorsally, the maxillæ have much the same appearance, except that the cardo is not represented and the stipes is small. At the base of the palp along the external border is a tuft of hairs pointing forward, as do all the hairs on these mouth-parts. Posterior to the tuft are a few more of the short flattened hairs, which are similar to those described by Packard * as taste-hairs.

The ventral view of the labium shows the transversely placed submentum (*sm.*) tapering from each end towards the middle. The mentum (*mt.*) is in the shape of an elongated triangle, the apex being anterior; it bears a few bristles and some short flattened hairs. Distally, there is a pair of short, fat, three-jointed palps (*la.p.*), with a few hairs.

Dorsally, there is a clump of hairs at the base of the palps, and another larger one more posteriorly.

Labrum.

The shape of the upper lip (fig. 6) is roughly trapezoidal, the anterior margin being the longest, and slightly indented in the middle. Posteriorly there is a deep bay, formed of a fork of chitin (*c.f.*) which protrudes beyond the rest of the labrum; the handle, as it were, of the fork forms the main support, or mid-rib (*mr.*), of the labrum, and bears two wing-like lateral expansions which keep the whole rigid.

Dorsally the surface is slightly rounded, but on the underside there is a mid-ventral ridge formed by the junction of the two sides, which slope steeply down towards it. There is on each antero-lateral corner a socket which receives the condyles on the mandible.

The whole of the ventral surface of the labrum is covered with numerous rows of tiny hairs, all of which point forwards. The rows themselves are arranged across the labrum, but slope forward from the sides towards the mid-ventral ridge. The anterior margin is beset with stiff bristles which bend slightly towards the middle.

The Hypopharynx.

The tongue, or hypopharynx (fig. 7), is in the shape of a triangle with the base bulged out; the apex is directed forwards, while at each end of the base is a chitinous knob (*art.*) articulating with a strut from the side of the head. With the exception of these knobs the hypopharynx is completely covered with hairs pointing forwards, as usual.

* A. S. Packard, 'Textbook of Entomology,' 1898, p. 282.

Viewed from the side, this organ is slightly curved upwards at the tip, and ventrally the surface is entire. On the dorsal side, however, there is a distinct groove (*gr.*) which fits the corresponding ridge on the labrum; the edge of the groove is strengthened by a thicker band of hairs. The hairs at the apex of the hypopharynx are longer than the others, and are frequently forked.

Interrelations of Mouth-parts.

The arrangement of the mouth-parts is such that it prevents any solid matter from entering the gullet. This is effected by the enormous number of hairs that surround the mouth, all pointing outwards, so that although the mouth is always open it is impossible for any solid particles to enter.

A comparison might be made here between this larva and the larva of *Dytiscus*, which also sucks the juices of its prey. The *Dytiscus* larva has its mandibles tubular, but the mouth can be closed by an apparatus which has been described as a "mouth lock," which automatically closes up the aperture when the mandibles shut. The larva pierces its prey with its mandibles, closes them, and proceeds to suck the juices through the mandible-tubes by means of the pharyngeal pump. When the mandibles open it can swallow small particles in the ordinary way *.

The Pharynx.

The floor and sides of the anterior end of the pharynx are strongly chitinised (fig. 8, *ph.*), and the tongue is a direct continuation of the floor. The sides at this point receive an additional support from the chitinous fork which protrudes from the posterior end of the labrum (fig. 6, *c.f.*). More posteriorly, the chitinous fork ends and the sides and floor of the pharynx become membranous, the chitin tapering down to a narrow ventral strip. The roof of the pharynx up to this point is also membranous, but here it turns sharply upwards and forms a small vertical chitinous plate (figs. 1 & 8, *c.p.*), from which muscles (fig. 8, *d.m.*) run to the dorsal integument of the head. From the apex of this plate another larger one slopes downwards (fig. 8, *c.p.'*), and runs into the dorsal surface of the œsophagus. Two strong bands of muscle (figs. 1 & 8, *p.m.*) are attached to the posterior surface of this plate, and run to the back of the larva's head; while from its edges bands of muscle (fig. 8, *l.m.*) run down on either side of the pharynx and are attached to the posterior end of the plate forming its floor. This plate is perforated by two pairs of small holes, the function of which I cannot ascertain at present.

This apparatus evidently forms a suction-pump, and is worked by contraction of the muscles attached to the two dorsal plates, which raises them and makes a vacuum into which the liquid food flows, while contraction of the lateral descending muscles

* L. C. Miall, 'The Natural History of Aquatic Insects,' 1912, p. 44.

lowers the roof again. A similar contrivance is found in some groups of Hemiptera*, only in them there are no ventral muscles, the roof falling back into its place by the natural elasticity of the pharynx.

The method of feeding of this larva is obviously different from that of the *Dytiscus* larva, for it has no means of shutting its mouth, and hence cannot suck through the mandible-tubes only. The mouth, although guarded by an immense number of outwardly directed bristles, has sufficient aperture to allow of the passage of a fine hair; this, if placed on the tip of the hypopharynx and pushed gently along, runs down into the pharynx. On the other hand, a hair pushed down the mandible-tube bends forwards and curves out again at the mouth; this is difficult to understand unless it is due to the forwardly directed hairs that lie on the base of the mandible. A stiffer bristle might overcome this resistance, but I could not insert one into the tube; it is probable that liquid, such as would be sucked up through the mandible, would trickle through the hairs and be drawn into the pharynx by the action of the suction-pump.

It is clear, at any rate, that no large particles of food can find their way through the mass of hairs that surround the mouth; they are are all strained off and removed later by the terminal adhesive organs. It is probably the difficulty of extracting these particles that causes the larva to continue to cleanse itself long after the apparent need for it is over.

EXPLANATION OF THE PLATE.

Lettering.

a.c., articulation for condyle of mandible; *ant.*, antenna; *a.op.*, anterior opening of canal through mandible; *art.*, articulation of hypopharynx; *br.*, brush of hairs on mandible; *c.*, condyle of mandible; *cd.*, cardo; *c.f.*, chitinous fork; *c.p.*, chitinous plate of pharynx; *c.p.′*, posterior chitinous plate; *d.m.*, dorsal pharyngeal muscle; *ga.*, galea; *gr.*, groove of hypopharynx; *hyp.*, hypopharynx; *la.*, lacinia; *lbr.*, labrum; *la.p.*, labial palp; *l.m.*, lateral pharyngeal muscle; *md.*, mandible; *m.r.*, mid-rib of labrum; *mt.*, mentum; *mx.p.*, maxillary palp; *œs.*, œsophagus; *op.*, opening into gullet; *ph.*, chitinous floor of pharynx; *p.m.*, posterior pharyngeal muscle; *p.op.*, posterior opening of canal through mandible; *pth.*, prothorax *sm.*, submentum; *st.*, stipes; *t.*, tooth on mandible.

The figures, with exception of fig. 8, were all drawn with a camera lucida.

Fig. 1. Dorsal view of the head of a larva (× 16). The prothorax has been cut away to expose it, and the dorsal integument removed.
2. Dorsal view of right mandible. (× 30.)
3. Dorsal view of left mandible. (× 30.)
4. Dorsal view of first maxillæ and labium (× 30). (Note asymmetrical sclerites.)
5. Ventral view of first maxillæ and labium. (× 30.)
6. Ventral view of labrum. (× 30.)
7. Dorsal view of hypopharynx. (× 30.)
8. Diagram of the pharyngeal pump.

* F. Muir and J. C. Kershaw, "On the Homologies of the Mouth-parts of Hemiptera," Psyche, vol. xviii. no. 1, 1911, p. 5.

7. On a Colubrid Snake (*Xenodon*) with a vertically movable Maxillary Bone. By E. G. Boulenger, F.Z.S., Curator of Reptiles.

[Received November 10, 1914: Read February 9, 1915.]

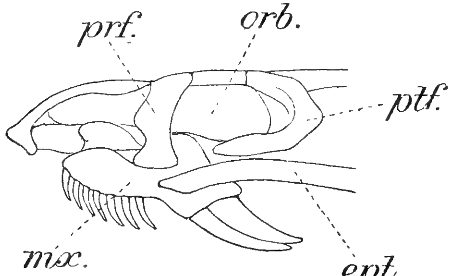
(Text-figure 1.)

Index.

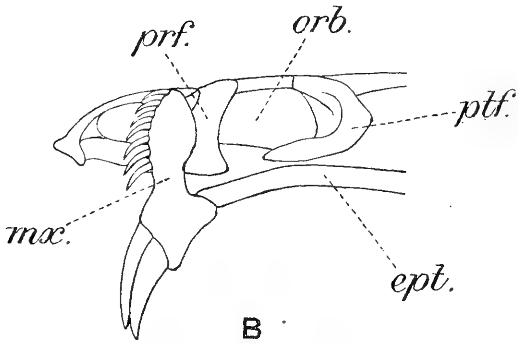
In Vipers the maxillary bones, to which the poison-fangs are firmly attached, are movably articulated to the prefrontals and ectopterygoids, the poison-fangs being, when at rest, folded against the roof of the mouth and becoming erected, or even thrust forward, when the animal is about to strike. This vertical mobility of the maxillary bone, which gives these snakes such a mechanical advantage when they are about to strike, has always been regarded as essentially characteristic of the members of the family Viperidæ. The Society recently received from Mr. W. A. Smithers, C.M.Z.S., a generous donor to its collection, a specimen of *Xenodon merremi*, an aglyphodont colubrid inhabiting Brazil and Paraguay, which is characterized by an extremely short maxillary with only six or seven teeth, followed after an interspace by a pair of strongly enlarged but likewise solid, ungrooved fangs. On taking the snake from the box in which it was packed and catching hold of it behind the head, I was most surprised to see the creature, on opening its mouth in an attempt to bite, erect and depress its fangs in a thoroughly Viperine manner. Further observations showed that the mobility of its maxilla was so great that the fangs could be not merely erected, but thrust forward and sideways, revealing the fact that the mechanism in this snake is more perfect than in a large number of Vipers of similar size.

This discovery of a solid toothed Colubrid with a vertically movable maxilla is of special interest, as I think it goes a long way towards settling the problem, so often discussed, of the derivation of the Viperine maxillary bone. The Viperidæ were formerly believed to have sprung from the Proteroglyph Colubrids. In the Catalogue of the British Museum, published in 1893, my father, G. A. Boulenger, F.R.S., expressed the opinion that the poison apparatus of the Vipers was in all probability derived from the Opisthoglyphs. Later, in a paper published in the Proceedings of this Society, he pointed out that, from the Aglyphodont forms in which the teeth increase in size posteriorly, we are gradually led to the Opisthoglyphs, which can be differentiated only by the presence of more or less deep grooves on the posterior fang-like teeth, the series culminating in such forms as show the maxillary bone much abbreviated, the solid teeth reduced to two or three only, and the fangs extremely large and grooved. The latest contribution to the subject is one by Mr. John Hewitt *, who attempts to show that the Viperidæ are not of Opisthoglyph ancestry, but are more closely related to the Proteroglyphs. The most important arguments he uses to establish his point are that, in the first place, in the Opisthoglyphs the

Text-figure 1.



A



B

Maxillary (*mx.*) of *Xenodon merremi* at rest (A), and erected (B).
ept., ectopterygoid; *orb.*, orbit; *prf.*, prefrontal; *ptf.*, postfrontal.

fang-bearing portion of the maxilla is situated far behind the prefrontal, and consequently that as there appears to be no tendency amongst Opisthoglyphs for a forward movement of the fang-bearing portion, it is difficult to conceive how the evolution of the Viperine character commenced; secondly, that in the Proteroglyphs the fang-bearing portion of the maxilla is some-

* Ann. Transvaal Mus. iii. 1911.

what enlarged, often in a vertical direction, showing a resemblance to the state of things found in *Causus*.

The first argument is easily disposed of, as in a number of Opisthoglyphs the fangs are situated just below the prefrontal (*Miodon*, *Polemon*, *Brachyophis*). Now in *Xenodon* the portion of maxilla bearing the fang-like teeth will be found to be much enlarged, and in a more or less vertical direction, and it only remains for the last two teeth to be furnished with grooves to transform *Xenodon* into an Opisthoglyph with the fangs situated below the prefrontal. Further, we have only to compare the maxilla of *Xenodon* with that of the least specialized of the Vipers, *Causus*, to see that merely a slight tilting up of the maxilla of the former snake, with the loss of the few front teeth and a very slight modification of the bone, is needed to bring about a condition similar both in structure and mechanism to that of Vipers. Thus *Xenodon* with its vertically movable maxillæ enables us to trace the probable evolution of this bone, and the old view, recently revived, that Vipers are descended from Proteroglyphs must, in my opinion, be abandoned.

Mr. Hewitt in his papers states that the various experiments on snake-venom seem to show that there is more in common between the Proteroglyphs and the Vipers, than between the Opisthoglyphs and either of the other divisions. That this is so in the majority of cases has been demonstrated by Phisalix. It should be borne in mind, however, that, as has recently been shown by Fitzsimons, the poison of the most highly venomous Opisthoglyph, *Dispholidus typus*, in its physiological action is particularly characteristic of that of the South American Vipers of the genus *Lachesis*. The physiological action of the venoms can, therefore, have little importance in the settlement of the broader problem of the classification of Snakes from the point of view of descent.

8. A New Liver-Fluke (*Platynosomum acuminatum*) from the Kestrel. By WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S.

[Received September 4, 1914: Read February 9, 1915.]

(Text-figure 1.)

INDEX.

In January 1912 I received from Mr. J. S. Dunkerley, of the Zoological Department, Glasgow University, a single fluke from the liver of a kestrel (*Cerchneis tinnunculus*), shot on the west coast of Scotland. It appears to represent a new species of the genus *Platynosomum* Looss, and for it I propose the name *Platynosomum acuminatum*.

In a note accompanying the specimen Mr. Dunkerley observed and that the parasite was found in the gut, but there can be little question that it must have wandered there from the liver.

The specimen when received had been stained and mounted, was somewhat twisted in the course of preparation. Its total length is 6·3 mm., and its maximum breadth, just behind the ventral sucker, is 1·5 mm. The body is broadest at its middle part, and both the head and tail ends are markedly attenuated.

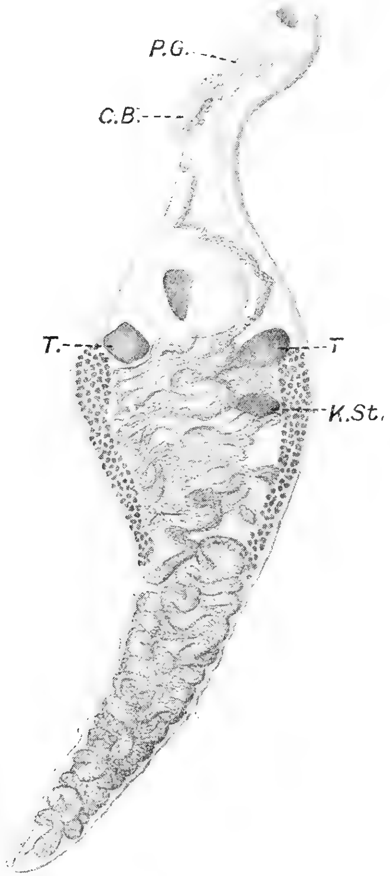
The oral sucker, which is twisted to the right, is rather deep and measures ·45 × ·40 mm. The globular ventral sucker measures ·6 × ·75 mm. and is situated 1·97 mm. from the anterior end. The pharynx is contiguous with the oral sucker and measures ·17 × ·15 mm. There is a short œsophagus, ·25 mm. in length, and the intestinal diverticula are long and narrow, their ends being lost in the folds of the uterus.

The genital aperture lies over the pharynx, and, like the oral sucker, is twisted to the right. The cirrus-pouch is comparatively large, measuring ·7 × ·16 mm. It contains a thin convoluted vesicula seminalis, a pars prostatica of medium length, and a rather longer ductus. The cirrus was slightly extruded.

The testes lie symmetrically, immediately behind the ventral sucker and separated from each other by nearly half the width of the body. They are oblong-oval in outline with their long axes obliquely transverse. They measure about ·25 × ·36 mm.

A short distance behind the left testis lies the transversely oval ovary, which is somewhat smaller than either of the testes. The yolk-glands are entirely lateral, forming rather a broad band on each side from the level of the testes to about 2·3 mm. from the posterior end of the body. They thus extend over a space equal to about one-quarter of the body-length. The follicles are rather small.

Text-figure 1.



Platynosomum acuminatum, sp. n. Ventral view. × 20.

C.B. Cirrus-pouch. P.G. Genital aperture. K.St. Ovary. T. Testes.

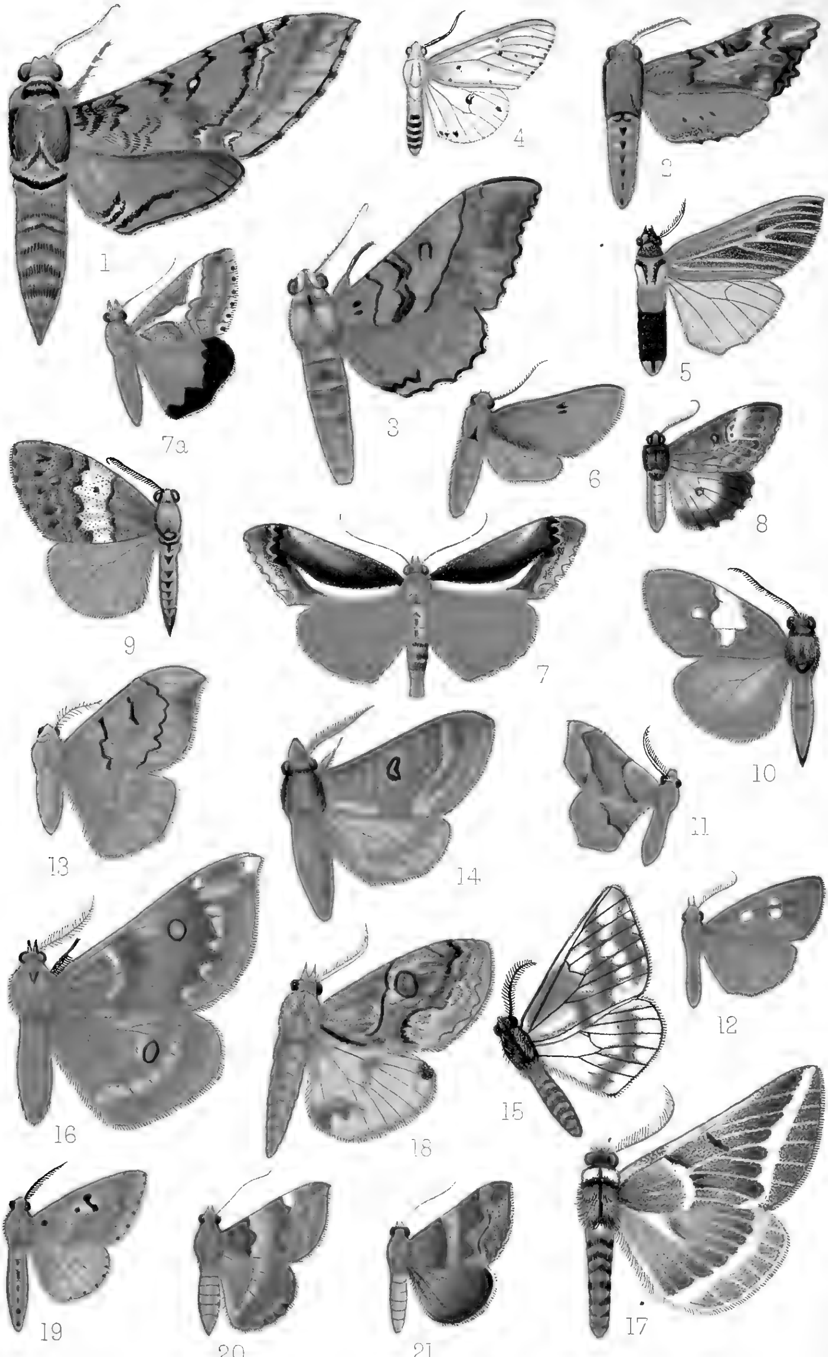
The uterus fills up the greater part of the postacetabular space. Towards the posterior end it tends to form small semicircular loops, but further forward the convolutions become more decidedly transverse, without, however, ever actually traversing the whole space between the intestinal diverticula. The convolutions are confined entirely behind the ventral sucker, and the terminal part of the uterus passes forwards as a single narrow tube, slightly twisted but unconvoluted. The vagina appears to be only weakly developed. The numerous eggs measure ·033–·039 × ·018–·020 mm.

Amongst the many species of *Platynosomum* this new form bears the closest resemblance to *P. deflectens* (Rud., Braun, 1902) and *P. petiolatum* (Raill., Braun, 1902). From both it differs only in minor details. *P. deflectens* is a considerably smaller species with relatively larger suckers. An œsophagus is almost absent, while the cirrus-pouch is short and plump. The testes are globular and more closely apposed. *P. petiolatum* is a larger species with a shorter neck. The œsophagus is extremely short, and the cirrus-pouch extends past the anterior border of the ventral sucker. The yolk-glands, again, are somewhat more extensive but sparser, while the uterus is not so voluminous. Apart from these anatomical details, the difference in host indicates that the present species is distinct from either of the above mentioned forms.

I have to thank Mr. Dunkerley for his courtesy in submitting the specimen for examination.

Reference.

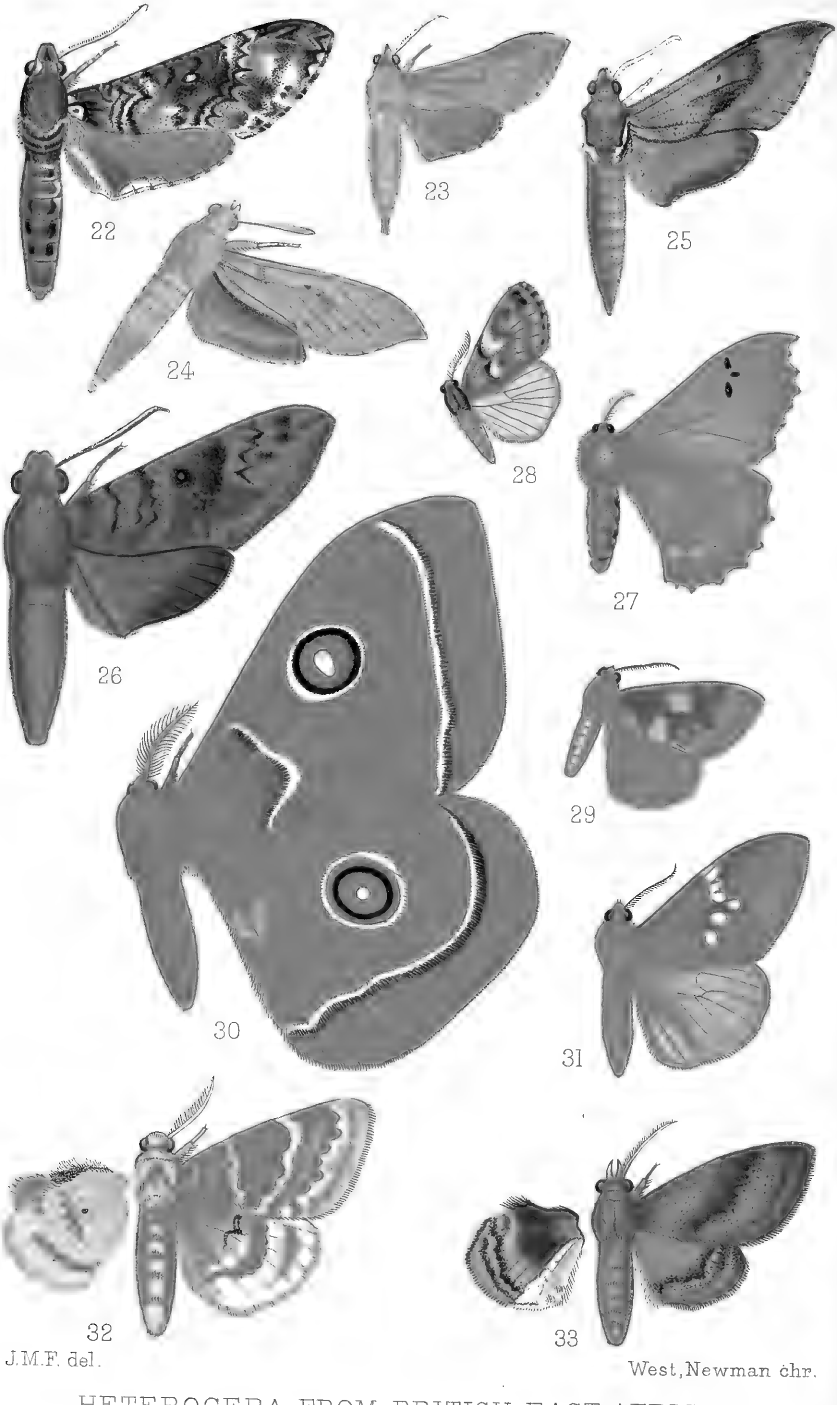
Braun, M. "Die Fascioliden der Vögel," Zool. Jahrb., Syst. Abt. xvi., 1902.



J.M.F. del.

West, Newman chr.

HETEROCERA FROM BRITISH EAST AFRICA.



J.M.F. del.

West, Newman chr.

HETEROCERA FROM BRITISH EAST AFRICA.

9. Notes on a Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911–12. By Lt.-Col. J. M. Fawcett*.

[Received June 22, 1914: Read February 23, 1915.]

(Plates I. & II.†)

INDEX.

The literature on British East African Heterocera is not extensive, and a great part of it is contained in recent German publications mainly dealing with their adjoining territory, and to which I have not had access. But the district is remarkable mainly for specially developed forms. The most interesting collection under notice contains a large number of those—many of which appear to be still undescribed, and also a number of known forms which have not hitherto been recorded from British East Africa. The majority of the latter are known through allied forms from the West Coast districts, from which they present striking variations in colour; I have not been able to examine the genitalia.

Out of a total of 126 species which I have examined, 36 appear to be still undescribed, which seems a large proportion, considering that the country where the collection was made is now traversed by the Uganda Railway, which must offer special facilities to collectors, but this region has never yet been thoroughly worked out. I believe Mr. Feather has a large number of Heterocera still to be examined, and I hope to be able to give the result of my enquiries into them in a future paper. Professor Poulton, of the Hope Museum at Oxford, has the butterfly portion of the collection, and I understand that he has discovered several new species amongst the specimens.

Great credit is due to Mr. Feather for the exactness with which

* Communicated by the SECRETARY.

† For explanation of the Plates see p. 113.

he has preserved the locality and date of every specimen, by which the time of flight of the various forms is recorded, and also for the excellent condition of the specimens.

My thanks are especially due to the Hon. Walter Rothschild, and to Sir George Hampson, whose kind assistance was of great value to me in working out the various species in the British Museum.

The following is a list of the localities given in this memoir :—

(1) Kedai, British East Africa.		Altitude 2500 feet, 120 miles from the coast.
(2) Kibweisi,	ditto.	Altitude 3000 feet, 114 miles up Uganda Railway.
(3) Voi,	ditto.	Altitude 1800 feet, 101 miles up Uganda Railway.
(4) Masongaleni,	ditto.	Altitude 3000 feet, 182 miles up Uganda Railway.

In describing the various new species, I have indicated in each case the form in the British Museum which I have found to be nearest to it, and stated the points of difference between them. The figures of new species are drawn to exact size by myself. From the fact that many of the species were taken in November and December and again in March and April, it would appear that they are at least double-brooded.

A few species are added to this paper which were taken by Lady Colvile at Meru, B. E. Africa, but unfortunately I have not got the dates or elevation of the locality.

HETEROCERA.

Syntomidæ.

1. Metarctia neæra, sp. n. (Pl. I. fig. 6.)

Description.— ♂. Head, body, and wings unicolorous pale reddish brown, the hind wings almost diaphanous in the centre. A very indistinct fuscous spot at the apex of cell of fore wing.

Habitat. Kedai, 24th November. Expanse 40 mm.

This species is allied to *M. pulverea* Hampson, from Ruwenzori, from which it differs in having a blunter apex to the fore wing, and in lacking the black spot at the base of interspace 2, and the irroration of black atoms which covers the fore wing in *pulverea.*

2. Metarctia flavicincta Aurivillius.

Habitat. Meru, B. E. Africa. Taken by Lady Colvile.

3. Metarctia lateritia Herr.-Schäff.

Habitat. Meru, B. E. Africa. Taken by Lady Colvile.

4. Thyretes negus Oberthür.

Habitat. Kedai, 25th November.

Agrees with the description of *negus*, except that the white spot in cell of fore wing is quadrilateral and not triangular.

ARCTIADÆ.

5. DIACRISIA MACULOSA Stoll, Form MACULARIA Walker.
Habitat. Mombasa, 21st March.

6. DIACRISIA JACKSONI Rothschild.
Habitat. Kedai, 25th November.

7. DIACRISIA EPICASTE, sp. n. (Pl. I. fig. 5.)

Description.—♂. Head and collar grey, the latter with a bright orange fringe, thorax pale yellow; patagia streaked with grey. Abdomen orange above, ochreous underneath, with a lateral row of small black spots. The five middle somites of the abdomen black dorsally, orange laterally.

Fore wing pale cream-yellow; the interspaces between the veins with grey streaks; an orange discoidal spot; cilia and inner margin orange: hind wing pale cream-colour, cilia orange.

This form differs from all other species of *Diacrisia* which I have seen in its deep black abdomen.

Habitat. Masongaleni, 18th and 20th April. Expanse 46 mm.

8. AMSACTA EVADNE, sp. n. (Pl. I. fig. 4.)

Description.—♂. Head, thorax, and wings white; costa of fore wing cream-coloured. Abdomen, 1st somite and ventral area white, remaining somites yellow; the five middle somites with black bands dorsally.

Fore wing with four small black spots in interspace 1: one below median nervure, one below middle of vein 2, and two above vein 1. A black spot at base of interspace 2, and one at apex of discoidal cell. Two parallel rows of minute black spots distally, and a row of marginal black spots between the veins. No black spots on costa.

Hind wing: a black spot at apex of cell, and another beyond it submarginally on vein 6. A V-shaped black spot at anal angle with two minute specks inside it.

This form is nearest to *Amsacta flavizonata* Hampson, from North Nigeria, which form has no black spots on the hind wing.

Habitat. Kedai, 17th November. Expanse 40 mm.

9. TERACOTONA RHODOPHÆA Walker.
Habitat. Kedai, 25th November.

10. ARGINA CRIBRARIA Clerck.
Habitat. Mombasa, 30th October.

11. RHODOGASTRIA BUBO Walker.
Habitat. Kedai, 21st January.

NYCTEMERIDÆ.

12. DEILEMERA LEUCONOË Hopffer.

Habitat. Kibweisi, 10th February.

AGARISTIDÆ.

13. ÆGOCERA OBLIQUISIGNA Hampson.

Habitat. Kedai, 5th January.

14. PARÆGOCERA CONFLUENS Weymer.

Habitat. Kedai, 9th June.

15. XANTHOSPILOPTERYX THRUPPI Butler.

Habitat. Kedai, 7th November.

16. XANTHOSPILOPTERYX SUPERBA Butler.

Habitat. Kedai, 27th November.

17. TUERTA TRIMENI Felder.

Habitat. Masongaleni, 1st April and 25th June.

NOCTUIDÆ.

18. PARATUERTA MARSHALLI Hampson.

Habitat. Kedai, 12th March.

19. PARATUERTA FEATHERI, sp. n. (Pl. I. fig. 7.)

Description — ♂. Head and thorax red-brown; abdomen yellow, with two black dorsal spots on 2nd and 3rd somites, and four fuscous dorsal bands on succeeding somites. Fore wing red-brown suffused with pink; a pale pinkish costal subapical fascia. Outer margin pale pinkish, with a red-brown tornal spot. A broad white silver band from the base of costa along vein 1, reaching two-thirds of the length of the inner margin of the wing, and then bent up towards the apex, and narrowing to a point between veins 4 and 5. This band is bordered above and outwardly by a dark sap-green band, which also bends up and reaches the costa before the apex. Below, the white band is bounded by a pale pinkish band which gradually merges into an indistinct green band along the inner margin.

Hind wing dull yellow with a red-brown anal spot, surrounded by a small patch of red-brown irrorations. Underside dull yellow. Apex and outer margin of fore wing pale fuscous and a fuscous spot below apex of cell.

Habitat. Kedai, 8th December. Expanse 46 mm.

20. PARATUERTA ARGENTIFASCIA, sp. n. (Pl. I. fig. 7*a*.)

Description.— ♂. Head, thorax, and fore wing red-brown thickly irrorated with black and grey atoms. Abdomen dull yellow with a dorsal series of small elongate fuscous spots. A triangular olive-brown spot in cell of fore wing, and below it a broad silvery white band along the median nervure from near its base (where it starts from a point), extending both above and below it, to the base of vein 3, where the band joins another broad silvery band bent up to the costa before the apex The outer margin of these two silvery bands is bounded by a narrow waved olive-brown band from costa to inner margin. A marginal series of black points between the veins bordered inwardly by spots of grey irroration.

Hind wing dull yellow, with a broad black submarginal band with a very irregular inner margin. Underside pale yellow with broad black submarginal bands; margins grey; a black spot in cell of fore wing and a black bar on discocellulars joined to submarginal band.

Habitat. Kedai, 24th November. Expanse 44 mm.

The above two forms are nearest to *P. marshalli* Hampson, which differs from them in the white band being broken up into spots where it bends upwards, and in having a black tooth on the band on its lower margin.

There seems to be some doubt as to the correct position of the genus *Paratuerta*. Sir G. Hampson places it at the end of the Noctuidæ Acronyctinæ while Dr. Karl Jordan, writing in Seitz, "Macrolepidoptera of the World," places what appears to be another species of the genus (viz. *leucographa*) in the Agaristidæ. I have followed the British Museum arrangement here.

21. Ovios nealces, sp. n. (Pl. I. fig. 8.)

Description.—♂. Head, thorax, and fore wing pale grey-brown with a violaceous reflection. Abdomen and hind wing pale ochreous with a broad fuscous marginal band.

Fore wing with a submarginal row of red-brown spots between the veins, which merges into a submarginal band towards the costa near the apex. A short white band from costa to vein 4 where it surrounds the reniform stigma. An indistinct orbicular spot in cell. Costa suffused with greyish irroration. In the female the white band of the fore wing is broader and more diffused.

Habitat. Kedai, 25th November. Expanse 38 mm.

22. Pasipeda roseiventris Gerstaecker.

Habitat. Kedai, 25th November.

Perhaps a local form of *P. sambesita* Walker. Recorded previously from B. E. Africa by Butler (P. Z. S. 1898, p. 424).

23. Setola pulchra Bethune-Baker.

Habitat. Kedai, 28th November.

24. Setoctena patricola Hampson.

Habitat. Masongaleni, 9th June.

25. CALLYNA MONOLEUCA Walker.

Habitat. Masongaleni, 6th April. The African specimens of this species are indistinguishable from specimens in the British Museum from India, Ceylon, and N. Guinea, except for their rather lighter hind wing.

26. ERICETA SOBRIA Walker.

Habitat. Kedai, 8th December.

27. MOCIS REPANDA Fabricius.

Habitat. Msola, November.

28. BAMRA MARMORIFERA Walker.

Habitat. Masongaleni, 25th May.

29. SPHINGOMORPHA CHLOREA Cramer.

Habitat. Masongaleni, 28th May and 9th June. A common species here as elsewhere.

30. ENMONODIA CAPENSIS Herr.-Schäff.

Habitat. Kedai, 2nd December. One ♀ specimen.
Perhaps better known as *Spirama capensis.*

31. NYCTIPAO MACROPS Linnæus.

Habitat. Kedai, 21st May, ♂; Masongaleni, 6th June, ♀.

32. ANUA MEJANESI Guén.

Habitat. Kedai, 14th January, ♂.

33. ACHÆA LIENARDI Boisduval.

Habitat. Masongaleni, 31st March and 7th April. At least four different forms of this variable species are represented in the collection.

34. ACHÆA CATELLA Guén.

Habitat. Kedai, 9th January.

35. ACHÆA DASYBASIS Hampson.

Habitat. Mombasa, 28th May.

36. ACHÆA PRÆSTANS Guén.

Habitat. Masongaleni, 7th June.

37. ACHÆA ALGIRA Linnæus, Form PROPERANS Walker.

Habitat. Kedai, 4th October. Masongaleni, 9th June. The form from Kedai is smaller and paler.

38. PARALLELIA ANGULARIS Boisduval.

Habitat. Meru, taken by Lady Colvile.

39. Parallelia portia, sp. n. (Pl. I. fig. 20.)

Description.— ♂. Head and thorax dark red-brown, abdomen ochreous. Fore wing: the basal area dark red-brown defined outwardly by a fine blackish line which is very irregular, being angled outwardly on median nervure and inwardly on vein 1. A broad grey median band, and beyond it a dark red-brown band defined outwardly by a fine postmedial dark line angled outwardly at veins 1, 4, and 6, and inwardly in interspace 2. Beyond this line is a narrow waved ferruginous band from vein 6 to inner margin where it ends in a black spot. A red-brown subapical spot defined inwardly by a whitish line, and continued across the distal area as a dark submarginal line. Marginal area greyish. Hind wing pale fuscous, with a fine medial line defined outwardly by a pale ochreous band: submarginal area fuscous, cilia whitish. In some specimens the outer edge of the grey median band of fore wing is much diffused and the band consequently broader.

Habitat. Kedai, 22nd December; Voi, 2nd May. Expanse 40 mm.

This form is nearest to *P. angularis* Boisd.; but differs from it in the basal line being angled and not straight, in having a fulvous or ferruginous band behind the postmedial line, and in the hind wing being banded instead of plain fuscous.

40. Parallelia rectifascia, sp. n. (Pl. I. fig. 21.)

Description.— ♂. Similar to *P. portia* described above but smaller and darker. It differs from *portia* in the line defining the red-brown basal area of the fore wing being straight and not angled. The grey median band is narrower and straight on both edges. The dark red-brown postmedial band is angled outwardly only on vein 1 and inwardly only on vein 2. Ferruginous band as in *portia*, but apical spot darker and not defined inwardly with a whitish line. Hind wing: outer distal area black, inner area paler; cilia white.

Habitat. Kedai, 9th March and 9th and 14th December. Expanse 38 mm.

41. Trigonodes hyppasia Cramer.

Habitat. Masongaleni, 18th June; Kedai, 7th January.

42. Ophideres materna Linnæus.

Habitat. Voi, 2nd May, ♂; Kedai, 3rd January, ♀.

43. Plusia orichalcea Fabricius.

Habitat. Kedai, 5th January.

44. Cyligramma latona Cramer.

Habitat. Kedai, 8th January.

45. Cyligramma lilacina Guérin.

Habitat. Masongaleni, 25th May.

46. Rhanidophora albigutta, sp. n. (Pl. I. fig. 12.)

Description.— ♂. Head, thorax, and fore wing pale brown, or mouse-colour. Abdomen and hind wing dull yellow. Fore wing with three white circular spots, one in cell and two, one above the other, on discocellulars.

Differs from *R. cinctigutta* Walker in the white spots of the fore wing having no black rings.

Habitat. Kedai, December. Expanse 40 mm.

47. Grammodes geometrica Fabricius.

Habitat. Kedai, 25th November.

48. Prodenia littoralis Boisduval.

Habitat. Masongaleni, 8th January and 9th June. Common, as elsewhere.

Lymantriadæ.

49. Lælia testacea Walker.

Habitat. Masongaleni, 23rd June.

50. Caviria flavifrons Hampson.

Habitat. Masongaleni, 31st May.

51. Pteredoa telesilla Druce.

Habitat. Kedai, 8th December.

52. Psalis securis Hübner.

Habitat. Masongaleni, 18th June.

53. Aroa discalis Walker.

Habitat. Kedai, 22nd February.

54. Aroa libyra Druce.

Habitat. Kedai, 28th December.

55. Aconophlebia triangulifera Hampson.

Habitat. Kedai, 8th December.

Only the type specimen is in the British Museum.

56. Lymantria melete, sp. n. (Pl. I. fig. 9.)

Description.— ♀. Head and thorax pale fuscous, abdomen pale red with a dorsal row of black spots. Antennæ black. Fore wing fuscous brown with a medial white fascia from costa to inner margin, suffused with an irroration of fuscous atoms. In some specimens this irroration is so dense that the white fascia becomes very indistinct. A black point at apex of cell. An indistinct postmedial lunular grey band, beyond which the submarginal area is irrorated with grey. Hind wing pale fuscous.

Habitat. Kedai, 8th June; Masongaleni, 24th March. Expanse 46 mm.

This form is nearest to *L. gondona* Swinhoe, but it is a larger and darker insect with the hind wing fuscous, instead of pale yellow. The band in *gondona* is narrow, and lacks the black point on the discocellulars.

57. LYMANTRIA MELIA, sp. n. (Pl. I. fig. 10.)

Description.—♂. Head reddish, thorax and fore wing pale brown, abdomen and hind wing pale red. Antennæ black. Fore wing with a median white fascia from costa to middle of interspace 1. A white spot beyond it at base of interspace 3. Cilia and costa edged with pale red. Underside of wings pale red.

Habitat. Kedai, 24th November, 12th December, and 1st March. Expanse 46 mm.

This form is nearest to *L. albimacula* Wallengren, but differs in the white markings of the fore wing being much more restricted, and in having a red abdomen and hind wings instead of yellow as in that species.

58. LYMANTRIA METELLA, sp. n. (Pl. II. fig. 31.)

Description.—♀. Head and body red, antennæ black. Fore wing bright fulvous, with a median white band broken up into spots in the interspaces, and angled outwards in interspace 3. The spots are situated as follows:—a double spot below the costa, a double spot at apex of cell, and three round spots in interspaces 1, 2, and 3. Cilia fulvous. Hind wing pale pinkish red, darker at the base and near the inner margin.

Underside similarly coloured to upperside, but paler, and the white spots of the fore wing more indistinct. The scaling of the wings is very sparse, and they are almost diaphanous on the distal areas.

Habitat. Masongaleni, 26th December. Expanse 60 mm.

59. LYMANTRIA MENECLES, sp. n. (Pl. II. fig. 28.)

Description.—♂. Head and tibiæ red; thorax red-brown. Abdomen red. Fore wing grey-brown inclining to fulvous on the inner margin. A median curved blackish line from costa to vein 1, bordered outwardly by a broad white band, which is profusely irrorated by black atoms, and divided into two parts by the median nervure. These white spots are bordered outwardly by another blackish band which is broadest on the costa. A submarginal waved blackish band. Cilia chequered red and brown. Hind wing cream-colour, with red marginal line and cilia.

This form is nearest to *Lymantria albimaculata* Walker, but is smaller, and has a red abdomen instead of yellow.

Habitat. Kedai, 25th November and 12th December. Expanse 40 mm.

60. LYMANTRIA ARETE, sp. n. (Pl. I. fig. 19.)

Description.—♂. Head and thorax pale reddish brown. Abdomen pale red, with a dorsal row of elongate fuscous spots.

Wings testaceous with bands of fuscous and ferruginous irroration. A round black spot at base of cell, and a similar spot in cell followed by a curved black bar on discocellulars. Three indistinct pale lines, one antemedial, one medial on discocellulars angled inwardly below them, and one postmedial. Margin pale testaceous. Between the postmedial line and the margin and also between the medial and postmedial lines is a darker band formed by fuscous irroration. The veins and interspaces 2, 5 and 6 defined with ferruginous irroration. A marginal row of black points between the veins of both wings. Cilia reddish. Hind wing pale testaceous without markings, but rather darker towards the apex.

Habitat. Kedai, 15th December. Expanse 40 mm.

I was unable to find any species represented in the British Museum which is at all near to this species.

61. Lymantria melissa, sp. n. (Pl. II. fig. 29.)

Description.—♂. Head and thorax orange, abdomen pinkish, antennæ black. Fore wing hair-brown, with a broad chrome-yellow marginal band. A quadrate spot occupying one-third of cell, and another of the same size on the middle of inner margin, both spots being pale pink. A narrow and indistinct fascia of the same colour running up from the inner margin parallel with the outer edge of the brown part of the wing. An elongate pink band along the basal part of the inner margin. Hind wing pink, with a broad chrome-yellow margin as in the fore wing. Underside similar to upperside, but paler.

Habitat. Masongaleni, 15th May. Expanse 50 mm.

I have not been able to find anything near this species in the British Museum.

62. Dasychira obliquilinea, sp. n. (Pl. I. fig. 18.)

Description.—♂. Head, antennæ, thorax, and abdomen pale fuscous brown. Fore wing fuscous brown, the outer margin and the costa greyish, irrorated with fuscous. Basal area of fore wing fuscous brown with some greyish irroration. A fine black oblique medial line from costa to vein 1, where it almost meets a black line along base of inner margin. Beyond this is a deep brown whorl coming to a point outwardly on vein 5, and situated in a dark fuscous area which occupies the space between the medial and postmedial lines. A black postmedial line curved outwardly before the apex and bent inwardly on veins 2 and 3, and finally outwardly on inner margin. Outer area greyish crossed by two irregularly waved submarginal lines. Cilia greyish fuscous.

Hind wing greyish fuscous with two lunulate black spots at anal angle, one at end of cell and one at apex.

Habitat. Kedai, 8th January. Expanse 50 mm.

This form is nearest to *Dasychira nubifera* Holland, from South Nigeria, of which one specimen is in the British Museum, and which lacks the fine medial black line and is darker and of a greenish colour. *D. nubifera* also has a complete submarginal black band on the hind wing.

63. Dulichia fasciata plana, subsp. n.

Description.— ♂. Head, thorax, and abdomen pale dull yellow. Wings pale cream-colour with the following marks:—an indistinct black spot at middle of inner margin surrounded by some black marginal hairs. Three small indistinct spots of black irroration as follows: one on the discocellulars, one distally in interspaces 1 and 5.

Habitat. Masongaleni, 5th February. Expanse 46 mm.

This form is near to *Dulichia fasciata* Wallengren from Natal, but all the specimens are without the prominent black median band of that form. *D. fasciata* also occurs in the same place, but the specimens are smaller.

63 *a*. Dulichia fasciata Wallengren.

Habitat. Masongaleni, 5th February.

Saturniadæ.

64. Nudaurelia belina Westwood.

Habitat. Masongaleni, 9th December and 9th March; Kedai, 20th January.

There is a green form and a red form and an intermediate form of this species in this locality, but they occur in the same places and at the same times. Mr. Feather bred the red form from larvæ in January. The specimens I possess from Natal resemble the intermediate form, and are rather smaller.

65. Nudaurelia jacksoni Rothschild.

Habitat. Meru, taken by Lady Colvile.

66. Nudaurelia tyrrhæa Westwood.

Habitat. Meru, taken by Lady Colvile. Somewhat smaller than my specimens from Natal.

67. Nudaurelia nereis Rothschild.
(Nov. Zool. 1898, p. 605.)

Habitat. Voi, 2nd May.

Some doubt exists as to this species. It is near to *N. menippe* Westwood, but is considerably smaller and lacks the antemedial white fascia of that species. Mr. Rothschild thinks the specimen might be referable to another small species, *N. sufferti* Weymer (Berlin. Ent. Zeit. 1896, p. 85, pl. 8. fig. 1).

68. Nudaurelia vau, sp. n. (Pl. II. fig. 30.)

Description.— ♂. Head, body, and fore wing bright ferruginous, the latter profusely irrorated with black atoms between the veins, and pinkish on the costal margin. A white antemedial line margined basally with black, and angled outwardly above vein 1, from subcostal nervure to inner margin. A round hyaline spot on discocellulars surrounded by an ocellus which is brown with a black and then a white ring round it. This ocellus is large, being of equal size to that on the hind wing. A submarginal white line defined outwardly by a black line from the costa before apex (where it curves outwardly towards the outer margin) to the inner margin.

Hind wing pink with an indistinct V-shaped whitish mark on the inner margin. A somewhat similar ocellus to that on the fore wing on the discocellulars, but the hyaline spot is smaller, and it has in addition a crimson ring between the black one and the outer white one. A submarginal white line defined outwardly by a black line as in the fore wing. The marginal area beyond this line is concolorous with the fore wing. Underside marked similarly, but pink. Antennæ highly pectinated and ferruginous.

Habitat. Masongaleni, 30th November. Expanse 116 mm.

This form is nearest to *Nudaurelia macrophthalma* Kirby, but differs in having a full-sized ocellus on the fore wing, and a prominent white V-shaped antemedial line which is obsolete in *macrophthalma*, the latter is recorded from Chari and Lake Tchad in West Africa. Owing to this peculiar character I have named this form "*vau.*"

69. Nudaurelia zaddachii De Witz.

Habitat. Lake Albert, 9th June.

70. Gynanisa maia Klug.

Habitat. Kedai, 25th November.

71. Gynanisa westwoodi Rothschild.

Habitat. Masongaleni, 14th November.

72. Attacus antinori Oberthür.

Habitat. Meru, taken by Lady Colvile.

73. Epiphora lugardi Kirby.

(Ann. Mag. Nat. Hist. (6) xii. p. 165.)

Habitat. Masongaleni, 20th April, ♂ ; Kedai, 14th April, ♀.
Also taken at Meru by Lady Colvile.
Not in the British Museum Collection.

74. Argema besanti Rebel.

(Verh. zool.-bot. Ges. Wien, 1895, p. 69.)

Habitat. Kedai, 25th November.

Mr. Feather writes of this very rare form, of which I understand only four specimens are known to have been taken, as follows:—"I took *besanti* on one of those abnormal nights when insects were flying about in millions. It had started raining about 2.30 in the afternoon, quite a gentle rain, which continued until the afternoon of the following day. I stayed up till about 3 A.M., taking insects at light, and *besanti* was the last insect I took before turning in."

75. SATURNIA BIOCULATA Aurivillius.

Habitat. Kedai, 25th November.

76. UROTA SINOPE Westwood.

Habitat. Kedai, 25th November.

77. USTA ANGULATA Rothschild.

Habitat. Kedai, 27th November, ♀.

78. PSEUDAPHELIA APOLLINARIS Westwood.

Habitat. Kedai, 31st December, ♂.

79. LUDIA CRENULATA, sp. n. (Pl. II. fig. 27.)

Description.— ♂. Head, thorax, and both wings brick-red. Antennæ bright fulvous. Abdomen greyish with five orange bands at the intersection of the somites. An elongate black spot on the discocellulars of the fore wing, and two other black spots above it, one in interspace 5, and one subcostally in interspace 6. Hind wing with nine yellow spots on the distal area—two in the middle of interspace 1, one at the base of interspaces 2 and 3; two near the apex of the cell, two in interspace 5 and one in interspace 6. Cilia yellow, and highly crenulated. Between vein 6 and the apex of the fore wing this crenulation gives the appearance of a portion of the wing having been cut out.

Underside of fore wing similar to upperside: hind wing with an antemedial and a postmedial grey crenulate line, between which the area is red-brown thickly irrorated with greyish atoms, which also extend to the margin. The yellow spots of the upperside are much more distinct on the underside.

Habitat. Kedai, 4th December, ♂. Expanse 60 mm.

This is a very remarkable form, and the nearest I could find to it in the British Museum is the figure of "*Heniocha grimmia*" Hübner, of which only Hübner's figure is known. But that figure shows a quite differently coloured insect.

80. PARUSTA THELXINOË, sp. n. (Pl. I. fig. 16.)

Description.— ♂. Head dark fuscous, antennæ reddish ochreous, thorax ochreous; abdomen, 1st somite dark brown, remaining somites bright ochreous above, fuscous beneath. Wings pale fuscous with a reddish tinge. Fore wing with an antemedial whitish fascia curved basally at costa and inner margin. A small oval orange spot with white centre and ringed outwardly by a fine black line on discocellulars. A postmedial whitish lunulate fascia from inner margin near tornal angle to before apex, where it forks, and becomes two subapical white spots. The medial space between the two fasciæ darker.

Hind wing almost diaphanous in cell and inner margin, but covered with fine yellowish hair. A postmedial fascia, as in the fore wing, bordered internally by a darker band. An oval orange black-ringed spot on discocellulars similar to that on the fore wing.

Habitat. Kedai, 12th and 24th November. Expanse 70 mm.

This form is allied to *Parusta xanthops* Rothschild (Nov. Zool. vol. xv. 1908, p. 256, pl. ix. fig. 2), but differs in being larger and darker, and in the fore wing being much more acute. The figure referred to is that of a worn specimen, almost diaphanous, but the colour is described as cream-buff.

81. GOODIA ORIENS HEPTAPORA, subsp. n. (Pl. I. fig. 13.)

Description.—♂. Head and palpi dark chocolate-brown, collar greyish with a dark fringe; thorax pale brown. Fore wing ochreous with a pinkish tinge at base; a fine black antemedial line from costa to inner margin, bent in basally on median nervure, and outwards again on vein 1. A dark line on discocellulars, and a black postmedial lunular line beyond it, bent in on costa. Between these two lines there is a red-brown patch, and a darker one on the outer margin below the apex which is falcate. Hind wing pale ochreous with a pinkish tinge, unmarked, but rather darker towards the margins.

♀. Larger; pale ochreous and very sparsely scaled. The ante- and postmedial lines of the fore wing obsolete.

Habitat. Kedai, 9th and 25th November. Expanse, ♂ 46 mm., ♀ 50 mm.

This form is nearest to *Goodia oriens* Hampson, from Ruwenzori, but differs in coloration. In *oriens* the thorax is covered with black hairs, the distal area is blackish, especially towards the inner margin, and the cilia are black.

Goodia hollandi Butler (P.Z.S. 1898, pl. xxxii. fig. 1) is a much larger insect, is without the antemedial and discocellular black lines, and the postmedial line only reaches from costa to vein 5; while, on the other hand, it has a submarginal line on the hind wing, which is absent from this form.

BRAHMÆIDÆ.

82. BRAHMÆA MACULATA Conte.

Habitat. Masongaleni, 11th November.

This species is not in the British Museum collection. The specimen was identified for me as *maculata* by Sir George Hampson.

BOMBYCIDÆ CERATOCAMPIDÆ.

83. SABALIA EUTERPE, sp. n. (Pl. I. fig. 15.)

Description.—♂. Head black with two orange spots at base of the antennæ, which are black and bipectinated. Thorax covered with long black hairs; patagia greyish. Abdomen black with five orange rings, and an orange spot at its extremity. Wings white, the veins fuscous. Fore wing: an antemedial fuscous fascia which fills nearly the whole cell; a black line on discocellulars; postmedial and submarginal fuscous fasciæ; a black marginal line; cilia fuscous. Hind wing white with only a submarginal fuscous fascia, angled towards the margin at vein 3.

Habitat. Kedai, 1st March and 25th November. Expanse 46 mm.

This form is nearest to *Sabalia sericea* Weymer (only a figure of which is in the British Museum), but differs as follows:—the cell is fuscous; the fuscous submarginal band is carried down to vein 2 in the fore wing, whereas it stops on vein 4 in *sericea*. In the hind wing the fuscous band is deeper, more sinuous, and nearer the margin, and the veins are black throughout.

84. Sabalia thalia, sp. n. (Pl. I. fig. 17.)

Description.—♂. Head black; orange spots at base of the antennæ, which are black and bipectinated. Collar broadly white with a black spot dorsally. Thorax covered with long black hair. Abdomen black with five orange rings, and an orange spot at its extremity. Fore wing pale brown, the veins white. A white antemedial fascia defined outwardly with dark brown, bent in basally on costa and inner margin. A brown spot on discocellulars. A white submarginal line from apex to tornal angle, defined inwardly by dark brown, beyond which the marginal area is brown, crossed by the white veins. Hind wing ochreous at base; a dark spot on discocellulars, and a white submarginal band as on the fore wing.

Cilia of fore wing brown, of hind wing whitish.

Habitat. Kedai, 26th & 27th November and 12th & 14th April. Expanse 74 mm.

This form is nearest to *Sabalia picarina* Walker, which has a white hind wing and deep black marginal band.

The specimens of the above two species which I have seen are all males, and the species would appear to be at least double-brooded.

84 *a*. Anaphe panda Boisduval.

Habitat. Kedai, 12th March.

These specimens differ from *panda* from Natal in the fuscous border of the inner margin being curved up basally towards the thorax, and in having no distal band on hind wing, and in being smaller.

Sphingidæ.

85. Poliana marmorata, sp. n. (Pl. II. fig. 22.)

Description.—♂. Head, thorax, and palpi fuscous above; white spots above the eyes. Palpi beneath white, as also pectus and lower surface of abdomen. Abdomen fuscous brown above with darker bands, and a short whitish lateral band on first three somites. Fore wing grey marbled with fuscous-brown bands and patches. Two white basal spots followed outwardly by a dark-brown basal band. Three antemedial fuscous lines angled outwardly on median nervure. A large medial brown patch extending from costa to below vein 2, in the middle of which is a white discocellular spot. Three waved postmedial blackish lines margined outwardly by white and an ochreous band. Submarginal and marginal lunular lines, the latter broken up into spots on veins 2, 3, and 4. Cilia chequered black and white on both wings. Hind wing fuscous, with a darker patch at anal angle, and some basal whitish hairs. Underside pale fuscous with indistinct darker bands, the hind wing white on the abdominal margin.

Habitat. Masongaleni, 23rd April. Expanse 74 mm.

This form is nearest to *Poliana buchholzi* Plötz, from West Africa, a figure of which is in the Dublin Museum.

86. Dovania circe, sp. n. (Pl. I. fig. 1.)

Description.—♂. Head and antennæ ochreous; dark chocolate bands along sides of palpi; collar and thorax purplish brown, grizzled with grey, the patagia with white edges. Black bands along sides of thorax meeting on metathorax, which is bright ochreous. Abdomen pale ochreous with brown bands on each somite, these bands ending laterally in a row of dark brown spots. Legs black, banded with ochreous.

Fore wing greyish ochreous with a slight pinkish suffusion on disc. Three dark antemedial strigæ from costa to vein 1. A fourth medial striga from costa to median nervure. Between the 3rd and 4th strigæ an ochreous band reaching to vein 1, below which are three indistinct strigæ to inner margin. A black obliquely curved striga from costa at end of cell on which is placed a white reniform spot. A postmedial inwardly curved line edged outwardly with white, from costa to inner margin, and immediately beyond it an ochreous band outwardly defined by a band of brown spots between the veins, and darkest on the costa. From apex a short black striga curved inwardly. Cilia chequered brown and white.

Hind wing dark red, paling inwardly to bright ochreous. Anal angle paler with a grey suffusion, with three dark lines across it, the outer one of which is continued submarginally to the costa, beyond which the apical area is dark red-brown. Cilia as in fore wing.

Habitat. Kedai, 25th November. Expanse 90 mm.

This species is nearest to *Dovania pœcila* Rothschild.

87. Prædora marshalli Rothschild.

Habitat. Kedai, 8th December, ♂, and 20th April, ♂ & ♀.

88. Pseudoclanis postica Walker.

Habitat. Kedai, 20th December.

89. Polyptychus fumosus pelops, subsp. n. (Pl. I. fig. 3.)

Description.—♂. Body and wings reddish brown with a pinkish suffusion; markings dark red-brown. Antennæ pale ochreous; sides of palpi, under part of body and legs dark brown. Head and thorax with a dark brown medial line. Abdomen, first two somites with dark brown bands. Fore wing with two black subbasal spots at base of cell. Three antemedial oblique blackish lines from costa to inner margin, the 2nd and 3rd with a brown band between them. Reniform brown with dark edges. A double brown postmedial line from costa, running obliquely to inner margin, enclosing a darker space, and immediately beyond it an indistinct waved line. Subapical area dark red-brown as in *P. grayi*; a red-brown spot near anal angle.

Hind wing red-brown; the anal area paler with a dark striga on it ending in a black anal spot. Cilia dark brown, with white between the veins.

Habitat. Kedai, 14th & 22nd April. Expanse 70 mm.

This form is nearest to *Polyptychus fumosus* Rothschild, from Ruwenzori. Its colours are, however, much richer and darker than that species, as represented by Mr. Rothschild's figure, which shows a pale fuscous insect without a trace of pinkish or red-brown suffusion.

This form, being moreover from a different locality, must at least be a good local race of *fumosus*, even if not specifically distinct.

90. Ceridia mira Rothschild.

Habitat. Kedai, 17th December, ♀; 29th December, ♂.

A remarkable form with highly pectinated antennæ of the form of a small Saturnid. Mr. Rothschild had not seen the female till he saw the specimen mentioned above. It only differs in its larger size and less highly pectinated antennæ.

91. Lophostethus demolini Angas.

Habitat. Masongaleni, 11th November.

92. Cephonodes hylas Linnæus, subsp. virescens Wallengren.

Habitat. Kedai, 4th January; Masongaleni, 12th September.

The writer has bred this species from six different forms of larvæ on Gardenia in Natal (Trans. Z. S. vol. xv. p. 312, April 1901).

93. Nephele didyma Fabricius, Form hespera Fabricius.

Habitat. Kedai, 8th January.

94. Nephele accentifera Beauvois.

Habitat. Msala, November.

95. NEPHELE RECTANGULATA Rothschild.

Habitat. Mombasa, 12th May.

96. NEPHELE VAU Walker.

Habitat. Meru, taken by Lady Colvile.

97. NEPHELE VESPERA, sp. n. (Pl. II. fig. 26.)

Description.— ♂. Head, body, and wings with dark brown bands and lines. Fore wing: a dark basal band followed by three antemedial waved lines; two medial waved lines bent in on the inner margin, and enclosing a pale round discocellular spot; two postmedial lines, the inner one nearly straight, and the outer crenulate from costa to inner margin, and between them and the antemedial lines a large dark-brown patch angled outwardly nearly to the margin below vein 4; three black submarginal spots before the apex, joining the latter by a fine black line. Hind wing with a broad brown marginal band. Underside paler, with markings more indistinct. Palpi white beneath, and a whitish line above the eyes.

Habitat. Kedai, 20th January. Expanse 80 mm.

This form is nearest to *Nephele funebris* Fabricius, from S. Africa, but differs from all species of *Nephele* that I have seen in having no black bands on the abdomen, which in this species is plain fuscous.

98. TEMNORA ERATO, sp. n. (Pl. I. fig. 2.)

Description.— ♂. Head red-brown, dark grey vertically; thorax grey. Abdomen greyish with bright ochreous bands, and a dorsal row of black spots on the somites. Fore wing: basal third grey; disc pinkish, with two brown patches on the costa defined by whitish outwardly. Antemedial and postmedial lines, the latter crenulate below the costa, and becoming large brown lunules between the veins on the disc. A white line to apex with an ochreous patch beneath it. A black submarginal spot below apex; inner margin brown. Hind wing pale fuscous with an obsolete submarginal line, which only becomes distinct at anal angle. Two distal black spots on veins 3 and 4.

The female does not differ from the male except in the fore wings being longer and narrower and the discal area being paler.

Habitat. Masongaleni, 29th April, ♂; Kedai, 24th November, ♂ & ♀. Expanse, ♂ 50 mm., ♀ 60 mm.

This form is nearest to *Temnora natalis* Walker, but is much smaller.

99. RHOPALOPSYCHE HIRUNDO Gerst.

Habitat. Kedai, 8th January; Meru (Lady Colvile).

100. HIPPOTION DEXIPPUS, sp. n. (Pl. II. fig. 25.)

Description.— ♂. Head, thorax, and antennæ bluish grey, the fringes of the patagia white, and white spots above the eyes.

Abdomen paler grey. Fore wing grey, palest antemedially; a black spot at end of cell, and a fuscous-grey oblique band across the middle, broadest on the costa, and curving inwards gradually until it becomes linear on the inner margin. An indistinct submarginal line from apex to inner margin where it becomes blackish. Between this line and the medial band there are some small black spots above the inner margin. Hind wing pale ochreous with medial and submarginal dark-grey bands, between which the distal area is mottled with dark grey spots. Cilia white. Underside similar to the upperside, but paler.

Habitat. Kedai, 25th November. Expanse 72 mm.

This form is nearest to *Hippotion rosæ* Butler, from Delagoa Bay, but is much smaller, and has no pink antennæ as in that species.

101. Hippotion diyllus, sp. n. (Pl. II. fig. 23.)

Description.—♂. Head, thorax, abdomen, antennæ, and fore wing very pale yellowish ochreous; hind wing rather darker towards the margin, with a pinkish tinge on the discal area. Cilia white, with minute dots at the end of the veins of the fore wing. Two subapical blackish dots on the costa of the fore wing, and a small orange spot below the cell, at the base of interspace 3. Underside similar but paler on the margins.

Habitat. Kedai, 25th November. Expanse 56 mm.

This form, though very different in colour, resembles somewhat in structure the common green *Basiothæa medea* Fabricius, but is a true *Hippotion.*

102. Hippotion exclamationis, sp. n. (Pl. II. fig. 24.)

Description.—♂. Head, body, and fore wing pale ochreous; hind wing greyish fuscous with pale submarginal and marginal ochreous bands. Fore wing with a small black spot at extremity of cell, and close to it a black elongate spot in interspace 4; the two spots being in the form of a note of exclamation. A submarginal row of small black spots on the veins of the fore wing.

Habitat. Masongaleni, 9th June. Expanse 70 mm.

This form is nearest to *Hippotion roseipennis* Butler (which also occurs in this district), but differs from it in being pale buff, instead of dull green with a reddish hind wing. It also lacks the postmedial line of *roseipennis*, and instead of a submarginal line from the apex of the fore wing has a line of black spots on the veins.

103. Hippotion roseipennis Butler.

Habitat. Kedai, 16th January. A faded specimen.

104. Hippotion eson Cramer.

Habitat. Meru, taken by Lady Colvile.

105. Hippotion celerio Linnæus.

Habitat. Meru, taken by Lady Colvile.

NOTODONTIDÆ.

106. STAUROPUS DASYCHIRIOIDES Butler.

Habitat. Kedai, 25th November.

Only the type specimen of this species is at present in the British Museum, and Sir George Hampson expressed some doubt about its belonging to the genus *Stauropus.*

107. PHALERA LEYDENBURGI Distant.

Habitat. Kedai, 25th November; Masongaleni, 4th March.

LASIOCAMPIDÆ.

108. CHILENA CONTINUA Aurivillius.

Habitat. Masongaleni, 25th May.

109. CERATOPACHA GEMMATA Distant.

Habitat. Kedai, 17th November, ♀; 25th November, ♂.

The female differs from the male in being larger, rather paler, and being without the black abdomen; but has the black brush of hairs on the costa of the hind wing underneath.

110. CERATOPACHA DECORA, sp. n. (Pl. II. fig. 32.)

Description—♀. Head, legs, thorax, and antennæ pale cream-coloured. Abdomen yellow above, white beneath, thickly covered with hair; anal somite whitish.

Fore wing bright ochreous. An indistinct white curved basal line; a waved whitish antemedial line defined outwardly by dark ochreous, from costa to inner margin. A black spot at lower end of cell. A waved oblique postmedial whitish line, bent inwards on costa and defined inwardly by dark ochreous, from costa to inner margin. An irregular lunular submarginal white line, also bent inwardly on costa and defined inwardly by dark ochreous.

Hind wing paler ochreous basally, with a fuscous striga from costa to end of cell. A golden yellow distal band from costa to inner margin. Beyond this band the marginal area is white with an indistinct ochreous band from costa to vein 3. Cilia ochreous. Underside very pale ochreous; fore wing unmarked, hind wing with a faint indication of the yellow band of the upperside and having a black brush of hairs on the basal half of the costa.

Habitat. Kedai, 18th March. Expanse 60 mm.

Differs from *gemmata* in the whitish lines of the fore wing being waved, and not straight as in that species, and the hind wing has a prominent golden yellow band which is absent from *gemmata.*

111. PACHYMETA FLAVIA, sp. n. (Pl. I. fig. 14.)

Description.—♂. Head and thorax grey-brown with a purple tinge. Abdomen reddish ochreous; antennæ ochreous. Fore wing: base fulvous, median area purplish grey, crossed by triple antemedial and postmedial dark waved lines from costa to inner margin. A dark brown renal stigma enclosing a fulvous reniform on discocellulars. Outer area fulvous brown subapically, crossed by a submarginal row of bright fulvous lunules. Cilia dark brown. Hind wing pale reddish brown, crossed by an indistinct darker submarginal fascia.

Female similarly coloured, but much larger, a good deal paler, and without purple suffusion.

Habitat. Kedai, 25th November, ♂; Masongaleni, 31st March, ♀. Expanse, ♂ 46 mm., ♀ 74 mm.

This form is nearest to *Pachymeta purpurascens* Aurivillius, from Mashonaland, but is paler and smaller. *P. purpurascens* is a much stouter larger species, is suffused throughout with purple, and has *no* discoidal reniform stigma.

112. Pachymeta roxana, sp. n. (Pl. II. fig. 33.)

Description.—♂. Head, thorax, fore wing, and abdomen pale reddish brown. Antennæ whitish.

Fore wing crossed by an oblique dark brown line from costa to inner margin, beyond which is a dark brown fascia. Distal area paler; a submarginal lunular dark brown band. Underside paler, with a dark chocolate submarginal band.

Hind wing pale fuscous inclined to ochreous basally; a distal dark brown band followed outwardly by a band of whitish lunules which are defined outwardly by dark brown, margin pale. Cilia fuscous.

Underside of hind wing dark chocolate-brown on the basal half, followed by bands as on the upperside. The inner area white from inner margin to vein 1. The costa angled to a point at centre.

Habitat. Kedai, 21st January. Expanse 50 mm.

The chief feature of this form is the underside of the hind wing; I have not been able to find any species near it in the British Museum collection.

113. Gonometa postica Walker.

Habitat. Masongaleni, 11th November, ♀.

This form is a good deal larger and redder than specimens which I have bred in Natal (see Trans. Zool. Soc. vol. xv. p. 313, 1901), and the fore wing is shot with vivid purple. It is a pity that only a female was sent to me, as a specimen of the very different male would have been most interesting.

Limacodidæ.

114. Parasa vivida Walker.

Habitat. Kedai, 26th November.

Hypsidæ.

115. Egybolis vaillantina Stoll.

Habitat. Mombasa, 14th September.

116. Callioratis bellatrix Dalman.

Habitat. Teita Hills, 17th September.

Geometridæ.

117. Eupagia tullia, sp. n. (Pl. I. fig. 11.)

Description.— ♂. Frons, palpi, and thorax bright red-brown (or chestnut), apex of head and shaft of antennæ white. Abdomen reddish ochreous. Fore wing with outer margin angled at vein 3; base ochreous, striated with reddish brown; an oblique brown antemedial line from costa to inner margin, and a similar postmedial line, angled below costa near apex, to inner margin; the area between these two lines bright red-brown; outer area pinkish striated with red-brown, and bearing a diffused fuscous spot near tornal angle. Hind wing ochreous striated with red-brown, with two dark medial bands from vein 6 to inner margin, angled outwardly at vein 3; outer margin angled at veins 3 and 6.

2nd Form. viridescens, nov.

This form is exactly similar to *tullia* in size, shape, and markings, but the medial band is dark sap-green, instead of bright red-brown, and defined outwardly by a whitish line, beyond which the outer submarginal area is paler green instead of pinkish.

Habitat. Kedai, 11th April (red form); 20th March (green form). Expanse 38 mm.

These forms are nearest to *Eupagia determinata* Walker, in which species the postmedial line of the fore wing is straight and not bent inwards below the costa.

118. Nothabraxas rudicornis Butler.

Habitat. Kedai, 24th November.

119. Petrodava olivata Warrender.

Habitat. Masongaleni, 30th April.

120. Macaria umbrata Warrender.

Habitat. Kedai, 28th December.

121. Biston maturnaria Walker.

Habitat. Kedai, 22nd November.

122. Cusiala maculatissima Grünb.

Habitat. Kedai, 24th March.

123. Petovia dichroaria Herr.-Schäff.

Habitat. Kedai, 2nd November.

Cossidæ.

124. Duomitus kilimanjarensis Holland.

Habitat. Kedai, 7th December.

EXPLANATION OF THE PLATES.

Plate I.

Fig.
1. *Dovania circe*, p. 106.
2. *Temnora erato*, p. 108.
3. *Polyptychus fumosus pelops*, p. 107.
4. *Amsacta evadne*, p. 93.
5. *Diacrisia epicaste*, p. 93.
6. *Metarctia neæra*, p. 92.
7. *Paratuerta featheri*, p. 94.
7*a*. *Paratuerta argentifascia*, p. 94.
8. *Ovios nealces*, p. 95.
9. *Lymantria melete*, p. 98.
10. *Lymantria melia*, p. 99.
11. *Eupagia tullia*, p. 112.
12. *Rhanidophora albigutta*, p. 98.
13. *Goodia oriens heptapora*, p. 104.
14. *Pachymeta flavia*, p. 110.
15. *Sabalia euterpe*, p. 104.
16. *Parusta thelxinoë*, p. 103.
17. *Sabalia thalia*, p. 105.
18. *Dasychira obliquilinea*, p. 100.
19. *Lymantria arete*, p. 99.
20. *Parallelia portia*, p. 97.
21. *Parallelia rectifascia*, p. 97.

Plate II.

Fig.
22. *Poliana marmorata*, p. 105.
23. *Hippotion diyllus*, p. 109.
24. *Hippotion exclamationis*, p. 109.
25. *Hippotion dexippus*, p. 108.
26. *Nephele vespera*, p. 108.
27. *Ludia crenulata*, p. 103.
28. *Lymantria menecles*, p. 99.
29. *Lymantria melissa*, p. 100.
30. *Nudaurelia vau*, p. 101.
31. *Lymantria metella*, p. 99.
32. *Ceratopacha decora*, p. 110.
33. *Pachymeta roxana*, p. 111.

10. On some new Pentastomids from the Zoological Society's Gardens, London. By Mary L. Hett, B.Sc., F.Z.S., Demonstrator of Zoology at Bedford College for Women, University of London.

[Received December 11, 1914: Read March 9, 1915.]

(Text-figures 1–4.)

Index.

While reporting on the Pentastomids obtained from the Zoological Society's Gardens during the past twelve months, I have observed a certain number of individuals which apparently belong to new species or varieties.

1. Porocephalus grandis, sp. n. (Text-figs. 1, 2.)

There were in all seven specimens of this Pentastomid obtained from African vipers, viz.:—

1 ♂ and 1 ♀ from *Bitis gabonica.*
4 ♀'s from *Cerastes cornutus.*
1 ♀ from *Bitis nasicornis.*

The male specimen is probably mature, the female specimens are certainly so, the uterus in all cases containing embryos in different stages of development.

The female specimens (text-fig. 1, A) vary in length from 78 to 94 mm., the average length being 82 mm. The width is 8 to 9 mm. There are 22 strongly projecting rings on the body and 2 or 3 indistinct ones on the head. Stigmata are numerous over the entire surface of the body.

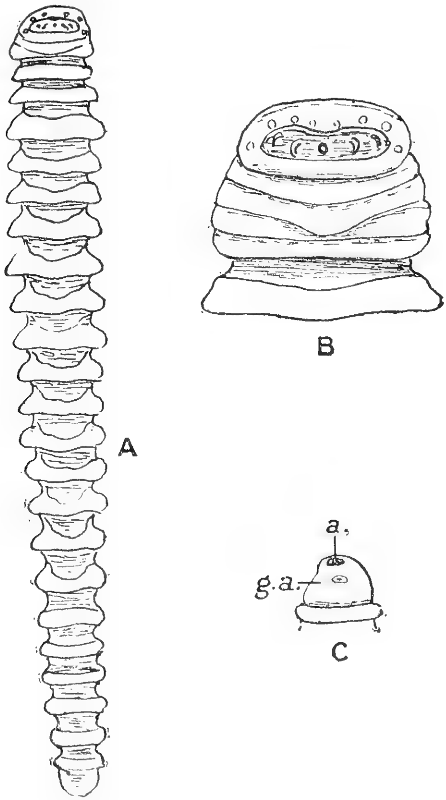
The single male specimen is 30 mm. long. The rings number about 26.

The hooks are simple and, together with the mouth, lie in a pit bordered by papillæ. The pit may be due to contraction after death, but this seems hardly likely, as it is found in all the specimens. The mouth is nearly circular and lies between the inner pair of hooks (text-fig. 1, B).

The body tapers towards the posterior end. The terminal segment is small and conical; it bears the transverse, slit-like anus, in front of which lies the genital aperture in the female (text-fig. 1, C).

The internal organs are, on the whole, typical, but in the female the anterior third of the ovary is paired. The ovary thus constitutes a **Y**-shaped structure, each arm of the **Y** passing directly into the oviduct of that side (text-fig. 2). I can find no mention of this condition in any other species.

Text-figure 1.



Porocephalus grandis.

A. Female specimen, nat. size. B. Cephalothorax, × 4.
C. Terminal segment, × 2.

a., anus ; *g.a.*, genital aperture.

In general features the specimens bear a strong resemblance to *Porocephalus armillatus* Wyman, but differ from it in the following particulars :—

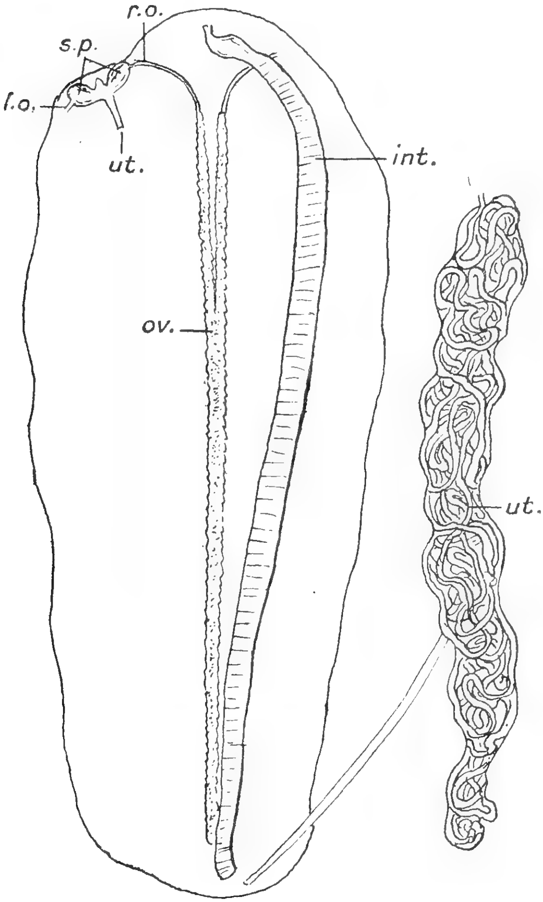
(1) The body is relatively thicker than in *P. armillatus*.

(2) The papillæ are differently arranged, and the two conspicuous

papillæ in front of the mouth in *P. armillatus* are replaced by a small lobe.

(3) The hooks are sunk in a pit and not so wide apart; the space between the two inner hooks is also relatively greater.

Text-figure 2.



Porocephalus grandis.

Female specimen dissected from the ventral side, slightly enlarged.

int., intestine; *l.o.*, cut end of left oviduct; *ov.*, ovary; *r.o.*, right oviduct; *sp.*, spermatheca; *ut.*, uterus.

(4) The rings are not so sharply defined. In the female there are 22 distinct ones and 2 or 3 indistinct, instead of 19 altogether;

and the postero-ventral margin of each ring has a slight projection in the median line instead of an indentation. Further, Wyman gives the number of rings in the male of *P. armillatus* as "14 distinct rings and 4 partly defined," while here there are 26.

(5) The anal segment is more obtuse.

Through the courtesy of the authorities at the British Museum (Natural History), I was able to look through a small collection of Pentastomids in their possession. Among these specimens was one unnamed, from the horned viper or puff-adder. From a superficial observation it appeared to agree in all respects with the species described above.

2. Porocephalus globicephalus, sp. n. (Text-fig. 3.)

A single mature female specimen from the lung of the Mocassin Snake (*Tropidonotus fasciatus*).

Text-figure 3.

Porocephalus globicephalus, ♀. × 2.

The length of the body is 50 mm. and the number of annulations is about 50.

The hooks are simple and sharply curved. The mouth is pear-shaped with a pointed anterior end. The head is globular and divided from the body by a well-marked neck. The anus is a wide transverse slit on the terminal segment.

This is a North-American species, but it greatly resembles the Indian species *P. pattoni* Stephens. The main points of difference are the greater number of rings, *P. pattoni* having only 36; and also the position of the anus, which is more nearly terminal in *P. globicephalus*.

3. Porocephalus bifurcatus Diesing. (Text-fig. 4, A.)

The identification of Diesing's species is a task of some difficulty, because, as pointed out by Leuckart, he almost certainly described immature specimens. He gives the length of the female as 20–22 mm. and the number of annulations as 40, though, in the first edition of his Monograph, he figures about 100. This apparent discrepancy may be due to the fact that in some cases the body contracts in such a way as to make the rings appear double. He also describes the hooks as geminate.

Among the Pentastomids sent to me from the Zoological Society's Gardens are seven which I take to be *P. bifurcatus* (text-fig. 4, A): one is from *Boa imperator* and six from *Coluber melanoleucus*. Like Diesing's specimens they are all from the New World, and they agree with his diagnosis, except in so far as regards:—(1) length, (2) number of annulations, (3) geminate hooks. The specimens in question are from about 30 to 40 mm. in length. In most cases the annulation is obliterated, but in three cases it is visible and the rings number 26, 33, and 37 respectively. The hooks are single.

But these are exactly the differences which ordinarily occur between immature and adult forms, the geminate hooks especially being a larval character.

I cannot find any essential distinction between these forms and the African species named *P. boulengeri* by Vaney and Sambon (text-fig. 4, B), specimens of which I have described in detail in a paper to appear shortly. Dr. Sambon points out* that "difference of realm is a powerful argument in favour of diversity of species," but in this case the African and New World species resemble each other so closely that it would seem impossible to distinguish them as separate species†. So that if my identification of the specimens mentioned above with *Porocephalus bifurcatus* be correct, the African specimens must be regarded merely as a new variety of that species.

* Trans. Soc. Trop. Med. Liverpool, vol. iii. 1910, pp. 132–140.

† Text-fig. 4, A, is taken from the specimen from *Boa imperator*. It appears relatively longer and more slender, but this is only due to greater extension. The specimens from *Coluber melanoleucus* resemble "*P. boulengeri*" even more closely.

4. Porocephalus bifurcatus var. orientalis, nov. (Text-fig. 4, C, D.)

There were 16 specimens obtained as follows:—

1 ♀ from *Zamenis mucosus.* (There were also 3 specimens of *P. pattoni* in the same snake.)

11 ♀'s from *Naia tripudians.*

4 ♂'s from *Naia tripudians.*

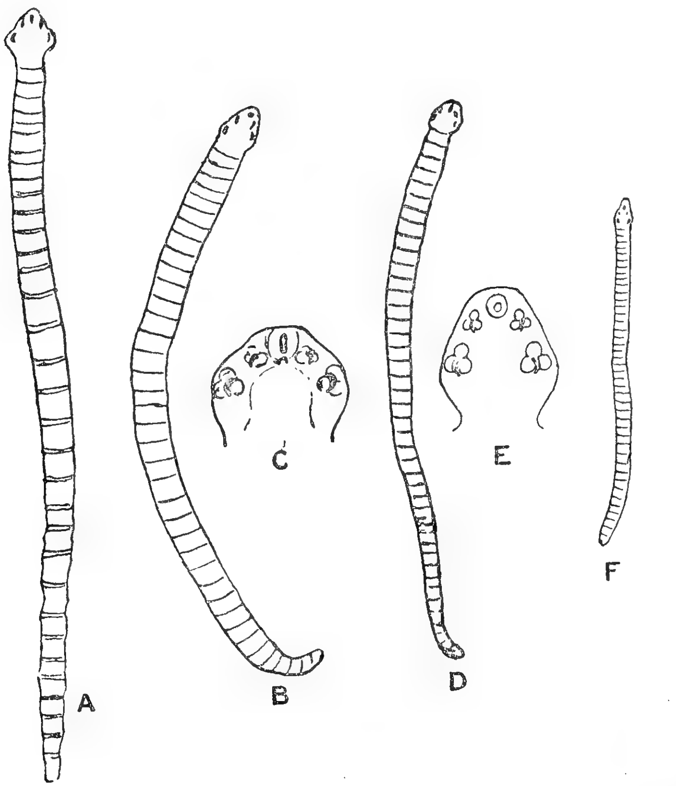
They differ from *P. bifurcatus* in the following particulars:—

(1) The body is relatively more slender.

(2) The rings are 40 or occasionally more in number, while in *P. bifurcatus* they are usually under 40.

(3) The mouth is more oval and the anterior end of the cephalothorax is slightly more rounded.

Text-figure 4.



A. *Porocephalus bifurcatus*, ♀, × 2. B. "*P. boulengeri*," ♀, × 2. C. Head of *P. bifurcatus*, var. *orientalis*, × 8. D. *P. b.* var. *orientalis*, ♀, × 2. E. Head of *P. bifurcatus* var. *mediterraneus*, × 10. F. *P. b.* var. *mediterraneus*, ♀, × 2.

5. POROCEPHALUS BIFURCATUS var. MEDITERRANEUS, nov. (Text-fig. 4, E, F.)

There were 10 specimens, all from *Zamenis gemonensis*: viz. 4 females, 2 males, and 4 small specimens much contracted, which are also probably males.

The body is relatively more slender than in var. *orientalis*, and much darker in colour. The length of the males varies from 10 to 15 mm., that of the females from 20 to 30 mm.

The annulations are 40 to 45.

In conclusion, my thanks are due to the authorities of the Zoological Society for placing the material at my disposal and to Dr. H. W. Marett Tims for his advice and assistance.

11. Report on the Deaths which occurred in the Zoological Gardens during 1914, together with a List of the Blood-Parasites found during the Year. By H. G. Plimmer, F.R.S., F.Z.S., Pathologist to the Society.

[Received and Read February 9, 1915.]

Index.

On January 1st, 1914, there were 733 mammals, 2073 birds, and 371 reptiles in the Zoological Gardens: and during the year 373 mammals, 1174 birds, and 470 reptiles were admitted, making a total for the year of 1106 mammals, 3247 birds, and 841 reptiles.

During 1914, 309 mammals, 867 birds, and 301 reptiles have died: that is, a percentage of 27·9 for mammals, 26·6 for birds, and 35·7 for reptiles. Out of the total deaths for the year, 1590 in all, 719 occurred in animals which had not been six months in the Gardens: that is, nearly half the total number. It has been found that after six months' residence in the Gardens, the death-rate falls rapidly; so it is assumed that by this time the new animals have got over their journeys, have died from any diseases they may have brought with them, or have got quite used to their new environment. Of these 719 animals, 141 were mammals, 375 were birds, and 203 were reptiles; and if these be deducted from their respective totals, the death-rate percentage will come out as 15·1 for mammals, 15·1 for birds, and 11·6 for reptiles.

The following Tables show the facts which have been ascertained in outline. Table I. summarizes the actual causes of death in the three groups specified. Under Reptiles are included Amphibia.

Table I.—Analysis of the Causes of Death.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
1. *Microbic or Parasitic Diseases.*				1
Tuberculosis	12	113	4	2
Mycosis	6	88	10	3
Pneumonia	53	118	69	4
Septicæmia	2	1	...	
Abscess	4	...	1	5
Pericarditis	1	1	...	
Empyema	2	...	...	
Peritonitis	6	...	...	6
Cholecystitis	1	...	...	
Hydatids	1	...	...	

TABLE I.—Analysis of the Causes of Death (*continued*).

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
1. *Microbic or Parasitic Diseases* (cont.).				
Toxoplasmosis	1	1	...	7
Piroplasmosis	1	...	...	8
Saccharomycosis	...	3	...	9
Gangrene	1	...	...	
Necrosis	1	...	...	
Sarcoptic Scabies	2	...	...	
Demodecic Scabies	1	...	...	10
Filariosis	...	1	...	11
Worm Cysts	...	...	1	
2. *Diseases of Respiratory Organs.*				
Bronchitis	11	...	...	12
Broncho-pneumonia	24	...	...	
Congestion of lungs	14	133	19	
3. *Diseases of the Heart.*				
Pericarditis	...	1	...	
Degeneration of heart-muscle	...	1	...	
4. *Diseases of the Liver.*				
Hepatitis	1	3	.	
Fatty degeneration	1	4	.	
Cirrhosis	3	...	...	13
5. *Diseases of the Alimentary Tract.*				
Gastritis	1	...	1	
Gastric ulceration	3	...	...	
Gastro-enteritis	16	6	7	14
Enteritis	33	169	17	
Proctitis	1	...	...	
Over-distension of stomach	...	1	...	
Gangrene of intestine	1	...	1	
Impacted fæces	1	...	...	
6. *Diseases of Urinary and Generative Organs.*				
Nephritis	66	129	4	15
Cystic kidneys	...	1	...	
Pyosalpinx	1	...	...	
7. *Various.*				
Carcinoma	4	...	...	16
Sarcoma	3	5	...	17
Angioma	1	...	...	
Rickets	1	...	...	
Injuries discovered *post-mortem*	2	5	...	

Besides those tabulated above,

46 mammals, 96 birds, 13 reptiles, were killed by order or by companions,

4 ,, 10 ,, 102 ,, died from malnutrition or starvation,

8 ,, 42 ,, 67 ,, were too decomposed for examination.

In Table I. a classification is made of those diseases which were the immediate causes of death, but in most cases the animals were suffering from other diseases as well. Table II. summarizes those other diseases from which the animals were suffering; and if this Table be taken in conjunction with Table I., a much more accurate estimate of the amount of disease in the Gardens will be arrived at.

Table II.—Other Diseases found in the animals tabulated in Table I.

Diseases.	Mammals.	Birds.	Reptiles.	Reference to Notes following.
Tuberculosis	2	15	1	
Mycosis	...	6	1	
Pneumonia	4	1	4	
Pericarditis	3	...	...	
Peritonitis	3	...	1	
Abscess	...	...	1	
Empyema	1		...	
Septicæmia	2	..	...	
Pleuritis	2	...	..	
Malaria	...	15	...	18
Filaria	5	19	3	19
Hæmogregarines	...	...	19	20
Trypanosomes		2	1	21
Leucocytozoa		3	...	22
Sarcocystis	1	...	...	
Pentastomes	..		2	
Hydatids	2		.	
Worms	3	2	...	
Bronchitis	11	...	...	
Broncho-pneumonia	9	...	...	
Congestion of lungs	23	125	3	
Œdema of lungs	...	80	...	
Collapsed lungs	2	...	...	
Abscess of lung	1	...	.	
Hydrothorax	1	...	..	
Pericarditis	...	11	1	
Fatty heart	3	7	.	
Atheroma	3	29	...	23
Aneurism	..	1		
Hepatitis	1	6	1	
Fatty liver	27	80	14	
Cirrhosis of liver	1	2	..	
Gall-stones	2	1	.	
Gastritis	1		...	
Gastric ulceration	13	..	...	
Dilated stomach	1	1		
Gastro-enteritis	2	...	2	
Enteritis	23	113	8	
Intussusception	1	...	...	
Intestinal obstruction	1	..	...	
Nephritis	58	111	6	
Stone in kidney	2	...	...	24
Inflamed oviduct	...	1	...	
Prolapsus ani	...	...	2	
Sarcoma	...	1	2	
Ascites	...	4	1	
Rickets	12	2	1	25
Injuries	2	9	...	

Table III. shows, in still further detail, the distribution of diseases amongst the various orders of mammals.

TABLE III.—The Distribution of Diseases causing Death amongst the principal Orders of Mammals.

Diseases.	Primates.	Carnivora.	Rodentia.	Ungulata.	Edentata & Insectivora.	Marsupialia.
Tuberculosis	4	2	2	2	...	2
Mycosis	...	...	...	2	...	4
Pneumonia	8	10	16	3	10	6
Abscess	...	2	...	2	...	...
Toxoplasmosis	...	1	...	...	...	...
Piroplasmosis	...	1	...	...	...	...
Empyema	...	1	1	...	...	...
Pericarditis	...	...	...	1	...	...
Cholecystitis	...	...	...	...	...	1
Sarcoptic Scabies	...	...	...	2	...	...
Demodecic Scabies	1	...	...	...	...	...
Gangrene	...	...	...	1	...	...
Necrosis	...	...	...	1	...	...
Septicæmia	...	...	2	...	...	...
Peritonitis	1	1	...	2	...	2
Hydatids	1	...	...	...	...	...
Bronchitis	3	2	3	2	1	...
Broncho-pneumonia	7	2	4	2	3	6
Congestion of lungs	4	1	3	1	5	...
Cirrhosis of liver	1	2	...	...	...	...
Fatty liver	...	...	...	...	...	1
Hepatitis	...	1	...	...	...	...
Gastritis	...	...	...	...	1	...
Gastric ulceration	1	2	...	...	...	...
Gastro-enteritis	1	11	1	1	2	...
Enteritis	11	6	7	7	...	2
Impacted fæces	1	...	...	...	...	...
Proctitis	1	...	...	...	...	...
Gangrene of intestine	...	1	...	...	...	...
Nephritis	7	24	10	14	2	9
Pyosalpinx	...	1	...	...	...	...
Carcinoma	...	2	2	...	...	...
Sarcoma	1	1	...	1	...	...
Angioma	...	1	...	...	...	...
Rickets	...	...	1	...	...	...
Injuries	1	...	...	1	...	...

Notes on the foregoing Tables.

1. The total incidence of infectious diseases in the Gardens is about 8·5 per cent. for mammals, and 10 per cent. for birds and reptiles.

2. The following are the percentages of deaths from tubercle during the year: mammals ·9 per cent., birds 3·5 per cent., and reptiles ·5 per cent. on the total numbers for the year. The

mammals have reached the lowest figure during the last seven years: of the 12 cases, 3 were pet animals, and 2 came from a suspected source. Two had been kept for about five years in the open, both summer and winter. The birds show a slight increase, and in 63 of the cases the infection was general. About 50 of the birds came from the Small Bird House, where there was an epidemic during the spring and summer months. In three of the birds it was of bovine type, and in a Coati it was of "perlsucht" type.

3. All the mould diseases have been grouped under Mycosis. Of the 6 mammals, 4 were Kangaroos and 2 Gazelles. The number of deaths from mycosis in birds is still very high, and constitutes close on 10 per cent. of the deaths. It has increased in reptiles, and has been found in the larger frogs and tortoises. It is produced in them by a much larger mould than that found in the mammals and birds, which generally leads to the formation of tumours.

4. There has been a considerable increase in the incidence of pneumonia in mammals and birds, but a considerable decrease in reptiles, due to the careful sterilization of the cages with steam. In three of the reptiles it was due to worms, the rest were pneumococcal.

5. In three of the mammals the abscesses, which were large and excavating, had started in connection with the teeth: in the remaining mammal the abscess was in the mediastinal glands, and was due to nematode worms.

6. Due in a Seal to perforation of stomach which contained $4\frac{1}{2}$ lbs. of stones, and in two Tasmanian Wolves to perforation of the intestine, caused by a mycotic growth in the intestine.

7. Found in a Fossa from Madagascar, and in a Fruit-Pigeon from the Aru Islands, in both for the first time.

8. Found in an Indian Wild Dog, which fortunately was only three weeks in the Gardens.

9. This Saccharomyces was of the *Oidium albicans* type.

10. An acute infection in a Barbary Ape, with *Demodex folliculorum*, producing extensive ulceration of the face.

11. The designation is not used here in its usual sense. In this case the liver of a Honey-eater was riddled with nematode worms, but no embryos were found in the blood.

12. There has been a slight general increase in diseases of the respiratory organs: these are largely dependent on weather.

13. Two of these cases were in Cats, and one in a Chimpanzee, whose gall-bladder was full of gall-stones.

14. In 3 of the mammals, 10 of the birds, and 2 of the reptiles the inflammation was caused by parasites or foreign bodies. In 87 of the birds it was hæmorrhagic and of bacterial origin. The remainder of the cases were apparently due to the quantity or quality of the food not being suitable to the animal.

15. There has been a general decrease in the number of cases of nephritis. 18 of the cases in mammals and 13 of those in

birds were acute. The great majority of the cases were of varying degrees of chronicity and were associated with other old-age changes.

16. These cases of cancer occurred as follows:—epithelioma of neck in a Wolf and in a Gerbille; cancer of liver and glands in a Bear, and of pancreas in a Marmot.

17. Of the sarcomata, one was in the testis of an old Dingo, another, an angiosarcoma, in the liver of a Barbary Sheep, and the third, an adeno-sarcoma, in the kidney of an Ouakari.

18. Under the term malaria are grouped 12 cases due to *Hæmoproteus danilewskyi* and 3 due to *Plasmodium præcox*: see section on blood-parasites below.

19, 20, 21, 22. See the section on blood-parasites below.

23. The number of cases of atheroma indicates that a large number of old birds have died.

24. One case in an Otter, the other in a Wallaby. Both were uric acid calculi.

25. The number of rickety animals in the Gardens has greatly decreased.

Blood-Parasites.

During the year the blood of every animal which died has been examined, with the result that parasites have been found in 70; in 30 species for the first time.

They have been distributed as follows:—

Filariæ. In 5 mammals; in 3 species for the first time.
19 birds; in 6 species for the first time.
3 reptiles; in 3 species for the first time.

Trypanosomes. In 2 birds; in both for the first time.
1 reptile.

Malaria. { *Hæmoproteus danilewskyi.* In 12 birds; in 8 species for the first time.
Plasmodium præcox. In 3 birds; in all for the first time. }

Leucocytozoa. In 3 birds; in 2 species for the first time.

Toxoplasma. In 1 mammal and 1 bird; in both for the first time.

Babesia. In 1 mammal.

Hæmogregarines. In 19 reptiles; in 3 species for the first time.

The following Tables show the occurrence of the blood-parasites in detail:—

Embryo Filariæ found in the blood of Mammals.

	Habitat.	Type.
Found in the following for the first time:		
2 Squirrel Monkeys (*Saimiris sciurea*)...	Brazil.	Long, thin.
2 Canadian Porcupines (*Erithizon dorsatus*).	N. America.	Long, pointed.
Marmoset (*Leontocebus mystax*)	S. America.	Long.

Embryo Filariæ found in the blood of Birds.

	Habitat.	Type.
White-throated Jay Thrush (*Garrulax albigularis*).	India.	
Himalayan Whistling Thrush (*Myiophoneus temmincki*).	India.	
Brazilian Hangnest (*Icterus jamaicai*)...	Colombia.	
2 Chilian Starlings (*Curæus aterrimus*).	Chili.	
Green Cardinal (*Gubernatrix cristatella*).	S. America.	
2 Blue Birds (*Sialia sialis*)	N. America.	
King Bird of Paradise (*Cicinnurus regius*).	Aru Islands.	Two kinds found; one very long, the other short, thick, pointed.
Occipital Blue Pie (*Urocissa occipitalis*).	India.	
Hermit-Thrush (*Hylocichla guttata*) ...	N. America.	
Found in the following for the first time:		
White-bellied Guan (*Ortalis albiventris*).	Brazil.	Short, thick, pointed.
3 Black-headed Partridges (*Caccabis melanocephala*).	Arabia.	Long, pointed, encapsuled.
Shining Weaver-Bird (*Hypochera nitens*).	W. Africa.	Short, thick, pointed.
Double-banded Finch (*Stictoptera annulosa*).	Australia.	Long.
Cuban Mocking-Bird (*Mimus orpheus*).	Cuba.	Long, striated, encapsuled.
Blue-headed Rock Thrush (*Petrophila cinclorhynchus*).	India.	Thick, short.

Embryo Filariæ found in the blood of Reptiles: in all for the first time.

Bull Frog (*Rana catesbiana*)	N. America.	Short, encapsuled.
Chicken Snake (*Coluber obsoletus*)	N. America.	Long, encapsuled.
Boa (*Boa constrictor*)	S. America.	Long.

Trypanosomes found in the blood of Birds: in both for the first time.

King Bird of Paradise (*Cicinnurus regius*).	Aru Islands.	Of the type of *T. avium*.
Blue-eyed Raven (*Macrocorax fuscicapillus*).	Aru Islands.	

Trypanosomes found in the blood of Reptiles.

Bull Frog (*Rana catesbiana*)..............	N. America.	Of the type of *T. rotatorium*.

Hæmogregarines found in the blood of Reptiles.

Diamond Rattlesnake (*Crotalus atrox*).	Texas.
2 American Black Snakes (*Zamenis constrictor*).	N. America.
Hog-nosed Snake (*Heterodon platyrhinos*).	N. America.
Mexican Snake (*Coluber melanoleucus*).	Mexico.
2 Pigmy Rattlesnakes (*Sistrurus miliarius*).	N. America.

	Habitat.	Type.
Russell's Viper (*Vipera russelli*)	India.	
Dark Green Snake (*Zamenis gemonensis*).	Europe.	
Indian Rat-Snake (*Zamenis mucosus*)	India.	
Boa (*Boa constrictor*)	S. America.	
Chicken Snake (*Coluber obsoletus*)	N. America.	
Say's Snake (*Coluber melanoleucus*)	N. America.	
Testaceous Snake (*Zamenis flagelliformis*).	N. America.	
Corais Snake (*Coluber corais*)	Brazil.	
Bull Frog (*Rana catesbiana*)	N. America.	
Green Tree-Snake (*Dendraspis viridis*)	W. Africa.	

Found in the following for the first time:

Emperor Boa (*Boa imperator*)	C. America.	Very large.
Long-necked Terrapin (*Chelodina expansa*).	Queensland.	Stout, short.

Hæmoproteus danilewskyi *found in the blood of Birds.*

	Habitat.
2 Blue-crowned Hanging Parakeets (*Loriculus galgulus*)	Malay.

Found in the following for the first time:

2 Seed-eaters (*Crithagra chrysopyga*)	W. Africa.
Java Sparrow (*Padda oryzivora*)	Java.
Cotton Teal (*Nettopus coromandelianus*)	India.
Violet-necked Lory (*Eos riciniata*)	Aru Islands.
3 Black-headed Partridges (*Caccabis melanocephala*)	Arabia.
Orange-bellied Fruit Pigeon (*Ptilinopus iozonus*)	Aru Islands.
Yellow-tufted Honey-eater (*Ptilotis auricomis*)	N.S. Wales.

Plasmodium præcox *found in the blood of Birds: in all for the first time.*

Quail Finch (*Ortygospiza polyzona*)	S. Africa.
Falcated Duck (*Eunetta falcata*)	Siberia.
Grey-winged Ouzel (*Merula boulboul*)	India.

Leucocytozoa found in the blood of Birds.

Owl (*Syrnium aluco*)	Europe.

Found in the following for the first time:

Falcated Duck (*Eunetta falcata*)	Siberia.
Chilian Starling (*Curæus aterrimus*)	Chili.

Babesia found in the blood of the following Mammal.

Indian Wild Dog (*Cyon dukhunensis*)	India.

Toxoplasma found in the blood of the following for the first time.

Fossa (*Cryptoprocta ferox*)	Madagascar.
Blue-tailed Fruit Pigeon (*Carpophaga concinna*)	Aru Islands.

12. On the Feet and Glands and other External Characters of the Viverrinæ, with the description of a New Genus. By R. I. Pocock, F.R.S., F.L.S., F.Z.S., Curator of Mammals.

[Received December 11, 1914: Read March 9, 1915.]

(Text-figures 1–7.)

Index.

Apart from *Genetta*, which occurs in South Europe, the Viverrine Carnivores, in the restricted sense in which that term is here employed *, are limited to the Ethiopian and Oriental Regions, and *Viverra* is the only genus hitherto considered to be both Ethiopian and Oriental †. The following species are included in it:—*V. civetta* of tropical Africa, and *V. zibetha*, *civettina*, *megaspila*, and *tangalunga*, which collectively range from western India as far eastward as southern China, Borneo, and the Philippines.

It is the main purpose of the present paper to show that the wide discontinuity in distribution between the African and Asiatic forms is paralleled by structural differences in the glands and feet, necessitating generic recognition (see p. 134) ‡.

Descriptions of the feet of *Viverra* may be found in various memoirs, text-books, and natural histories. These need not be enumerated since the descriptions appear either to be mere copies of previous records dating back at least to 1842, when Hodgson described and figured the hind feet of *V. zibetha*, or to have been derived, like Blanford's account, from Indian species only. It is quite true that statements regarding the feet of *V. civetta* have

* I use the term Viverrinæ for the little group popularly called Civets and Genets, and commonly referred to the three genera, *Viverra*, *Viverricula*, and *Genetta*. *Fossa*, *Linsang*, and *Poiana* are here eliminated from this subfamily.

† The occurrence of *Viverricula* in Sokotra, the Comoro Islands, and Madagascar must surely be assigned to human agency.

‡ Mr. Oldfield Thomas (P. Z. S. 1911, p. 137) has shown that the type of *Viverra* is *zibetha*; and since he agreed with Schreber and other early post-Linnæan authors, who have been followed in this particular by subsequent writers, in restricting the term *zibetha* to the so-called large Indian Civet, it follows that the African species, no other name being apparently available, must receive the new generic title.

been printed, but, instead of being taken from actual specimens, these have been published apparently on the assumption that the African species resembles its Asiatic congeners. At all events, I cannot find any evidence from the works I have consulted that the feet of *V. civetta* have ever been carefully examined with a view to comparison with those of *V. zibetha* or of any other Oriental species*.

The facts substantiated in this paper are the result of the examination of specimens belonging to the two species just mentioned, which died in the Zoological Gardens and came into my hands in a perfectly fresh state. Of *V. zibetha* I have only seen one example, a male, from the Malay Peninsula; but in the case of *V. civetta* my observations have been checked by an inspection of individuals of both sexes of what I take to be the typical race of this species, namely, the form that occurs in Sierra Leone, Liberia, Ashanti, etc.

The Feet of Viverra zibetha *Linn.*

In his work upon Indian Mammals, Blanford described the feet of *Viverra* as follows:—"Feet truly digitigrade, the metatarsus, metacarpus, and feet being hairy throughout, with the exception of a central and five toe-pads on all feet and a metacarpal pad on each fore limb. Claws small, partially retractile and blunt." This description applies to the feet of *V. zibetha* so far as it goes; but it requires amplification.

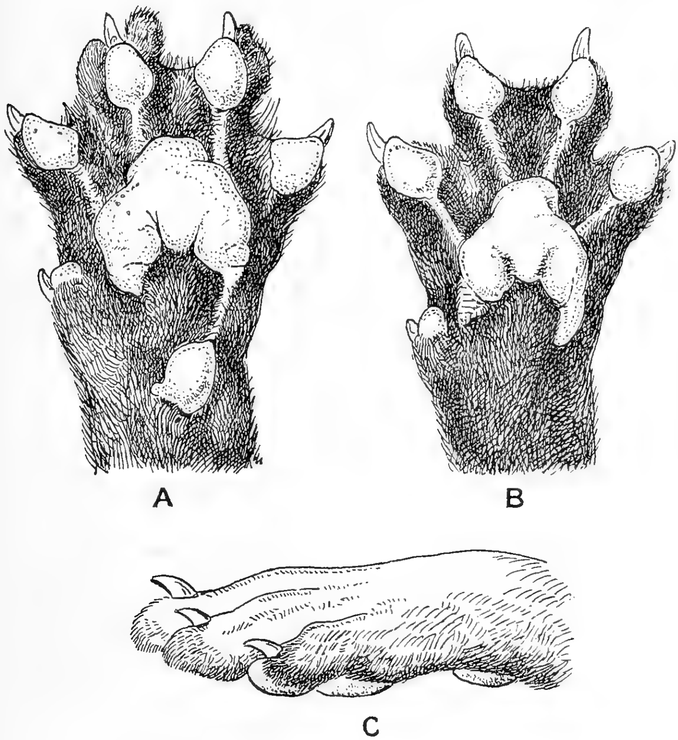
The *fore foot* (text-fig. 1, A, C) is broader and more massive than the hind foot, as in most Carnivores, and carries a larger plantar pad. This pad is smooth and of the usual trilobate form, but with its posterior angles more produced than in the Canidæ and Felidæ. The pollical lobe, however, of the pad is either suppressed or indistinguishably fused with the posterior end of the internal lateral lobe corresponding to the second digit †. The digits are moderately long and fully webbed, the web extending along the inner (admedian) part of the large smooth digital pads well beyond their proximal ends. The lateral webs are more

* Miss Carlsson, however (Zool. Jahrb. Syst. xxviii. p. 559, 1910), gave a brief description of the feet of *V. civetta*, illustrated by two text-figures, to show the differences between them and the feet of *Galidia*, with which the feet of *Mungos* were also compared. So far as it is possible to judge from the somewhat indifferent prints, the paws of the specimen of *V. civetta* she examined agree with those that have come into my hands.

† As in previous papers upon the feet of Carnivora, I use the term "plantar" indifferently for the large main pad of both fore and hind limbs. The trilobed condition of this pad results from the fusion of three originally quite distinct pads set opposite the intervals between the four principal digits, and hence called "interdigital" pads. (See Whipple, Zeitschr. morph. Anthropol. vii. 1904; Kidd, 'The Sense of Touch in Mammals, etc.,' A. & C. Black, 1907; Boas, Zool. Anz. 1909, p. 524.) Sometimes the pad lying primarily opposite the interval between the first and second digits forms part of it; but in the case of the Carnivora, at all events, when this element is indistinguishable, its absence appears to be due to suppression. However that may be, I call this element, when present, the "pollical or hallucal lobe," because of its relations to the 1st digit. The three main lobes of the pad are called the "median," the "internal lateral," and the "external lateral" lobes.

emarginate than the median; and the width of the web joining the 3rd and 4th digits is about equal to the transverse diameter of either pad. Except for a narrow streak of naked or nearly naked skin passing from the digital to the plantar pad, the web is everywhere covered with hair. The pollex or 1st digit has a small but distinct pad situated about on a level with the posterior end of the internal lateral lobe of the plantar pad but separated

Text-figure 1.



A. Inferior view of left fore foot of *Viverra zibetha.*
B. Inferior view of left hind foot of the same.
C. External view of left fore foot of the same.

therefrom by a bridge of hair. The claws are short and retractile. Those of the 1st, 2nd, and 5th digits are unguarded by lobes of skin; but those of the 3rd and 4th digits are protected externally by a lobe of hairy skin, while there is, in addition, on the inner (admedian) side of the 3rd digit a very large flap-like lobe guarding the adjoining claw and the claw of the 4th digit, when the two digits in question are in contact. These claws, in short, are retractile and as well protected by skin-lobes as in many species of *Felis* *.

The *carpal pad* is moderately large but low. It is cordate in outline with the point projecting outwards and forwards. It is composed almost wholly of the ulnar element of the primitively double carpal pad, the radial or inner element being represented merely by a very small lobe jutting from its postero-internal end. Connecting the point of the carpal pad with the postero-external extremity of the plantar pad is a narrow strip of naked or nearly naked skin. Apart from this strip the plantar pad is everywhere surrounded by hair.

The *hind foot* (text-fig. 1, B) in its general features resembles the fore foot. There are, however, no well-defined skin-lobes protecting and forming sheaths for the claws. The hallux or 1st digit is set a little farther back, but is still close to the postero-internal angle of the plantar pad. This portion of the plantar pad terminates in a small area of naked skin, which may represent the hallucal lobe of the plantar pad. At all events it occupies the position of that lobe. There is no trace of any pad or naked area of skin on the lower side of the foot behind (above) the plantar pad.

I have not been able to examine the feet, either fresh or preserved in alcohol, of *V. civettina*, *megaspila*, and *tangalunga*. Of the first, the so-called Malabar Civet, no material of any kind is available. Of the other two, there are several dried skins in the British Museum. So far as it is possible to judge from these, the feet of *V. tangalunga* resemble those of *V. zibetha*, at all events in the matter of hair-growth; but those of *V. megaspila* have the area between the plantar and digital pads much less thickly hairy. It is not indeed possible to affirm the presence of hairs on this area in all specimens; but in some examples short hairs are visible between the pads. Perhaps this species differs from *V. zibetha* and *V. tangalunga*, so far as this character is concerned, in the same way as the specimens of *Viverricula malaccensis* and *V. rasse*, described below, differ from each other.

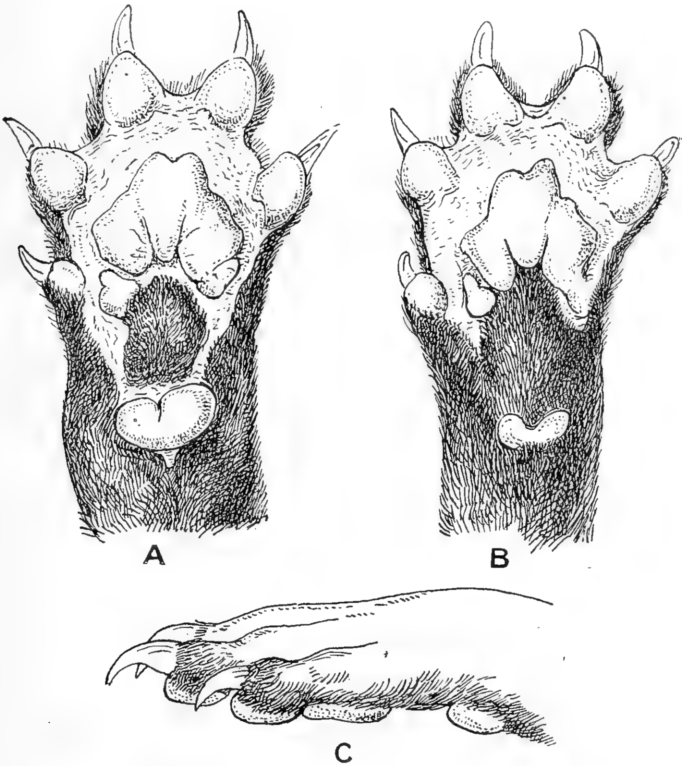
The Feet of Civettictis (*gen. nov.*) civetta *Schreb.*

The *fore foot* (text-fig. 2, A, C) differs markedly from that of *V. zibetha* in the following particulars. The whole of the underside round the plantar pad up to the margin of the webs and the digital pads is quite naked. The pollical lobe of the plantar pad, though small, forms a quite distinct excrescence set just behind the postero-internal angle of the plantar pad and on a level with the digital lobe of the pollex, from which it is separated by a narrow area of naked skin. From the pollical lobe and from the corresponding external angle of the plantar pad, there usually

* It does not appear to be generally realized that the extent to which the claws are "sheathed" varies considerably in different spscies of Felidæ.

runs backwards on each side a narrow strip of naked or nearly naked skin, the two uniting posteriorly just in front of the carpal pad and anteriorly just behind the plantar pad. They circumscribe a large, subovate area thickly covered with hair, and corresponding to the hairy area behind the plantar pad in *V. zibetha.*

Text-figure 2.



A. Inferior view of left fore foot of *Civettictis civetta.* [Sometimes the carpal pad is more distinctly cleft and the strips of naked skin running forwards from it may be overgrown with hair proximally.]

B. Inferior view of left hind foot of the same. [Sometimes the metatarsal pad is cleft by a line of hair.]

C. External view of left fore foot of the same.

The *carpal pad* is large, transverse, and markedly bilobed. The two lobes, both rounded or subovate, are separated by a depression, the outer or ulnar lobe being about twice as large as the inner or radial lobe. Behind them there is a small pointed area of naked skin.

The *claws* are long, projecting, not, or scarcely at all, retractile, and quite unprotected by sheaths of hairy skin.

The *hind foot* (text-fig. 2, B) differs correspondingly from that of *V. zibetha*, the area at the sides and in front of the plantar pad being naked and the pollical lobe of the plantar pad forming a distinct excrescence. Behind it there is a small backwardly directed area of naked skin. The hallux is situated a little more forward, and its digital pad is larger. In addition, however, there is a distinct flat, bilobed, sometimes divided, naked pad situated some little distance behind (above) the plantar pad, and representing the two streaks of naked skin traversing the underside of the metatarsus in *Genetta* and *Poiana* and the single small spot on that of *Fossa* *.

The Feet of Viverricula malaccensis *and* V. rasse.

I have seen no fresh specimens of *V. malaccensis*, but judging from dried skins the feet resemble those of *Viverra zibetha* in most respects. The pollex and hallux nevertheless, as noticed by previous writers, are considerably higher up; and I can find no trace of lobes of skin on the fore paw similar to those protecting the claws in *V. zibetha*. Hodgson (Calcutta Journ. Sci. ii. 1842, pl. i.) gave a sketch of the underside of the hind foot and drew attention to the presence of a small naked spot on the side of the plantar pad. This is the hallucal lobe of that pad. Its development seems to be variable, but in no case is it distinctive of this Civet, as the manner of its citation by Hodgson, Gray, and Mivart suggests.

In the specimen figured by Hodgson, and in the skins above mentioned, the area between the plantar and digital pads was thickly hairy; but in a spirit-preserved example in the British Museum, ticketed S.E. Java (*H. O. Forbes*), and therefore belonging to the species, or race, identified as *V. rasse* Horsf. by Bonhote †, the greater part of this area is naked, the hair being restricted to a triangular patch on the web between the 3rd and 4th digits and to somewhat similar patches extending backwards from the edge of the webs joining the 2nd and 5th digits to the 3rd and 4th respectively. The skin at the sides of the plantar pads and back to the digital pad of the pollex and hallux is also naked, and a narrow strip of naked skin runs from the carpal pad to the digital pad of the pollex (text-fig. 3, A, B).

The Feet of Genetta.

These have been often described but not quite so fully as might be. Mivart's figure and description of the feet of the species he identified as *G. tigrina* (P. Z. S. 1882, p. 152, fig. 3)

* A peculiarity in the hind foot of *Fossa* is the upward migration of the hallucal element of the plantar pad in company with the hallux. This and the little metatarsal pad constitute "the two bald places" mentioned by Mivart.

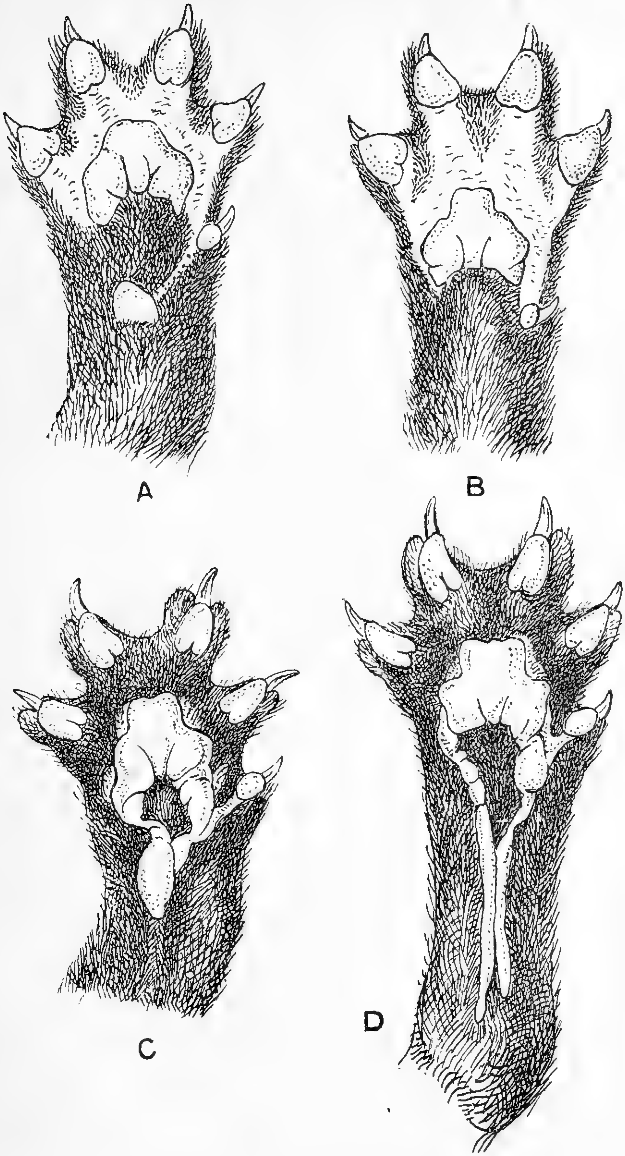
† Ann. Mag. Nat. Hist. 1898, i. p. 121.

P. Z. S. 1915. Part 1.

Owing to a mishap during printing, text-fig. 3, D, p. 137, was badly broken; this was unfortunately not discovered until after many copies had been distributed. The attached pages are to replace those previously issued.

June, 1915.

Text-figure 3.



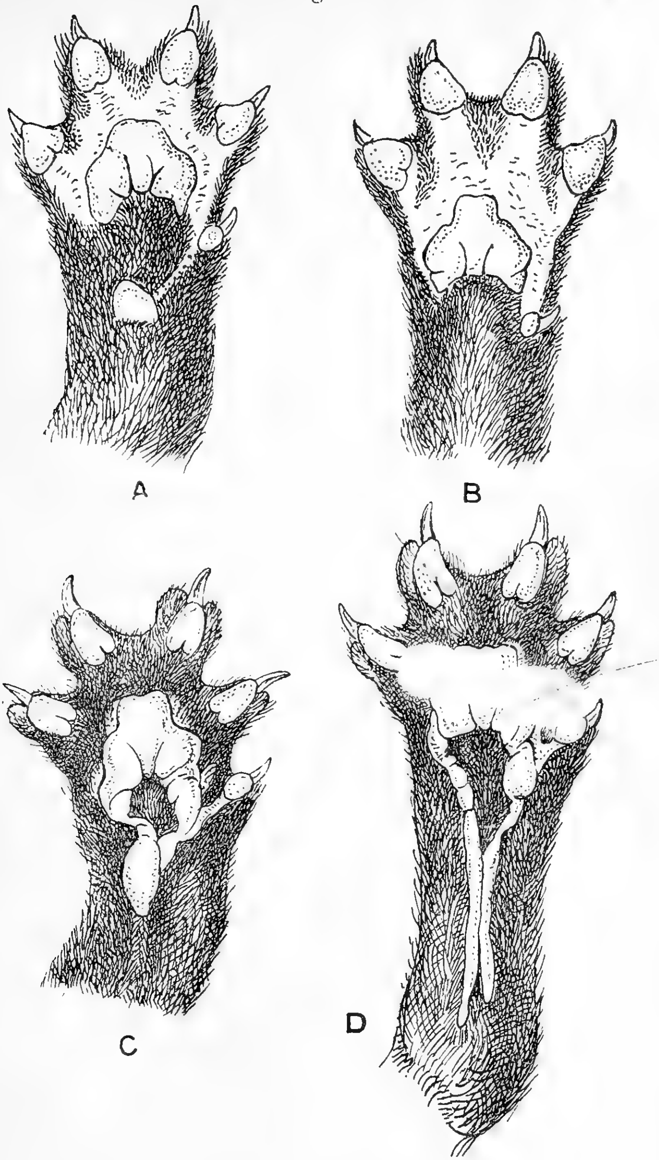
A. Inferior view of right fore foot of *Viverricula rasse*.
B. Ditto of right hind foot of the same.
C. Ditto of right fore foot of *Genetta rubiginosa*.
D. Ditto of right hind foot of the same.

suggest, for example, that in the fore paw the carpal pads are separated from the plantar pad by a continuous tract of hair, and that in the hind paw the plantar pad is similarly cut off from the two juxtaposed narrow ridges of naked skin that traverse the underside of the metatarsus. I have not examined the feet of *G. tigrina* and can say nothing of that species; but in *G. rubiginosa* and *G. pardina* that condition does not obtain, at all events in the specimens I have seen. The pads are smooth, the area between the digital and plantar pads is thickly covered with hair, and the toes are webbed up to the proximal ends of the digital pads. The plantar pads are normally trilobed, but there are a large pollical and a hallucal lobe in contact posteriorly with the internal lateral lobe of the plantar pad of the fore and hind feet respectively. A naked strip of skin passes from the digital pad of the pollex and hallux to the corresponding lobe of the plantar pad. The carpal pad is antero-posteriorly elongate and manifestly bilobed, the external or ulnar element is much larger than the internal, the latter is connected with the pollical lobe by a naked strip of skin and a corresponding strip extends forwards from the large lobe of the carpal pad to the posterior external angle of the plantar pad. Hence the hairy patch immediately behind the plantar pad is completely cut off by naked skin from the hairs clothing the rest of the underside of the paw. Similarly in the hind feet, the two contiguous ridges of naked skin, the outer of which extends farther up the metatarsus than the inner, diverge inferiorly and are continued as narrow strips of naked skin to the postero-external and internal angles of the plantar pad, circumscribing a long triangular hairy area.

The *claws* are retractile and, except those of the hallux and pollex, are protected externally by a lobe of hairy skin. Those of the fore foot, excluding the pollex, are protected on the outer side by a small lobe of skin, the lobes of the 2nd and 5th being smaller than of the 3rd and 4th, while the 3rd has, in addition, a larger internal lobe, similar to but relatively smaller than that of *Viverra zibetha*. In the hind foot, the claws of the 3rd and 4th digits are protected externally by small lobes. That is the condition observed in a male specimen of *G. rubiginosa* (text-fig. 3, C, D); but probably the size of these lobes will be found to vary considerably in different species, for in the fore foot of an example of *G. dongolana* the lobes are all smaller than in that of *G. rubiginosa*, the lobes on the 2nd and 5th digits and the internal lobe on the 4th being scarcely perceptible.

The feet of a specimen of *G. dongolana*, from Berbera, resemble those described above, except that the underside of the pollex and hallux is hairy, there being no strip of naked skin joining their digital pads with the corresponding lobes of the plantar pad, and that in the hind foot the lower divergent ends of the two ridge-like pads are not connected by means of naked strips of integument with the posterior angles of the plantar pad, the area below

Text-figure 3.



A. Inferior view of right fore foot of *Viverricula rasse.*
B. Ditto of right hind foot of the same.
C. Ditto of right fore foot of *Genetta rubiginosa.*
D. Ditto of right hind foot of the same.

suggest, for example, that in the fore paw the carpal pads are separated from the plantar pad by a continuous tract of hair, and that in the hind paw the plantar pad is similarly cut off from the two juxtaposed narrow ridges of naked skin that traverse the underside of the metatarsus. I have not examined the feet of *G. tigrina* and can say nothing of that species; but in *G. rubiginosa* and *G. pardina* that condition does not obtain, at all events in the specimens I have seen. The pads are smooth, the area between the digital and plantar pads is thickly covered with hair, and the toes are webbed up to the proximal ends of the digital pads. The plantar pads are normally trilobed, but there are a large pollical and a hallucal lobe in contact posteriorly with the internal lateral lobe of the plantar pad of the fore and hind feet respectively. A naked strip of skin passes from the digital pad of the pollex and hallux to the corresponding lobe of the plantar pad. The carpal pad is antero-posteriorly elongate and manifestly bilobed, the external or ulnar element is much larger than the internal, the latter is connected with the pollical lobe by a naked strip of skin and a corresponding strip extends forwards from the large lobe of the carpal pad to the posterior external angle of the plantar pad. Hence the hairy patch immediately behind the plantar pad is completely cut off by naked skin from the hairs clothing the rest of the underside of the paw. Similarly in the hind feet, the two contiguous ridges of naked skin, the outer of which extends farther up the metatarsus than the inner, diverge inferiorly and are continued as narrow strips of naked skin to the postero-external and internal angles of the plantar pad, circumscribing a long triangular hairy area.

The *claws* are retractile and, except those of the hallux and pollex, are protected externally by a lobe of hairy skin. Those of the fore foot, excluding the pollex, are protected on the outer side by a small lobe of skin, the lobes of the 2nd and 5th being smaller than of the 3rd and 4th, while the 3rd has, in addition, a larger internal lobe, similar to but relatively smaller than that of *Viverra zibetha.* In the hind foot, the claws of the 3rd and 4th digits are protected externally by small lobes. That is the condition observed in a male specimen of *G. rubiginosa* (text-fig. 3, C, D); but probably the size of these lobes will be found to vary considerably in different species, for in the fore foot of an example of *G. dongolana* the lobes are all smaller than in that of *G. rubiginosa*, the lobes on the 2nd and 5th digits and the internal lobe on the 4th being scarcely perceptible.

The feet of a specimen of *G. dongolana*, from Berbera, resemble those described above, except that the underside of the pollex and hallux is hairy, there being no strip of naked skin joining their digital pads with the corresponding lobes of the plantar pad, and that in the hind foot the lower divergent ends of the two ridge-like pads are not connected by means of naked strips of integument with the posterior angles of the plantar pad, the area below these ridges being continuously hairy from side to side across the metatarsus.

The Feet as a Test of Specialisation.

In attempting to estimate by the structure of the feet the degree of specialisation of the four genera of Viverrine Carnivores, it may be assumed that this group is a specialised offshoot of a group of which the Paradoxures and their allies are existing representatives; and that this Paradoxurine group had feet not only with the area between the plantar and digital pads naked, but also the area behind the plantar pad. This latter area extended on the hind foot up to or almost up to the heel (tarsus) and covered nearly the whole width of the underside of the metatarsus. On the fore foot it included two large carpal pads, together approximately equalling or surpassing in size the plantar pad. The inner or radial carpal pad was in contact with the well developed pollical lobe of the plantar pad, and the outer or ulnar carpal pad similarly reached the external lateral lobe of the plantar pad. The central space between the median portion of the plantar pad and the carpal pads was depressed and covered with thinner naked skin. The pollex and hallux were low down, only a little distance behind the second digits of the paws, and abutted against the pollical and hallucal lobes of the plantar pad respectively.

The Viverrine genera above enumerated show to a varying extent departure from the type of foot just described in the following particulars:—(1) Growth of hair over the naked integument; (2) reduction in the size of the carpal pads and of the pollical and hallucal elements of the plantar pads; (3) separation of the pollex and hallux and of the carpal pad from the plantar pad.

Those genera which exhibit these modifications in the most marked degree are the most specialised, and those in which they are least marked are the most primitive of the group, so far at all events as the feet are concerned.

Judged by this standard the genera may be arranged from highest to lowest in the following order:—(1) *Viverricula*, (2) *Viverra*, (3) *Civettictis*, (4) *Genetta*. Or perhaps they should rather be placed in pairs, the Asiatic genera *Viverricula* and *Viverra* standing together at a considerably higher level than the two African genera *Civettictis* and *Genetta*.

In the high position of the pollex and hallux, the feet of *Viverricula* are the most specialised and the most feline of the section. On the other hand, the skin-lobes sheathing the claws in *Viverra* are also a specialised and feline feature.

Civettictis is certainly more primitive than *Viverra*. Not only is the area between the plantar and digital pads naked, but in the fore foot this naked area is extended backwards on each side to the carpal pad. The carpal pad also is much larger and has its ulnar or inner moiety well developed and the pollical and hallucal elements of the plantar pad form tolerably large excrescences *. Finally, in the hind feet remains of the naked metatarsal area persist as the small bilobed pad.

Between *Civettictis* and *Genetta* it is not easy to make a choice as regards degree of specialisation of the feet. The feet of *Genetta* are thickly hairy between the plantar and digital pads, the claws are short, partially retractile, and protected by small lobes of hairy skin, thus approaching those of *Viverra*. On the other hand, the pollical and hallucal lobes of the plantar pad are considerably larger than in *Civettictis*, and the carpal pads are not only larger, especially antero-posteriorly, but are situated nearer the plantar pad, both primitive features. Finally, in the hind limb the primitive naked area beneath the metatarsus is represented by the pair of median juxtaposed ridges above described. This is a much more primitive condition than that seen in any of the so-called Civets, two of which, *Viverra* and *Viverricula*, have lost all trace of this naked metatarsal area, while in *Civettictis* it is merely represented by the small bilobed metatarsal pad.

Vibrissæ and Rhinarium of Viverrinæ.

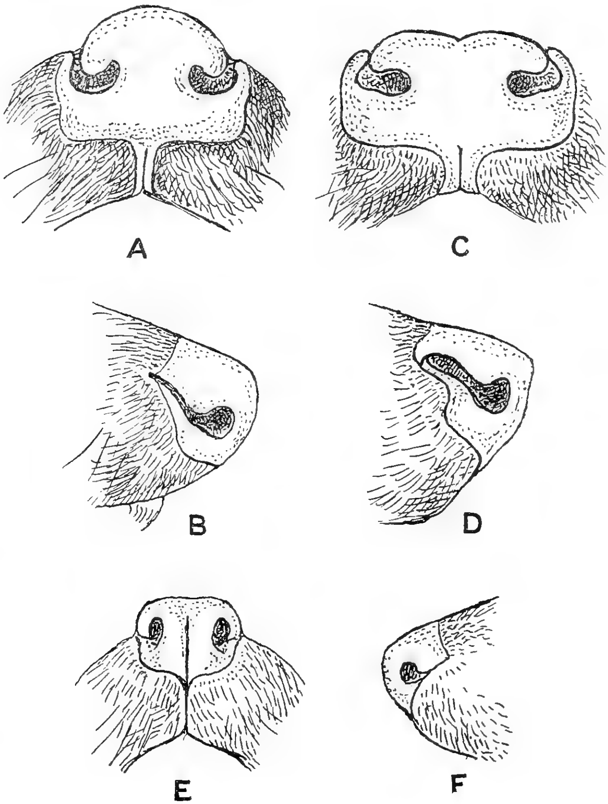
In the four genera here recognised as composing this subfamily, the vibrissæ are well developed and quite normal for the Carnivora—that is to say, there are an interramal tuft and two genal tufts in addition to the superciliary and mystacial tufts.

The rhinarium shows some interesting differences in the types examined. Daubenton long ago pointed out that the rhinarium of *Viverra zibetha* differs from that of *Civettictis civetta*. In the former (text-fig. 4, C, D) it is slightly convex antero-posteriorly above owing to the elevation of its lateral portion, but from the anterior view it is lightly bi-convex owing to a longitudinal depression along the middle line. The anterior median sulcus dividing its narrow labial portion scarcely extends above that portion, being obsolete, or nearly so, on the internarial area. In *C. civetta* (text-fig. 4, A, B) this groove is similarly shallow or indistinct above, but the upper margin of the rhinarium is more evenly convex from side to side, without trace of median depression, and in profile view it is straight, the lateral portion of the upper surface not being elevated. In *Viverricula* the rhinarium is like that of *Civettictis* in shape, but the infra-narial portion is narrower and the median sulcus extending from the labial portion is stronger and reaches up to the internarial area. In *Genetta rubiginosa* (text-fig. 4, E, F) the upper surface is flat in profile; while from the anterior aspect it is also flat with strongly rounded angles, but not biconvex as in *V. zibetha*, nor uniformly convex from side to side as in *Civettictis civetta*; and

* Provisionally, at all events, I do not attach much weight to this difference because, since Hodgson figured a small hallucal element in *Viverra zibetha*, the character must be variable and we do not know the extent of the variation.

the anterior median sulcus is more pronounced than in *Viverricula* and a little longer.

Text-figure 4.



A. Anterior view of rhinarium of *Civettictis civetta*. [The upper surface is too convex and too narrow.]

B. Side view of the same.

C. Anterior view of rhinarium of *Viverra zibetha*.

D. Side view of the same.

E. Anterior view of rhinarium of *Genetta rubiginosa*.

F. Side view of the same.

NOTE.—The width of the naked area dividing the lip below the rhinarium varies according to the degree of separation of the two portions of the lip.

It may be noted that in the biconvexity of its upper surface the rhinarium of *Viverra zibetha* approaches that of *Paradoxurus*, though it differs therefrom in the obsolescence of the anterior internarial sulcus. Since this, however, is retained in *Genetta*, it is impossible to affirm the existence of any absolute difference between the rhinaria of the Viverrinæ collectively and of the Paradoxurinæ.

Perfume-glands of the Viverrinæ.

The Glands of Genetta.

I do not find the description of the glands of *Viverra* (including *Civettictis*) and *Genetta*, published by Chatin (Ann. Sci. Nat. (5) xix. 1874), very intelligible. In the little summary given of their distinctive features, however, he states that the glands of *Genetta* differ from those of *Viverra* in having no special pouch for the storage of the secretion. This is quoted in many text-books and is referred to by Mivart (P. Z. S. 1882, p. 156) as "a most important difference." Mivart also gives a figure of the gland of a female specimen referred to *G. tigrina*, but the accompanying letterpress does not agree with the figure, nor does it convey an accurate idea of the glands of the Genets that I have examined. The following account, therefore, may help to an understanding of this gland in the Genets and of the more elaborate gland found in the Civets.

The glands consist of two elongated eminences covered with hair both externally and internally. When undisturbed the two lobes are closely apposed, their line of contact being marked by a longitudinal sulcus which is Y-shaped anteriorly, that is to say, just behind the vulva or prepuce. In no case does the median sulcus extend forwards to the vulva as figured by Mivart for *G. tigrina*.

In males of the three species examined by me, namely, *G. pardina*, *G. rubiginosa*, and *G. dongolana* *, the space between the glandular lobes, when these are pulled apart, may be seen to be imperfectly divided into three compartments—marked in Mivart's figure by the laterally extending grooves—one in front, one

* *G. dongolana* is probably nothing but a subspecies of *G. senegalensis*, the gland of which was described by Chatin.

Description of text-figure 5, *continued.*

D. Anal and glandular area of newly born young of *Genetta pardina* ♀, the labia of the gland separated, showing two pairs of depressions.

E. The same of ♂.

F. Inferior view of anal and glandular area of *Genetta felina* ♀.

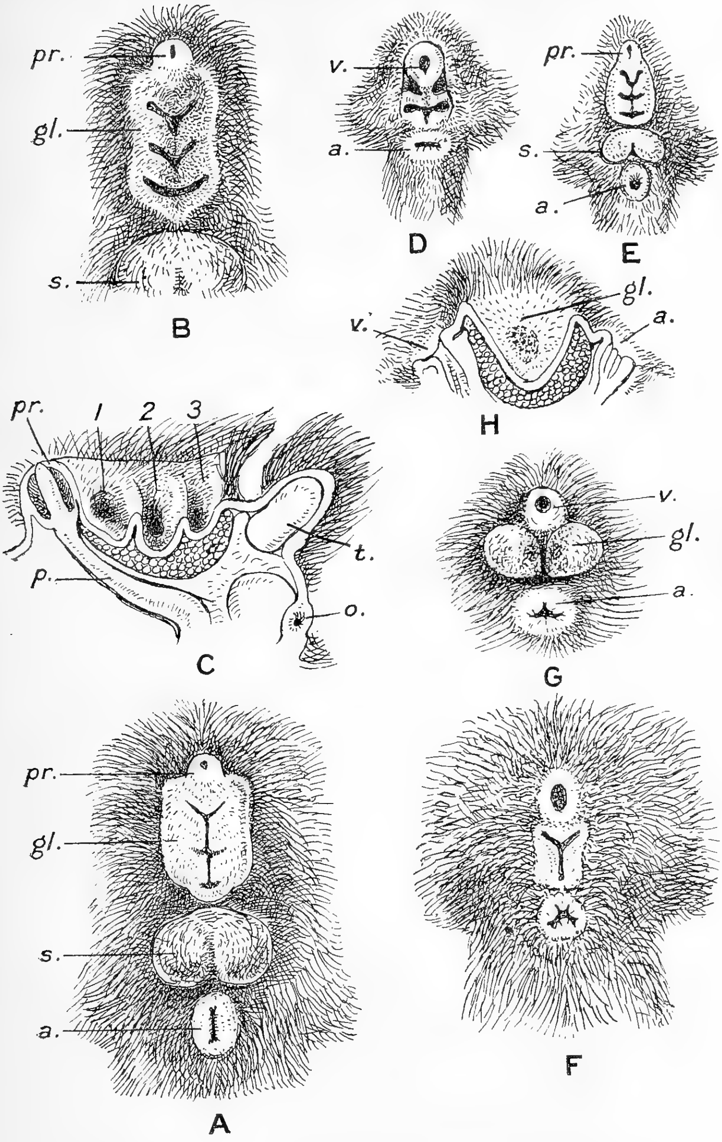
G. The same, with the labia of the glandular space separated.

H. Longitudinal and vertical section of the same.

a., anus; *gl.*, gland; *pr.*, prepuce; *s.*, scrotum; *v.*, vulva.

In fig. C; *p.*, penis; 1, 2, 3, the three glandular pouches; *t.*, testis; *o.*, orifice of anal gland within anus.

Text-figure 5.



A. Inferior view of anal and glandular area of *Genetta pardina* ♂.
B. The same, with the three glandular pouches partially distended.
C. Longitudinal and vertical section of the same.

behind, and one between the two. The compartments are separated by two transverse ridges of integument, extending across the space between the lobes but with their summits below the level of the anterior, posterior, and lateral walls of the space. Into the bottom of each of these compartments the secretion of the glands can be squeezed from a pair of laterally placed clusters of minute orifices. Thus there are six centres from which the liquid secretion exudes, three leading from the right and three from the left gland. Longitudinal and vertical section of the glandular area shows that the low partitions between the compartments of the glandular space are formed by simple uprising folds of the integument of its floor. Beneath the integument a narrow strip of the gland stretches the whole length of the glandular area; beneath and in front of the gland is the penis; behind it the testis, and below the testis the anal gland with its orifice just within the anus (text-fig. 5, A, B, C)*.

This is the condition of things in the males of the three species mentioned above; and the gland of a female Genet from Nairobi, similar in colour and markings to the S. African *G. rubiginosa*, resembled those of the males in being divided into three compartments and provided with three pairs of secreting areas, one pair for each compartment; and I do not doubt that the female Mivart identified as *G. tigrina* was similarly provided. But in a half-grown female of *G. dongolana* the gland is of a different and simpler type. The median sulcus is Y-shaped as in the male, but when the lobes are pulled apart, the space between them is seen to be undivided, with a naked floor continuous in front with the naked skin surrounding the vulva and limited posteriorly by the preanal area of integument, which is covered with short hair. Secretion under pressure can be squeezed from the inner face of the glandular lobes, but there are no definite and isolated paired secreting centres as in the male of this species and of the others described. That the characters in which the gland of this young female differ from those of the adult male are not attributable to its immaturity, is shown by the occurrence of a gland, similar to that of the adult male, in a young male that came at the same time and from the same place as the young female, but died two months before she did. The sexual differences between these two in the structure of the glands was very striking.

Again, I have drawings and notes of the gland of an adult female S. African Feline Genet (*G. felina*) that died as long ago as June 1910. In all essential respects this gland appears to have resembled that of the young female *G. dongolana*, but the glandular lobes were larger and the space between them deeper, especially posteriorly. The hair lining the inner faces of the lobes was stained with yellow secretion, which could be squeezed

* The glands are well developed in the newly born young of Genets. In the male *G. pardina* the gland resembles that of the adult; in the female it is provided with two pairs of secreting pouches (text-fig. 5, D, E).

from a definite area, pitted with numerous pores, upon each lobe (text-fig. 5, F, G, H).

The structure of the gland in the females of *G. dongolana* and *G. felina* throws light, I think, upon a difficulty that puzzled Mivart, who could not reconcile his observations upon the gland in the female of *G. tigrina* with those of Daubenton (Buffon's Hist. Nat. ix. 1761, p. 343, pls. 36–40) on the gland of what appears to have been a European Genet (*G. genetta*). Daubenton figured a simple, small glandular space lying between two lappets and furnished with a pair of secreting pores. Except that the pores were described as single orifices, this gland agrees tolerably closely with that of *G. felina*, described above. It is not surprising that these two species, which resemble each other closely in many respects, should have similar glands in the female. *G. tigrina*, on the contrary, belongs to a distinct group of the genus, which includes *G. pardina* and *G. rubiginosa* amongst other species.

So far as specific and sexual differences in the glands of Genets are concerned, my observations point to the possible division of the genus into two categories, as follows:—

1. Interglandular space tripartite and chambered, structurally alike in the two sexes (*G. tigrina*, *pardina*, *rubiginosa*);
2. Interglandular space of male as in section 1, that of female of a different and simpler type (*G. genetta*, *dongolana*, *felina*).

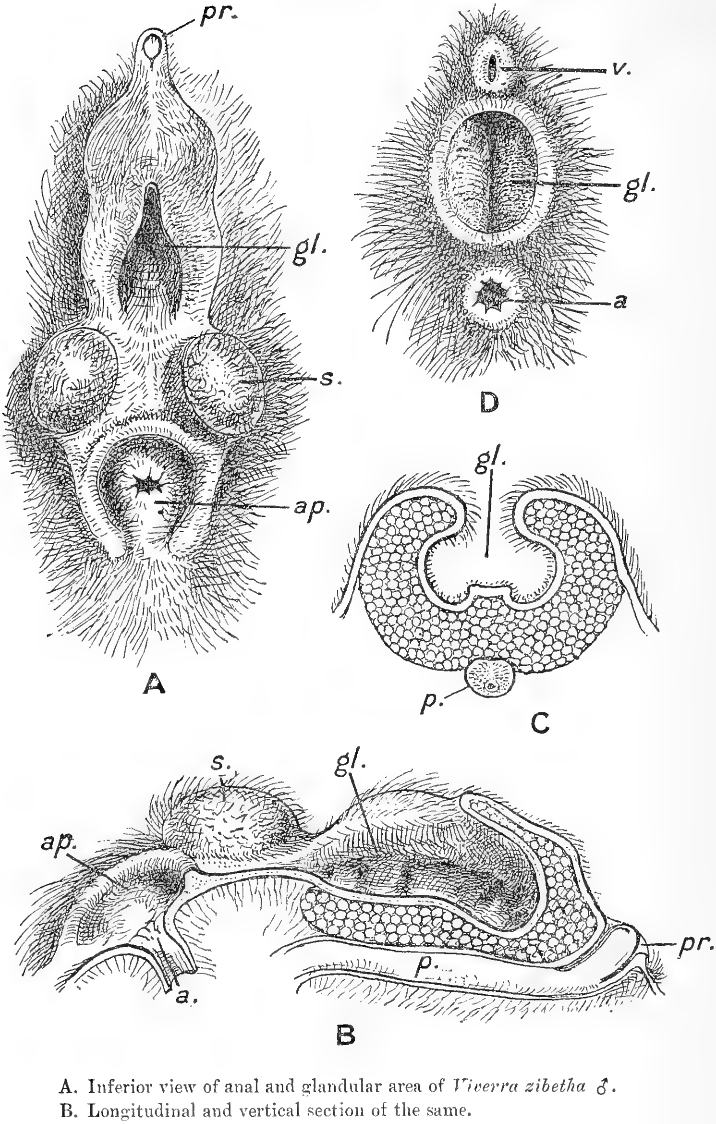
But until these organs have been studied in other species and in the males of *tigrina*, *felina*, and *genetta*, and the female of *pardina*, the value of this opinion consists merely in its suggesting a useful line of research.

The Glands of Viverra zibetha.

In the male of this species the gland differs in two or three points from that of *Genetta*. The glandular space between the lobes is not subdivided by transverse partitions, but is much wider in its deeper parts than at the orifice, the margins of which overlap the space towards the middle line. Nevertheless, in the specimen examined the margins or "labia" were not mesially in contact in the posterior half of the gland, being somewhat widely separated towards the scrotum and rather abruptly convergent towards the prepuce. Furthermore, the anterior part of the glandular space is roofed * over by the fusion of the integument forming the inner margins of the labia, so that the two lobes cannot be divaricated throughout their length up to the prepuce, as in *Genetta*. This overlapped area

* The gland is here described as seen from the ventral side, with the orifice looking upwards, as when the animal is lying on its back.

Text-figure 6.



A. Inferior view of anal and glandular area of *Viverra zibetha* ♂.
B. Longitudinal and vertical section of the same.
C. Transverse section of gland of the same.
D. Inferior view of anal and glandular area of *Viverricula rasse* ♀, the labia of the glandular space widely separated.

a., anus; *ap.*, anal pouch; *gl.*, interglandular space; *p.*, penis; *pr.*, prepuce; *s.*, one half of scrotum; *v.*, vulva.

constitutes a large storage pouch for secretion. The secretion appears to make its way into the depths of the glandular space through five areas on each side. The two anterior of these lie in the anterior pouch and the three posterior, the last nearest the scrotum being quite small, in the hinder part of the glandular space, which is only overlapped laterally by the labia (text-fig. 6, A, B, C).

Other points to be noticed in this region are the following :— The scrotum is divided, and the broad area between its two halves is naked and glandular and extends backwards from the open posterior mouth of the perfume-sac nearly to the anal area. But it is separated from the anal area by an upstanding rim of integument, which is continued to the right and left and curves backwards like a collar round the anal area without, however, quite encircling it posteriorly. The anus lies in the centre of the space thus circumscribed, and this space is naked save for the hairs that grow on the integumental rim. Thus in the specimen examined at all events there is a very definite glandular area, defined by an upstanding rim, round the anus, as in the Mungooses and, to a greater degree, in *Cryptoprocta*.

The figure published by Chatin (Ann. Sci. Nat. (5) xix. 1874, pl. ii. fig. 10) of the anal and glandular region in *V. zibetha* does not agree with the description just given. The anus is not encircled with an integumental ring, the halves of the scrotum are in contact, and the cleft between the glandular lobes is much shorter and not expanded posteriorly. His figure in fact tallies in all essential respects with those showing the corresponding parts in *C. civetta* (pl. i. figs. 1, 2, 3). Beyond suggesting that his specimen, if correctly named, may have been young, I can think of no plausible explanation of the discrepancies.

The Glands of Viverricula rasse.

In the female example of this species in the British Museum the two glands (text-fig. 6, D) are large and the space between them is undivided and is overlapped marginally, both at the sides and in front, to a lesser extent than in the case of the male *Viverra zibetha* described above.

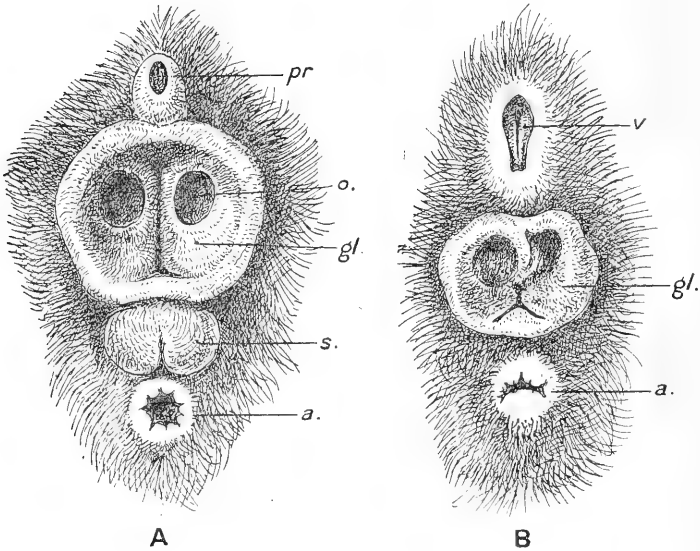
In the female, at all events, of this species, the glandular apparatus cannot be said to differ from that of *Genetta* in being provided with a distinct pouch for the storage of secretion, as Chatin and others following him have asserted.

The Glands of Civettictis civetta.

Chatin's figures and description of the glands of the African and Indian Civets show no anatomical differences between the two species, but sketches and notes I made in 1909 on the gland of a male *C. civetta* demonstrate one important distinction (text-fig. 7, A).

Superficially the gland, scrotum, and anus are as represented by Chatin. The cleft between the glandular lobes is a simple undilated slit, the two halves of the scrotum are not widely separated, and there is no integumental collar round the naked anal area. When the two glandular lobes are pulled apart, there appears on the inner face of each a moderately large oval orifice leading into a large hair-lined sac or pouch, which extends forwards, backwards, and upwards within the gland. The secretion is poured into this sac from its walls and makes its way into

Text-figure 7.



A. Inferior view of anal and glandular area of *Civettictis civetta* ♂, with the labia of the interglandular space widely separated.

B. The same of *Civettictis civetta* ♀. [The area round the vulva is naked back to the gland.]

a., anus; *gl.*, interglandular space; *o.*, orifice of pouch excavated in gland of ♂; *pr.*, prepuce; *s.*, scrotum; *v.*, vulva.

the space between the glandular lobes through the orifice. Thus the space between the two glands may be described as separated from the main pouch of the gland on each side by a wall perforated by a large aperture. It is this pouch, apparently, that Chatin described as the "réservoir" or "poche"; and he quite rightly insists upon the distinction between it and the interglandular space marked superficially by the cleft between the two glandular lobes. In this respect there is a marked difference between the gland of the male *Civettictis civetta* and of the

Genets; but there is also a marked difference between the glands of the former and of the male *Viverra zibetha*.

The gland in the female *C. civetta* (text-fig. 7, B) superficially resembles that of the male, and when the glandular lobes are pulled apart the space between them, lined with hairs and secretion, is seen to be in communication in front with a pair of deep pockets, separated by a vertical partition, each pocket passing forwards alongside the vagina and beneath the area of integument that separates the vulva from the glandular cleft. Thus the gland of the female *Civettictis civetta* is tolerably similar to that of the male.

Setting aside cranial and dental features * and making use of some of the characters set forth in this paper, the four genera of Viverrinæ, in the restricted sense in which that term is here used, may be briefly contrasted as follows :—

a. Interglandular space in the males and some females divided into three compartments by two transverse ridges of integument, in other females forming a small, shallow pouch; metatarsus with a long narrow double pad .... *Genetta*.

a'. Interglandular space never so divided and in the females always forming a deep, capacious pouch; metatarsal pad absent or very short.

  b. Each half of the gland excavated to form a pouch communicating with the interglandular space by a constricted orifice. A small metatarsal pad above the plantar pad; carpal pad markedly bilobed; sole of foot in front and at the sides of plantar pad quite naked; claws longer, unsheathed, less retractile .... *Civettictis*.

  b'. Halves of the gland not so excavated; no metatarsal pad; carpal pad not so markedly bilobed; sole of foot partially or wholly hairy; claws shorter, more retractile.

    c. Pollex and hallux as in *Genetta* and *Civettictis*, low down, their digital pads approximately on a level with the postero-lateral angle of the plantar pad; claws of 3rd and 4th digits of fore foot guarded by large skin-lobes † .... *Viverra*.

    c'. Pollex and hallux higher up, above the postero-lateral angle of the plantar pad; claws of 3rd and 4th digits of fore foot unguarded by lobes of skin.......... *Viverricula*.

---

* Since most contemporary mammalogists will probably consider cranial and dental characters of more value in the discrimination of genera than the external features here made use of in severing the African from the Oriental Civets, I may point out that the former may be further distinguished from the latter by the prominence of the tympanic bulla and of the paroccipital process that accompanies it. This difference is well shown in the case of *V. zibetha* and *C. civetta* in Blainville's Ostéogr. Mamm. Atlas, *Viverra*, pl. viii. The two molars of the upper jaw and the last molar of the lower jaw are also markedly larger in *C. civetta* than in *V. zibetha*; and in the matter of the dentition and of the tympanic area *V. megaspila* and *V. tangalunga* and *Viverricula malaccensis* go along with *V. zibetha*.

† At least in *V. zibetha*; unknown in *V. tangalunga* and *megaspila*.

EXHIBITIONS AND NOTICES.

February 9, 1915.

R. H. BURNE, Esq., M.A., Vice-President, in the Chair.

The SECRETARY read the following report on the Additions made to the Society's Menagerie during the months of November, December, and January, 1914–5:—

NOVEMBER.

The number of registered additions to the Society's Menagerie during the month of November was 58. Of these 42 were acquired by presentation, 9 were received on deposit, and 7 in exchange.

The number of departures during the same period, by death and removals, was 177.

Amongst the additions special attention may be directed to:—

2 Elands (*Taurotragus oryx*), from S. Africa, presented by A. H. Wingfield, F.Z.S., on November 18th.

DECEMBER.

The number of registered additions to the Society's Menagerie during the month of December was 52. Of these 27 were acquired by presentation, 18 were received on deposit, 3 in exchange, and 4 were born in the Gardens.

The number of departures during the same period, by death and removals, was 137.

Amongst the additions special attention may be directed to:—

1 Peter's Dwarf Mongoose (*Helogale undulata*), from Wangi, Tanaland, E. Africa, new to the Collection, deposited on December 1st.

1 Golden-eared Honey-eater (*Ptilotis chrysotis*), from New Guinea, new to the Collection, presented by Alfred Ezra, F.Z.S., on December 7th.

2 Red-crowned Fruit-Pigeons (*Alectrœnas pulcherrima*), from the Seychelles, received in exchange on December 21st.

JANUARY.

The number of registered additions to the Society's Menagerie during the month of January was 30. Of these 22 were acquired by presentation, 1 by purchase, 3 were received on deposit, 2 in exchange, and 2 were born in the Gardens.

The number of departures during the same period, by death and removals, was 132.

Amongst the additions special attention may be directed to:—

1 Sing-Sing Waterbuck (*Cobus defassa*), ♀, from Senegambia, presented by A. H. Wingfield, F.Z.S., on January 26th.

1 Squirrel-Monkey (*Saimiris sciurea*), from Demerara, and 1 Potto (*Potos caudivolvulus*), from Colombia, presented by Gordon R. W. Hutton on January 27th and 31st.

2 Senegal Genets (*Genetta senegalensis*), from Zaria, Nigeria, presented by Charles Migeod on January 19th.

1 Peter's Spotted Fire-Finch (*Lagonosticta niveiguttata*), from E. Africa, new to the Collection, received in exchange on January 11th.

The Application of X-rays to Microscopical research; illustrated by Skiagraphs revealing the internal structure of Foraminifera.

Mr. E. Heron-Allen, F.L.S., F.Z.S., brought before the Society a new method of determining the internal structure of the Foraminifera without transparent mounting or section-cutting, or other interference with the specimens, by means of Skiagraphs. These have been made by Mr. J. E. Barnard. A series of slides was exhibited showing:—(i.) The first experiment made for the purpose of ascertaining the structure of a Foraminifer of a new type, and of extreme rarity found in the Kerimba Archipelago (E. Africa). (ii.) An ordinary North Sea dredging showing the internal structure of the Foraminifera as if they had been mounted in balsam. (iii.) Thick and dense tests of *Massilina secans* (d'Orbigny) and Skiagraphs of the same. (iv.) The still thicker and denser tests of *Biloculina bulloides* d'Orbigny, the Skiagraphs showing the arrangement of the earlier chambers. (v.) *Cornuspira foliacea* (Philippi). The dense imperforate shells, and Skiagraphs revealing micro- and megalo-spheric primordial chambers. (vi.) Coarse and densely agglutinate tests of the arenaceous species *Astrorhiza arenaria* Norman, and Skiagraphs revealing the cavities containing the protoplasm body. (vii.) Two monothalamous arenaceous types of similar external appearance. The Skiagraphs reveal that one is *Botellina labyrinthica* Brady, and the other *Jaculella obtusa* Brady. (viii.) The dense hyaline tropical species *Operculina complanata* Defrance, with the obscuring papillæ constituting the var. *granulosa* of Leymerie, the Skiagraphs revealing curious distortions of some of the internal septa. (ix.) The equally dense species *Orbiculina adunca* (Fichtel & Moll), the central chambers obscured by thick shell-growth which does not affect the Skiagraph. (x.) The coarse and solidly built arenaceous species *Cyclammina cancellata* Brady, the dense cement shell studded with sandy particles. These disappear in the Skiagraph, which shows the labyrinthic structure and a megalospheric primordial chamber. (xi.) A Nodosarian, showing the method of growth by the addition of successive chambers. [From (vi.) to (xi.) were shown in two states, (*a*) in black on a white ground and (*b*) reversed.] (xii.) The common tropical form *Orbitolites complanata* Lamarck, the Skiagraphs showing the Milioline early chambers. Shells of this species were also exhibited which had been skiagraphed to ascertain whether they were in the process of viviparous reproduction described by Brady *.

The speaker's views upon the importance and ultimate potentialities of this new method of research have been set out at length in the Proceedings of the Royal Microscopical Society (Jan. 20th, 1915). At present the definition and resolution of these internal structures is limited by the fact that the original Skiagraph is not a magnification, the magnification being produced by projection; but it appears more than likely from the experiments of Mr. Barnard that a newer process of Microskiagraphy will, before long, give results which may ultimately yield information of the highest biological value in relation to the structure and functions (behaviour) of simple protoplasmic organisms. When this difficulty has been overcome Messrs. Heron-Allen and Barnard propose to continue these experiments upon *living* Foraminifera, and they see no reason why, in the near future, the nucleus should not be resolved, and some of its functions photographed in the living condition.

The Stomach and Intestines of the Open-bill.

Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, exhibited preparations made from two examples of the Indian Open-bill (*Anastomus oscitans*) which had recently lived in the Society's Gardens, and remarked as follows:—"In dissecting these birds I noticed two peculiarities which do not appear to have been described before. The Open-bill is stated to live on shell-fish and the conformation of the bill is described as forming a sifting apparatus. In the stomach there is an elaborate arrangement which would serve as a sifting organ to prevent large particles from passing into the duodenum. The stomach is divided into a soft-walled glandular proventriculus, separated by a constriction from a muscular gizzard, the lining membrane of which consists of a hardened layer of secretion, as in most birds with a gizzard. This communicates by a wide aperture with an elongated, rather small cardiac chamber, which is soft-walled and opens into the duodenum. The wall of the gizzard is raised in a strong, crescentic fold which blocks the aperture into the cardiac chamber, the free margin of the fold being frayed into flat plates placed like the teeth of a comb. The ridge and plates are covered with the hardened secretion lining the general cavity of the gizzard, and particles of food can reach the intestines only after being squeezed through these plates. The gizzard in each specimen was nearly full of large stones.

The second peculiarity related to the colic cæca. In Herons only one of these is present, but in Storks the normal pair occurs. In both examples of *Anastomus*, which has always been regarded as a stork, only one of the two cæca was present, as in *Balæniceps*."

* J. R. Micr. Soc. 1888, pp. 693–697, pl. x.

Sir Edmund G. Loder, Bt., F.Z.S., exhibited the tanned skin of a large Capybara (*Hydrochœrus hydrochœrus*), which he suggested might be identical with the "pigskin" of commerce, and the skull of a Walrus (*Trichechus rosmarus*) from Kamschatka, with record tusks. The weight of the skull and tusks was about 40 lbs. The tusks alone weighed $21\frac{1}{2}$ lbs., and measured $36\frac{1}{2}$ inches in length, $29\frac{1}{2}$ inches from outside the gum, and $9\frac{5}{8}$ inches in girth.

Mr. Guy Aylmer, F.Z.S., exhibited some skins of mammals from Sierra Leone, including those of a Serval (*Felis capensis*) and of a Servaline Cat (*F. servalina*), and stated that a native had brought him two kittens, almost certainly from the same litter, one being spotted like the Serval and the other obscurely speckled like the Servaline Cat. This he regarded as proof that the differences between the Servals and Servaline Cats are of no systematic importance.

February 23, 1915.

Prof. E. W. MacBride, D.Sc., F.R.S., Vice-President, in the Chair.

Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, exhibited mounted examples of three species of Cockroach, *Periplaneta americana*, *P. orientalis*, and *Phyllodromia germanica*, all of which had established themselves in different houses in the Society's Gardens, and stated his wish that some naturalist would endeavour to work out the causes of the selective distribution of these insects.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited, on behalf of Mr. Edward Gerrard, the mounted head of a male Sitatunga Antelope (*Limnotragus*) shot by Capt. H. D. Bentinck on the Bahr-el-Ghazal. Instead of being dark brown, the colour characteristic of the males of this buck, the head was whitish brown, suggesting that the individual was a partial albino.

Mr. D. Seth-Smith, F.Z.S., Curator of Birds, exhibited, on behalf of Mr. Edward Gerrard, a pair of Daurian or Bearded Partridges (*Perdix daurica*), which had recently been purchased in the flesh at a poulterer's shop in London. Numbers of these partridges arrive in London and other large European towns every winter in a frozen state, and are sold under the name of "Russian" or "Manchurian Partridges." The species inhabits

Central and Eastern Asia, and may readily be distinguished from the Common Partridge, *P. perdix*, by its paler colour, the elongated feathers on the sides of the throat, and by the black horseshoe patch on the breast.

Miss ANNIE C. JACKSON exhibited some living male specimens of the Indian Stick-Insect, *Carausius morosus*, and remarked :—

"The male of this species was figured by Redtenbacher in his monograph 'Insektenfamilie der Phasmiden' without any comment as to its rareness or otherwise. When, however, the species is bred in captivity males are very rare, and I believe I am right in saying that hitherto, though many insects have been bred in this country, only one male has been observed. Last year I reared about 3000 stick-insects and among them identified seven males. The female stick-insect you are doubtless familiar with, as there are many in the insect-house here. The male differs from the female in its smaller size and more slender appearance, and the antennæ and legs are proportionately longer. The red vermilion colour present in the adult female on the inner side of the femur of the front legs is absent; on the dorsal surface of the thorax there are two small red marks, while on the ventral surface both meso- and metathorax are streaked with red; in some females, however, the ventral surface of the thorax is similarly marked. One of the males differed from the others in having one of the front legs with a patch of red as in the adult female, the other one being normal; the leg with the red patch is distinctly shorter than the other, which suggests that the insect at an earlier stage lost the leg and developed this one in its place, as it has the power of doing, but why it should have grown one resembling that of an adult female I am unable to explain."

March 9, 1915.

R. H. BURNE, Esq., M.A., Vice-President,
in the Chair.

The SECRETARY read the following report on the Additions made to the Society's Menagerie during the month of February 1915 :—

The number of registered additions to the Society's Menagerie during the month of February was 62. Of these 27 were acquired by presentation, 5 by purchase, 25 were received on deposit, 2 in exchange, and 3 were born in the Gardens.

The number of departures during the same period, by death and removals, was 129.

Amongst the additions special attention may be directed to :—

2 Azara's Dogs (*Canis azarica*), from Santa Fé, Argentina, presented by George O'Donnel on February 10th.

1 Red Kangaroo (*Macropus rufus*) ♂, from Australia, presented by Capt. F. Dent on February 26th.

Dr. R. Broom, M.D., C.M.Z.S., exhibited a skull of *Chrysochloris asiatica* with four upper molars on each side. On November 24th, 1914, Dr. Broom exhibited a skull of *Chrysochloris hottentota* with only one molar on each side above. A few species of *Chrysochloris* have normally two molars, and used to be placed in the genus *Amblysomus*. But *Chrysochloris namaquensis* has one-third of the known specimens with two molars, one-third with three molars, and the rest with two molars on one side and three on the other. Most species of *Chrysochloris* have three molars. The specimen exhibited shows that even the type species is variable.

The following reports on the collections made by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea were read, and Mr. W. R. Ogilvie-Grant gave a short account of the expeditions and the results obtained:—

Coleoptera. By G. J. Arrow, G. A. K. Marshall, F.Z.S., and C. J. Gahan.

Diptera. By F. W. Edwards, B.A., F.E.S., and E. E. Austen, F.Z.S.

Odonata. By Herbert Campion.

Vermes. By Dr. L. Cognetti de Martiis.

These reports will be published in the 'Transactions.'

NOTICE.

In my "Description of a new Lizard from the Canary Islands" (P. Z. S. 1914, p. 681) unfortunately a slight error occurred in the dimensions given of the head of *Lacerta cæsaris*:—

Instead of "Width of head $\frac{1}{3}$ of the length" it should be "*Width of head* $\frac{2}{3}$ *of the length.*"

(Signed) Ph. Lehrs.

March 5th, 1915.

No. 139.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

February 9th, 1915.

R. H. Burne, Esq., M.A., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The Secretary read a Report on the Additions to the Society's Menagerie during the months of November and December, 1914, and January, 1915.

Sir Edmund G. Loder, Bt., F.Z.S., exhibited the tanned skin of a large Capybara (*Hydrochœrus hydrochœrus*), which he suggested might be identical with the "pigskin" of commerce, and the skull of a Walrus (*Trichechus rosmarus*) from Kamschatka, with record tusks. The weight of the skull and tusks was about 40 lbs. The tusks alone weighed $21\frac{1}{2}$ lbs., and measured $36\frac{1}{2}$ inches in length, $29\frac{1}{2}$ inches from outside the gum, and $9\frac{5}{8}$ inches in girth.

Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, exhibited preparations of the stomach and intestines of the Open-bill (*Anastomus oscitans*) and described the elaborate sifting apparatus in the stomach and the presence of only a single colic cœcum.

Mr. E. Heron-Allen, F.L.S., F.Z.S., exhibited a series of skiagraphs of Foraminifera, revealing their internal structure without transparent mounting or section-cutting, or other interference with the specimens, and illustrating the application of X-rays to microscopical research.

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. Guy Aylmer, F.Z.S., exhibited some skins of mammals from Sierra Leone, including those of a Serval (*Felis capensis*) and of a Servaline Cat (*F. servalina*), and stated that a native had brought him two kittens, almost certainly from the same litter, one being spotted like the Serval and the other obscurely speckled like the Servaline Cat. This he regarded as proof that the differences between the Servals and Servaline Cats are of no systematic importance.

Mr. H. G. Plimmer, F.R.S., F.Z.S., Pathologist to the Society, read his Report on the Deaths which occurred in the Society's Gardens during 1914, and on the Blood-parasites found during the same period.

Mr. E. G. Boulenger, Curator of Reptiles, read a paper on an Aglyphodont Colubrid Snake (*Xenodon merremii*), with a vertically movable maxillary bone. The vertical mobility of the maxillary bone in Snakes had previously been regarded as essentially characteristic of the Viperidæ. Observations on the Snake in question, which was recently received by the Society from Mr. W. A. Smithers, C.M.Z.S., showed that the mobility of its maxillary bones was so great that the fangs could be not merely erected, but were capable of being thrust forward and sideways, the mechanism being as perfect as in any of the Vipers.

Mr. Boulenger pointed out that the discovery of a solid-toothed Colubrid with vertically movable maxillæ went a long way towards settling the so often discussed problem of the derivation of the viperine maxillary bone. The author traced the probable evolution of the bone, expressing the opinion that the Viperidæ were descended from the Opisthoglyph Colubrids, and that the old view, recently revived, that they were of Proteroglyph ancestry, must be abandoned once and for all.

Dr. William Nicoll, M.A., M.D., F.Z.S., communicated the description of a new species of Liver-fluke from the Kestrel, the first of its kind found in Great Britain.

The next Meeting of the Society for Scientific Business will be held on Tuesday, February 23rd, 1915, at half-past Five o'clock p.m., when the following communications will be made :—

Miss Jackson.

Exhibition of a collection of Stick-insects.

J. F. Gemmill, M.A., D.Sc., F.Z.S.

(1) Abnormal Gills in the Starfish, *Porania pulvillus* O. F. M.

(2) On the Ciliation of Asterids, and on the Question of Ciliary Nutrition in Certain Species.

Miss Kathleen Haddon.

On the Methods of Feeding and the Mouth-parts of the Larva of the Glow-worm (*Lampyris noctiluca*).

Rowland E. Turner, F.Z.S.

Descriptions of New Fossorial Wasps from Australia.

Lt.-Col. J. M. Fawcett.

Notes on a small Collection of Heterocera made by Mr. W. Feather in British East Africa, 1911–12.

The following papers have been received:—

F. F. Laidlaw, M.A., F.Z.S.

Contributions to a Study of the Dragonfly Fauna of Borneo. —Part III. A Collection made on Mount Kina Balu by Mr. Moulton in September and October 1913.

G. Arnold, M.Sc., A.R.C.S., and C. L. Boulenger, M.A., D.Sc., F.Z.S.

On a Freshwater Medusa from the Limpopo River-System.

R. I. Pocock, F.R.S., F.L.S., F.Z.S.

On the Feet and Glands and other External Characters of the Viverrinæ, with the Description of a New Genus.

Miss M. L. Hett, B.Sc., F.Z.S.

On some New Pentastomids from the Zoological Society's Gardens.

Dr. L. Cognetti de Martiis.

Report on the Vermes (Oligochæta) collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

G. J. Arrow and G. A. K. Marshall, F.Z.S.

Report on the Coleoptera collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.—Parts I. and II.

F. W. Edwards, B.A., F.E.S., and E. E. Austen, F.Z.S.

Report on the Diptera collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

G. E. Nicholls, D.Sc., F.L.S.

A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia.

Herbert Campion.

Report on the Odonata collected by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea.

Bruce F. Cummings.

On Two new Species of *Polyplax* (Anoplura) from Egypt.

R. Broom, D.Sc.

On some new Carnivorous Therapsids in the Collection of the British Museum.

J. T. Cunningham, M.A., F.Z.S.

The Artificial Formation from Paraffin Wax of Structures resembling Molluscan Shells.

E. Heron-Allen, F.L.S., F.R.M.S., F.Z.S., and Arthur Earland, F.R.M.S.

The Foraminifera of the Kerimba Archipelago (Portuguese East Africa).—Part II.

Frank E. Beddard, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XVI. On Certain Points in the Anatomy of the Genus *Amabilia* and of *Dasyurotænia*.

R. Lydekker, F.R.S., F.Z.S.

The True Coracoid.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
February 16th, 1915.

No. 140.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

February 23rd, 1915.

Prof. E. W. MacBride, D.Sc., F.R.S., Vice President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, exhibited mounted examples of three species of Cockroach, *Periplaneta americana*, *P. orientalis*, and *Phyllodromia germanica*, all of which had established themselves in different houses in the Society's Gardens, and stated his wish that some naturalist would endeavour to work out the causes of the selective distribution of these insects.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited, on behalf of Mr. Edward Gerrard, the mounted head of a male Sitatunga Antelope shot by Capt. H. D. Bentinck on the Bahr-el-Gazal. Instead of being dark brown, the colour characteristic of the males of this buck, the head was whitish brown, suggesting that the individual was a partial albino.

Mr. D. Seth-Smith, F.Z.S., Curator of Birds, exhibited, on behalf of Mr. Edward Gerrard, a pair of Daurian or Bearded Partridges (*Perdix daurica*), which had recently been purchased in the flesh, at a poulterer's shop in London. Numbers of these partridges arrive in London and other large European towns every winter in a frozen state, and are sold under the name of

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

"Russian" or "Manchurian Partridges." The species inhabits Central and Eastern Asia, and may readily be distinguished from the Common Partridge, *P. perdix*, by its paler colour, the elongated feathers on the sides of the throat, and by the black horseshoe patch on the breast.

Miss ANNIE C. JACKSON exhibited some living male specimens of Stick Insects, and remarked that, although she had succeeded in rearing several thousands in parthenogenetic generation, she had obtained only seven males.

Miss KATHLEEN HADDON read a paper "On the Methods of Feeding and the Mouth-parts of the Larva of the Glow-Worm."

External digestion is a phenomenon of fairly wide occurrence among various groups of insects, and the mouth-parts are in some cases specially adapted to this purpose. The larva of the Glow-worm (*Lampyris noctiluca*) feeds on snails, of which it leaves no residue but an empty shell; it is unlikely that there is any preliminary anæsthetising as asserted by Fabre. The mandibles of the larva bite up the food and each mandible is pierced by a fine tube, through which a dark-coloured fluid is exuded. The bases of all the mouth-parts are covered with fine outwardly-directed hairs, which are bathed in the juices of the snail whilst the larva is feeding; the juice is sucked into the œsophagus, which is extremely narrow, by the action of a pharyngeal pump similar to that found in other sucking insects.

Dr. J. F. GEMMILL, M.A., F.Z.S., read a paper on the "Ciliation of Asterids and on the Question of Ciliary Nutrition in Certain Species."

The arrangement of the ciliary currents on the various surfaces of four widely different species of Starfishes is described in detail. This arrangement is constant for all individuals in each of the species, and, except as regards external surfaces, is practically the same in all the species. Everywhere the arrangement is shown to be explicable by physiological needs. Ciliation in the perihæmal spaces is demonstrated.

In the case of *Porania pulvillus* a mechanism for ciliary feeding is shown to exist, and the results of experiment demonstrate that this kind of feeding actually takes place. As regards *Astropecten*, it is only shown, so far, that the arrangement of the actinal and abactinal cilia makes ciliary feeding possible. In *Solaster papposus* ciliary feeding probably takes place, but in an entirely minor degree. The other Starfishes examined gave negative results. The important bearing of the above results on questions of phylogeny is briefly discussed.

Dr. Gemmill also gave an account of several examples of the phanerozonate Starfish, *Porania pulvillus*, with actinally placed gills. The abnormality is of interest as confirming various other lines of evidence, which show that the division of Asteroids into Phanerozonia and Cryptozonia is not an entirely natural one.

Mr. R. E. Turner, F.Z.S., F.E.S., presented a paper containing descriptions of a large number of new Fossorial Wasps, mostly collected by him while on a recent expedition to Australia, but including a few received from the Queensland and West Australian Museums.

Lt.-Col. J. M. Fawcett contributed a paper on a collection of Heterocera made by Mr. W. Feather in British East Africa. The bulk of the species was taken at light during damp evenings, and perhaps the most interesting capture is that of a specimen of the celebrated *Actias besanti* Rebel, a large and most beautiful Saturnid moth distinguished by its extremely long tails. This is a well-known rarity of the "first water," and only four specimens were previously known to have been taken, two of which are in the British Museum and two in Germany. Besides the forms described as new species, there are a good many previously-described forms not as yet represented in the National Collection, which of itself is evidence of their rarity. Mr. Feather is to be especially congratulated upon the very perfect condition of his specimens and the very accurate record he has kept of the dates of their capture and the localities.

Many of the forms dealt with in this memoir were only previously known to science through specimens brought from Tropical West Africa, and were previously unrecorded from British East Africa. But this region still remains to be properly worked out, and a great field of research is in store for anyone who can find time to take the matter in hand.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 9th, 1915, at half-past Five o'clock p.m., when the following communications will be made:—

F. F. Laidlaw, M.A., F.Z.S.

Contributions to a Study of the Dragonfly Fauna of Borneo. —Part III. A Collection made on Mount Kina Balu by Mr. Moulton in September and October 1913.

G. Arnold, M.Sc., A.R.C.S., and C. L. Boulenger, M.A., D.Sc., F.Z.S.

On a Freshwater Medusa from the Limpopo River-System.

R. I. Pocock, F.R.S., F.L.S., F.Z.S.

On the Feet and Glands and other External Characters of the Viverrinæ, with the Description of a New Genus.

Miss M. L. Hett, B.Sc., F.Z.S.

On some New Pentastomids from the Zoological Society's Gardens.

Reports on the Collections made by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea:—

Coleoptera. By G. J. Arrow, G. A. K. Marshall, F.Z.S., and C. J. Gahan.

Diptera. By F. W. Edwards, B.A., F.E.S., and E. E. Austen, F.Z.S.

Odonata. By Herbert Campion.

Vermes. By Dr. L. Cognetti de Martiis.

The following papers have been received:—

G. E. Nicholls, D.Sc., F.L.S.

A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia.

Bruce F. Cummings.

On Two new Species of *Polyplax* (Anoplura) from Egypt.

R. Broom, M.D., D.Sc., C.M.Z.S.

On some new Carnivorous Therapsids in the Collection of the British Museum.

J. T. Cunningham, M.A., F.Z.S.

The Artificial Formation from Paraffin Wax of Structures resembling Molluscan Shells.

E. Heron-Allen, F.L.S., F.R.M.S., F.Z.S., and Arthur Earland, F.R.M.S.

The Foraminifera of the Kerimba Archipelago (Portuguese East Africa).—Part II.

F. E. Beddard, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XVI. On Certain Points in the Anatomy of the Genus *Amabilia* and of *Dasyurotænia*.

R. Lydekker, F.R.S., F.Z.S.

The True Coracoid.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
March 2nd, 1915.

No. 141.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

March 9th, 1915.

R. H. BURNE, Esq., M.A., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Society's Menagerie during the month of February 1915.

Dr. R. BROOM, M.D., C.M.Z.S., exhibited a skull of *Chrysochloris asiatica* with four upper molars on each side. On November 24th, 1914, Dr. Broom exhibited a skull of *Chrysochloris hottentota* with only one molar on each side above. A few species of *Chrysochloris* have normally two molars, and used to be placed in the genus *Amblysomus*. But *Chrysochloris namaquensis* has one-third of the known specimens with two molars, one-third with three molars, and the rest with two molars on one side and three on the other. Most species of *Chrysochloris* have three molars. The specimen exhibited shows that even the type species is variable.

Mr. R. I. POCOCK, F.R.S., F.L.S., F.Z.S., Curator of Mammals, read a paper upon the feet, perfume-glands, and other external characters of the Viverrinæ, using this term in a restricted sense for the typical Civets and Genets referred hitherto to the three genera *Viverra*, *Viverricula*, and *Genetta*. He pointed out, however, that a new generic term must be introduced for the African Civet (*V. civetta*) which differs from the Oriental species (*V. zibetha*), the type of the genus *Viverra*, in the presence of a

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

small metatarsal pad, the absence of skin-lobes protecting the claws on the fore-feet, the nakedness of the area of the feet round the plantar pad, the structure of the perfume-gland, etc.

Miss MARY L. HETT, B.Sc., F.Z.S., gave an account of some new Pentastomids obtained from the lungs of snakes which had died in the Society's Gardens.

There is great difficulty in establishing diagnostic characters for the separation of species in the Pentastomids. Size and number of annulations have generally been used as standards of comparison and they hold good in a certain number of cases; but in many forms both these characters are so variable as to afford no sound basis for classification. This is illustrated by *Porocephalus bifurcatus* and three allied forms which are here described as varieties. They were all obtained from the lungs of snakes from different regions. An average specimen of each form differs from the other varieties in length and number of rings, but intermediate forms occur which almost bridge the gap between them in both particulars.

Hence it is difficult to regard them as separate species. If, however, the differences should prove to be of specific value, the four species, together with one other, should certainly be united in a new genus, as they differ from all other Pentastomids and resemble one another in several important particulars, notably in the possession of an anterior female genital aperture.

The following reports on the collections made by the British Ornithologists' Union Expedition and the Wollaston Expedition in Dutch New Guinea were read, and Mr. W. R. OGILVIE-GRANT gave a short account of the expeditions and the results obtained:—

Coleoptera. By G. J. ARROW, G. A. K. MARSHALL, F.Z.S., and C. J. GAHAN.

Diptera. By F. W. EDWARDS, B.A., F.E.S., and E. E. AUSTEN, F.Z.S.

Odonata. By HERBERT CAMPION.

Vermes. By Dr. L. COGNETTI DE MARTIIS.

These reports will be published in the 'Transactions.'

Mr. G. ARNOLD, M.Sc., A.R.C.S., and Dr. C. L. BOULENGER, M.A., F.Z.S., contributed a paper containing an account of the freshwater Medusa recently discovered by one of the authors in the Limpopo River system. This jelly-fish is referred to the same species (*Limnocnida rhodesiæ* Boulenger) as the form described from a tributary of the Zambesi River in 1912. Species of *Limnocnida* are now known to occur in the five principal river systems of Africa as well as in the Bombay Presidency of India.

The paper contains descriptions of the structure and habits of the jelly-fish, and attention is called to the occurrence of parasitic Infusorians of the genus *Trichodina* on both the African species, *L. tanganicæ* and *L. rhodesiæ*.

Mr. F. F. Laidlaw, M.A., F.Z.S., presented a paper on Bornean Dragonflies collected by Mr. J. C. Moulton on Mount Kina Balu, in which he described two new genera and seven new species.

The next Meeting of the Society for Scientific Business will be held on Tuesday, March 23rd, 1915, at half-past Five o'clock p.m., when the following communications will be made:—

W. R. Ogilvie-Grant, F.Z.S.

Exhibition of Partridges and other Game Birds.

F. E. Beddard, M.A., D.Sc., F.R.S., F.Z.S.

Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—XVI. On Certain Points in the Anatomy of the Genus *Amabilia* and of *Dasyurotænia*.

R. Lydekker, F.R.S., F.Z.S.

The True Coracoid.

J. T. Cunningham, M.A., F.Z.S.

The Artificial Formation from Paraffin-Wax of Structures resembling Molluscan Shells.

Bruce F. Cummings.

On Two new Species of *Polyplax* (Anoplura) from Egypt.

The following papers have been received:—

G. E. Nicholls, D.Sc., F.L.S.

A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia.

R. Broom, M.D., D.Sc., C.M.Z.S.

1. On some new Carnivorous Therapsids in the Collection of the British Museum.

2. On the Organ of Jacobson and its Relations in the "Insectivora."

E. Heron-Allen, F.L.S., F.R.M.S., F.Z.S., and Arthur Earland, F.R.M.S.

The Foraminifera of the Kerimba Archipelago (Portuguese East Africa).—Part II.

G. A. Boulenger, F.R.S., F.Z.S.

A List of the Snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
March 16*th*, 1915.

PAPERS.

LIST OF PLATES.

1915, Part I. (pp. 1–156).

NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1915, p. . . . The Distribution is as follows:—

Part I. issued in March.
" II. " June.
" III. " September.
" IV. " December.

'Proceedings,' 1914, Part IV. (pp 945–1077), were published on December 18th, 1914.

The Abstracts of the 'Proceedings,' Nos. 139–141, are contained in this Part.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1915.

PART II.

CONTAINING PAGES 157 TO 298, WITH 2 PLATES,
47 TEXT-FIGURES, TITLEPAGE, INDEX, ETC.

JUNE 1915.

PRINTED FOR THE SOCIETY,
SOLD AT ITS HOUSE IN REGENT'S PARK.

LONDON:
MESSRS. LONGMANS, GREEN, AND CO.,
PATERNOSTER ROW.

[*Price Twelve Shillings.*]

LIST OF CONTENTS.

1915, Part II. (pp. 157–298).

EXHIBITIONS AND NOTICES.

Contents continued on page 3 of Wrapper.

ZOOLOGICAL SOCIETY OF LONDON.

This Society was founded in 1826 by Sir Stamford Raffles, Mr. J. Sabine, Mr. N. A. Vigors, and other eminent Naturalists, for the advancement of Zoology and Animal Physiology, and for the introduction of new and curious subjects of the Animal Kingdom, and was incorporated by Royal Charter in 1829.

The Society consists of Fellows, and Honorary, Foreign, and Corresponding Members, elected according to the By-Laws. It carries out the objects of its foundation by means of its collection of living animals, by its Library, and by its Scientific Publications.

The Office of the Society, Regent's Park, N.W., where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at One p.m.

The Library, under the superintendence of Mr. Henry G. J. Peavot, is open daily (except Sunday) from Ten a.m. till Five p.m.; on Saturdays, Ten a.m. till Two p.m.

The Library is closed from Good Friday to Easter Monday, and upon all other Bank Holidays. It is also closed annually for cleaning purposes during the whole month of September.

The Meetings of the Society for General Business are held in the Meeting Room at the Society's Office on the third Wednesday in every month of the year, except in September and October, at half-past Four o'clock p.m.

The Meetings for Scientific Business are held in the Meeting Room at the Society's Office fortnightly on Tuesdays, except in July, August, September, and December and January, at half-past Five o'clock p.m.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four p.m.

The Society's Gardens are open daily from Nine o'clock until Sunset. Mr. R. I. Pocock, F.R.S., F.L.S., is the resident Superintendent and Curator of Mammals, Mr. D. Seth-Smith is Curator of Birds and Inspector of Works, Mr. E. G. Boulenger is Curator of Reptiles, and Prof. H. M. Lefroy is Curator of Insects. The Prosectorium for Anatomical and Pathological work is under the charge of Mr. Frank E. Beddard, M.A., D.Sc., F.R.S., Prosector, assisted by Mr. H. G. Plimmer, F.R.S., M.R.C.S., Pathologist to the Society.

TERMS FOR THE ADMISSION OF FELLOWS.

Fellows pay an Admission Fee of £5, and an Annual Contribution of £3, due on the 1st. of January, and payable in advance, or a Composition of £45 in lieu thereof; the whole payment, including the Admission Fee, being £50.

No person can become a Fellow until the Admission Fee and first Annual Subscription have been paid, or the annual payments have been compounded for.

Fellows elected in November and December are not liable for the Subscription for the year in which they are elected.

PRIVILEGES OF FELLOWS.

Fellows have Personal Admission to the Gardens upon signing their names in the book at the entrance gate, and may introduce Two Companions daily.

The Wife or Husband of a Fellow can exercise these privileges in the absence of the Fellow.

Until further notice, Fellows will receive 40 undated Green Cards, available on any Sunday or week-day up to the end of February of the year following the year of issue, and 20 White Cards available on any week-day up to the same date. Twenty of the Green Cards may be exchanged for a book containing two Orders for each Sunday in the year. Twenty White Cards may be exchanged for a book of dated Saturday Orders, each Order available for any day except Sunday in the week ending with the Saturday for which it is dated. Special children's tickets will no longer be issued, but the Green and White Cards will be perforated, and each half will be valid for a Child under twelve years of age. It is particularly requested that Fellows *will sign every ticket* before it goes out of their possession. Unsigned tickets are not available.

Fellows are not allowed to pass in friends on their written order or on presentation of their visiting cards.

Fellows have the privilege of receiving the Society's ordinary Publications issued during the year upon payment of an additional Subscription of One Guinea. This Subscription is due upon the 1st. of January, and must be paid before the day of the Anniversary Meeting, after which the privilege lapses. Fellows are likewise entitled to purchase these Publications at 25 per cent. less than the price charged to the public. A further reduction of 25 per cent. is also made upon all purchases of Publications issued prior to 1881, if above the value of Five Pounds.

Fellows also have the privilege of subscribing to the Annual Volume of 'The Zoological Record,' which gives a list of the Works and Publications relating to Zoology in each year, for the sum of One Pound Ten Shillings. Separate divisions of volumes 39 to 42 can also be supplied. Full particulars of these publications can be had on application to the Secretary.

Fellows may obtain a Transferable Ivory Ticket admitting two persons, available throughout the whole period of Fellowship, on payment of Ten Pounds in one sum. A second similar ticket may be obtained on payment of a further sum of Twenty Pounds.

Any Fellow who intends to be absent from the United Kingdom during the space of at least one year, may, upon giving to the Secretary notice in *writing*, have his or her name placed upon the "dormant list," and will then be called upon to pay an annual subscription of £1 only during such absence, but after three years must make a further application to be retained on that list.

Any Fellow, having paid all fees due to the Society, is at liberty to withdraw his or her name upon giving notice in *writing* to the Secretary.

Ladies or Gentlemen wishing to become Fellows of the Society are requested to communicate with "The Secretary."

P. CHALMERS MITCHELL,
Secretary.

Regent's Park, London, N.W.
June, 1915.

MEETINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON

FOR

SCIENTIFIC BUSINESS.

1915.

Tuesday, June ....
,, October ...... 26.
,, November .... 9 and 23.

The Chair will be taken at half-past Five o'clock precisely.

ZOOLGOICAL SOCIETY OF LONDON.

THE ZOOLOGICAL RECORD.

THE ZOOLOGICAL RECORD gives, by means of an annual Volume, complete lists of the Works and Publications relating to Zoology that have appeared during the year preceding the issue of the Volume, together with a Subject and a Systematic Index.

Since 1906 the ZOOLOGICAL RECORD has been amalgamated with the Zoology volume of the International Catalogue of Scientific Literature, and has appeared in two forms, different only in title-page and binding, one in series with the Zoological Record, the other forming Volume N, Zoology, of the Annual Issue of the International Catalogue.

On account of difficulties arising from the War, the Executive Committee of the International Catalogue is at present unable to undertake the issue of any volumes of the 14th Annual Issue. The Zoological Society of London, in these special circumstances, has undertaken to produce the Zoological Record as usual, precisely in accordance with the form that the volume has assumed since the amalgamation.

Fellows of the Zoological Society, and Institutions already on its subscription-list, and any new subscribers whose subscriptions are received before August 1st, 1915, will receive the volume dealing with the literature for 1914 (Zoological Record, Vol. 51: International Catalogue, 14th Annual Issue, N, Zoology) as usual at the end of the year.

Subscribers to the International Catalogue, who wish to assist the Zoological Society in this heavy burden, and to obtain the volume as soon as it is ready, may do so by sending 30*s.* to the Secretary of the Zoological Society, on or before August 1st 1915. In the event of the International Catalogue being issued as a whole for the 14th issue, later on, the sum of 30*s.* paid in advance to the Zoological Society will be deducted from the £17 due in the ordinary way for the complete issue.

The Society is able to supply complete sets of the Record on the following terms:—

Vols. 1 to 42, price £16 10*s.* net.   Vol. 43 and onwards at 40*s.* each.

The prices for *separate* volumes are as follows:—

Vols. 1 to 42 (except Vols. 4 and 6 which are sold with sets only), 10*s.* each.

Vols. 43 to 50 (obtainable separately only from Messrs. Harrison & Sons), 40*s.* each.

Vol. 51. 40*s.* each.

Index Zoologicus. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the 'Zoological Record,' 1880–1900; together with other names not included in the 'Nomenclator Zoologicus' of S. H. Scudder. Compiled (for the Zoological Society of London) by CHARLES OWEN WATERHOUSE and edited by DAVID SHARP, Editor of the 'Zoological Record.' London, 1902. Price to Fellows, 18*s.*; price to the public, 20*s.*, or if sold with a set of the 'Zoological Record,' 10*s.*

[P. T. O.

Index Zoologicus, No. II. An alphabetical list of names of genera and subgenera proposed for use in Zoology, as recorded in the 'Zoological Record,' Vols. 38–47 inclusive (1901–1910), and the Zoology volumes of the 'International Catalogue of Scientific Literature,' Annual Issues 1–10. Compiled (for the Zoological Society of London) by CHARLES OWEN WATERHOUSE, I.S.O., and edited by DAVID SHARP, M.A., F.R.S., [illegible] of the 'Zoological Record.' London, 1912. Price to Fellows, [illegible]2*s.* 6*d.* net; price to the public, 15*s.* net., or if sold with a set of the 'Zoological Record,' 10*s.*

SEPARATE DIVISIONS OF THE ZOOLOGICAL RECORD.

Divisions of Vols. 39 to 42 and Vol. 51 of the 'Zoological Record' can be supplied by the Society, but those of Vols. 43 to 50 can be had only from Messrs. Harrison & Sons, 46 St. Martin's Lane, W.C.

	s.	*d.*	
List of abbreviations of journals, etc.	2	0	net.
Special Records, viz.:—			
I. General Subjects	2	6	,,
II. Mammalia	2	6	,,
III. Aves	6	0	,,
IV. Reptilia and Batrachia	2	6	,,
V. Pisces	2	6	,,
VI. Tunicata	1	0	,,
VII. Mollusca	4	0	,,
VIII. Brachiopoda	1	0	,,
IX. Bryozoa	1	0	,,
X. Crustacea	2	6	,,
XI. Arachnida	2	0	,,
XII. Myriopoda	1	6	,,
XIII. Insecta	12	0	,,
XIV. Echinoderma	3	6	,,
XV. Vermes	3	0	,,
XVI. Cœlenterata	1	6	,,
XVII. Spongiæ	2	0	,,
XVIII. Protozoa	2	0	,,
Index of new names of genera and subgenera	2	0	,,

P. CHALMERS MITCHELL,
Secretary.

REGENT'S PARK, LONDON, N.W.
June, 1915.

ZOOLOGICAL SOCIETY OF LONDON.

LIST OF PUBLICATIONS.

THE scientific publications of the Zoological Society of London are of two kinds—"Proceedings," published in an octavo form, and "Transactions," in quarto.

According to the present arrangements, the "Proceedings" contain not only notices of all business transacted at the scientific meetings, but also all the papers read at such meetings and recommended to be published in the "Proceedings" by the Committee of Publication. A large number of coloured plates and engravings are issued in the volumes of the "Proceedings," to illustrate the new or otherwise remarkable species of animals described therein. Amongst such illustrations, figures of the new or rare species acquired in a living state for the Society's Gardens are often given.

The "Proceedings" for each year are issued in four parts, paged consecutively, during the months of March, June, September, and December. From January 1901 they have been issued as two half-yearly volumes, indexed separately.

An "Abstract of the Proceedings" is published by the Society on the Tuesday following the date of the Scientific Meeting to which it refers. It is issued along with the "Proceedings," free of extra charge, to all Fellows who subscribe to the Publications, but it may be obtained on the day of publication at the price of Sixpence, or, if desired, sent post free for the sum of Six Shillings per annum, payable in advance.

The "Transactions" contain such of the communications made to the Scientific Meetings of the Society as, on account of the nature of the plates required to illustrate them, are better adapted for publication in the quarto form. They are issued at irregular intervals.

Fellows and Corresponding Members, upon payment of a Subscription of One Guinea *before* the day of the Anniversary Meeting, are entitled to receive the Society's Publications for the year. They are likewise entitled to purchase the Publications of the Society at 25 per cent. less than the price charged to the Public. A further reduction of 25 per cent. is made upon purchases of Publications issued prior to 1881, if they exceed the value of Five Pounds.

Fellows also have the privilege of subscribing to the Zoological Record for a sum of One Pound Ten Shillings (which includes cost of delivery), payable on the 1st. of July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st. of December following.

The following is a complete list of the publications of the Society already issued.

TRANSACTIONS OF THE ZOOLOGICAL SOCIETY OF LONDON.

4to. 19 vols. and Index.

		Price to Fellows.		Price to the Public.
Vols. I.–IV. (out of print).				
Vol. V., containing 67 Plates ..	(1862–66)	5 4 3	....	6 19 0
„ VI., „ 92 „ ..	(1866–69)	11 5 0	....	15 0 0
„ VII., „ 73 „ ..	(1869–72)	10 4 0	....	13 12 0
„ VIII., „ 82 „ ..	(1872–74)	9 8 3	....	12 11 0
„ IX., „ 99 „ ..	(1875–77)	12 1 6	....	16 2 0
„ X., „ 95 „ ..	(1877–79)	10 0 3	....	13 7 0
Index, Vols. I.–X.	(1833–79)	0 7 6	....	0 10 0
Vol. XI., containing 97 Plates ..	(1880–85)	9 12 0	....	12 16 0
„ XII., „ 65 „ ..	(1886–90)	5 8 0	....	7 4 0
„ XIII., „ 62 „ ..	(1891–95)	6 8 3	....	8 11 0
„ XIV., „ 47 „ ..	(1896–98)	5 5 0	....	7 0 0
„ XV., „ 52 „ ..	(1898–1901) ..	5 15 6	....	7 14 0
„ XVI., „ 38 „ ..	(1901–1903) ..	5 8 0	....	7 4 0
„ XVII., „ 41 „ ..	(1903–1906) ..	5 18 6	....	7 18 0
„ XVIII., „ 43 „ ..	(1907–1911) ..	4 1 0	....	5 8 0
„ XIX., „ 24 „ ..	(1909–1910) ..	10 4 0	....	13 12 0
„ XX.—Part 1. (Pls. I.–V.) ..	(Feb. 1912) ..	0 18 0	....	1 4 0
„ 2. (Pls. VI.–XV.)	(April 1912) ..	2 5 0	....	3 0 0
„ 3. (Pls. XVI–XXIII.)	(Feb. 1913).	1 2 6	....	1 10 0
„ 4. (Pls. XXIV.–XXVI.)	(„).	9 0	....	12 0
„ 5. (Pls. XXVII.–XXX.)	(March 1914)	9 0	....	12 0
„ 6. (Pl. XXXI.)	(March 1914) ..	3 9	....	5 0
„ 7. (Pls. XXXII., XXXIII.)	(May 1914)	7 6	...	10 0
„ 8.	(May 1914)	2 3	....	3 0
„ 9.	(May 1914)	2 3	....	3 0
„ 10.	(June 1914)	2 3	....	3 0
„ 11. (Pl. XXXIV.)	(Nov. 1914) ..	7 6	....	10 0
„ 12. (Pls. XXXV.–XXXVII.)	(Nov. 1914)	9 0	....	12 0
„ 13. (Pl. XXXVIII.)	(June 1915) .	9 0	....	12 0

In consequence of a re-arrangement of the stock of the 'Transactions,' the Society is now able to offer for sale, at the reduced price of £30, sets of Vols. V.–XVI. inclusive, and separate papers, of which a list can be supplied, at about one-fourth their published price.

PROCEEDINGS OF THE COMMITTEE OF SCIENCE AND CORRESPONDENCE OF THE ZOOLOGICAL SOCIETY OF LONDON.

8vo. 2 vols. (Letterpress only).

	Price to Fellows.		Price to the Public.
Part I. 1830–31. 1 vol. 8vo., out of print.			
„ II. 1832. „	4*s.* 6*d.*	....	6*s.*

PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON.

FIRST SERIES.

Parts I.–XV. (1833–1847). 8vo. 15 vols. (Letterpress only.) Price to Fellows: 4*s.* 6*d.* each part; to the Public, 6*s.*

Index 1830–1847. Price to Fellows: 4*s.* 6*d.*; to the Public, 6*s.*

Parts I., VII.–IX., XI., XIV., XV., out of print.

SECOND SERIES.

Parts XVI.–XXVIII. (1848–1860). 8vo. 13 vols. (Letterpress only.) Price to Fellows: 4*s.* 6*d.* each part; to the Public, 6*s.*

Index 1848–1860. Price to Fellows: 4*s.* 6*d.*; to the Public, 6*s.*

The Parts of this series containing Coloured Plates are out of print.

PROCEEDINGS OF THE SCIENTIFIC MEETINGS OF THE ZOOLOGICAL SOCIETY OF LONDON. 8vo. 40 vols. and 4 Indices.

	Letterpress only.		With Plates uncoloured.		With Plates coloured.	
	Price to Fellows.	Price to the Public.	Price to Fellows.	Price to the Public.	Price to Fellows.	Price to the Public.
1861	4*s.* 6*d.*	6*s.*	9*s.*	12*s.*	33*s.* 9*d.*	45*s.*†
1862	4*s.* 6*d.*	6*s.*	9*s.*	12*s.*	33*s.* 9*d.*	45*s.*
1863	4*s.* 6*d.*	6*s.*	9*s.*	12*s.*	33*s.* 9*d.*	45*s.*†
1864	4*s.* 6*d.*	6*s.**	9*s.*	12*s.*†	33*s.* 9*d.*	45*s.**
1865	4*s.* 6*d.*	6*s.*†	9*s.*	12*s.*	33*s.* 9*d.*	45*s.*
1866	4*s.* 6*d.*	6*s.*†	9*s.*	12*s.*†	33*s.* 9*d.*	45*s.*
1867			9*s.*	12*s.**	33*s.* 9*d.*	45*s.*
1868			9*s.*	12*s.*	33*s.* 9*d.*	45*s.*
1869			9*s.*	12*s.*	33*s.* 9*d.*	45*s.*
1870			9*s.*	12*s.*	33*s.* 9*d.*	45*s.*
Index, 1861–1870			4*s.* 6*d.*	6*s.*		
1871			9*s.*	12*s.**	33*s.* 9*d.*	45*s.*
1872			9*s.*	12*s.**	33*s.* 9*d.*	45*s.*†
1873			9*s.*	12*s.*	33*s.* 9*d.*	45*s.*
1874			9*s.*	12*s.*†	36*s.*	48*s.*†
1875			9*s.*	12*s.*	36*s.*	48*s.*
1876			9*s.*	12*s.*	36*s.*	48*s.*†
1877			9*s.*	12*s.*	36*s.*	48*s.*
1878			9*s.*	12*s.*	36*s.*	48*s.*
1879			9*s.*	12*s.*	36*s.*	48*s.*
1880			9*s.*	12*s.*	36*s.*	48*s.*
Index, 1871–1880			4*s.* 6*d.*	6*s.*		
1881–1890. Ten volumes			Each		36*s.*	48*s.*
Index, 1881–1890			4*s.* 6*d.*	6*s.*		
1891–1900. Ten volumes			Each		36*s.*	48*s.*
Index, 1891–1900			4*s.* 6*d.*	6*s.*		

* No perfect copies in stock. † Out of print.

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

8vo. 29 vols. and Index.

	Price to Fellows.	Price to the Public.
1901–1910. Twenty volumes	Each 18s.	24s.
Index, 1901–1910	4s. 6d.	6s.
1911, vol. I.	18s.	24s.
" " II.	18s.	24s.
1912, " I.	18s.	24s.
" " II.	18s.	24s.
1913, " I.	18s.	24s.
" " II.	18s.	24s.
1914, " I.	18s.	24s.
" " II.	18s.	24s.
1915, " I.	18s.	24s.

LISTS OF THE ANIMALS IN THE SOCIETY'S GARDENS

List of the Vertebrated Animals now or lately Living in the Gardens of the Zoological Society of London. (Eighth Edition.) 8vo. 1883. Cloth, 4s. 6d.

List of the Vertebrated Animals now or lately Living in the Gardens of the Zoological Society of London. (Ninth Edition.) 8vo. 1896. Cloth, 6s.

CATALOGUE OF THE LIBRARY of the Zoological Society of London (Fifth Edition.) 8vo. 1902. Cloth, 6s.

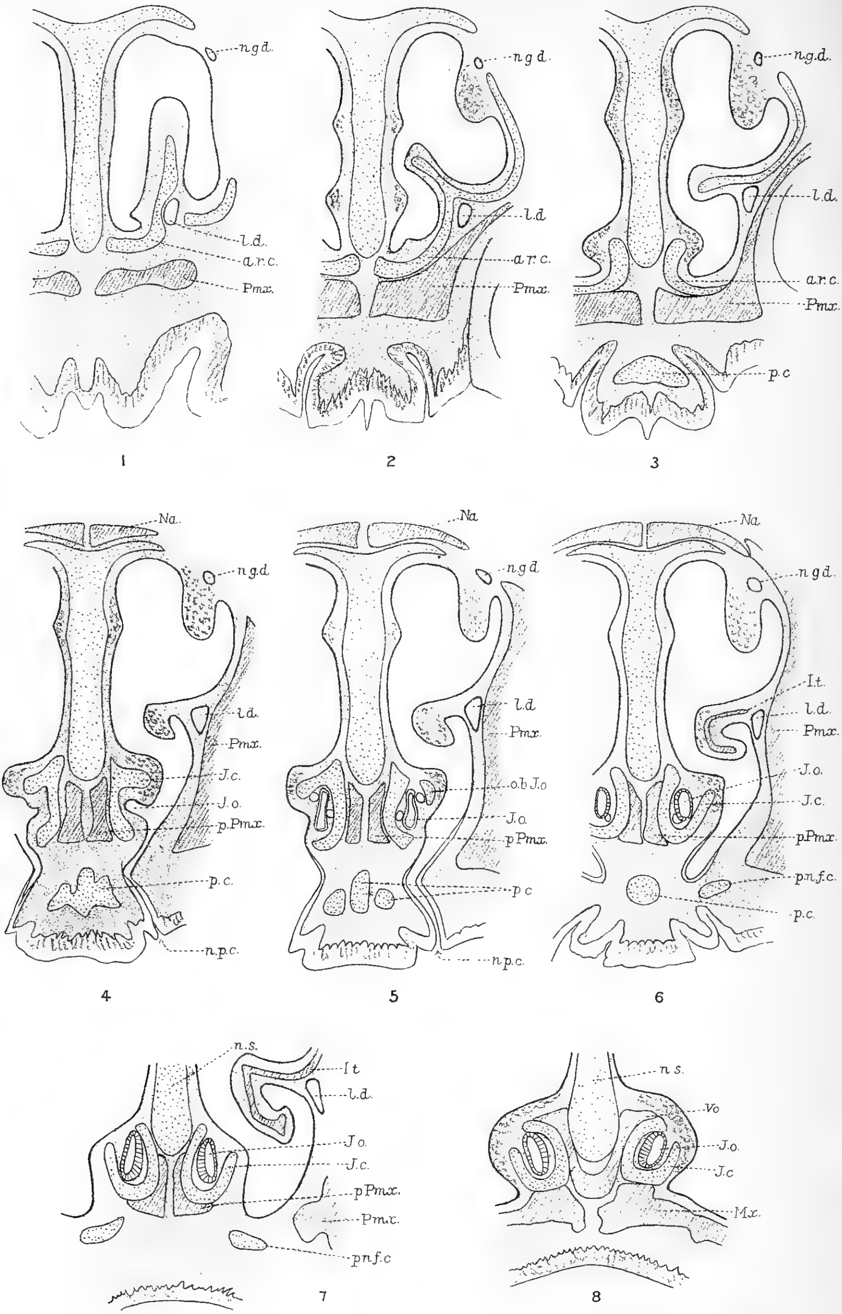
THE OFFICIAL ILLUSTRATED GARDEN GUIDE—12th Edition—with (1) a Railway and Street Map, showing a direct route to the "Zoo" from all parts of London and the Suburbs; (2) a Plan of the Grounds, showing at a glance the location of the animals; (3) a short description of some of the principal animals in the Collection (now containing over 3000 specimens), together with 50 Photographic Illustrations and Index. Price 6d. in Stiff Paper Cover, postage $1\frac{1}{2}d.$, or in Green Cloth Cover price 1s. 2d. post free.

THE HOUSE-FLY CAMPAIGN. An illustrated pamphlet by Prof. H. Maxwell Lefroy, M.A., F.Z.S.
8vo. 1915. Price 2d. (By post $2\frac{1}{2}d.$)

P. CHALMERS MITCHELL,
Secretary.

Regent's Park, London, N.W.
June, 1915.

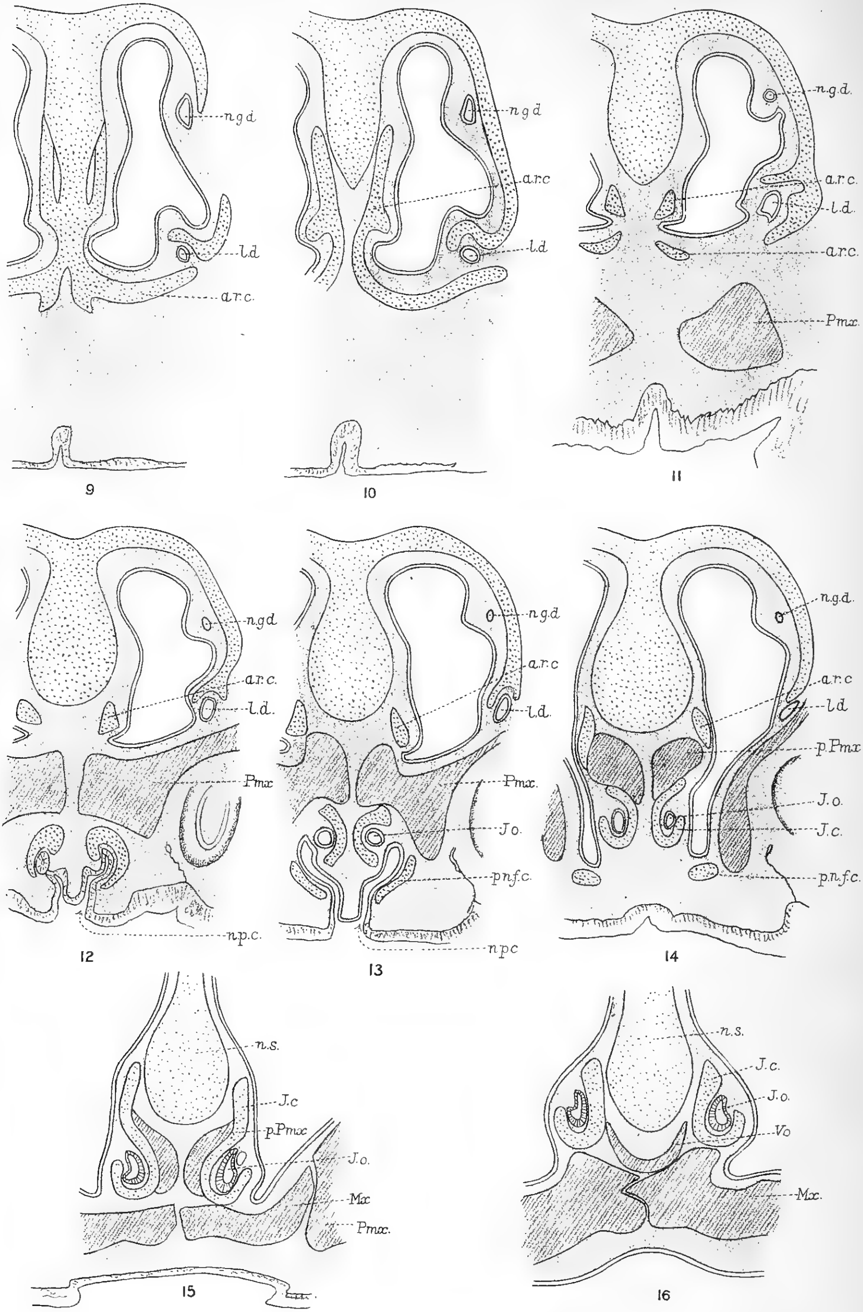
These publications may be obtained at the Society's Office *or through any bookseller.*



R.B.del.

Cambridge University Press.

JACOBSON'S ORGAN IN TUPAIA.



R.B. del.

Cambridge University Press.

JACOBSON'S ORGAN IN GYMNURA.

PAPERS.

13. On the Organ of Jacobson and its Relations in the "Insectivora."—Part I. *Tupaia* and *Gymnura*. By R. Broom, D.Sc., M.D., C.M.Z.S.

[Received March 9, 1915: Read April 13, 1915.]

(Plates I. & II.*)

Index.

In 1897, in "A Contribution to the Comparative Anatomy of the Mammalian Organ of Jacobson," published in the Trans. Roy. Soc. Edin., I called attention to the very great value of a study of the morphology of the cartilages connected with Jacobson's organ as a guide to the affinities of aberrant mammals. Changes in habit bring about most marked alterations in teeth, bones, and many viscera, but the delicate little cartilages in the nose are so little affected that we find almost exactly the same type of structure in forms so dissimilar as the sheep, cat, hedgehog, bat, and lemur. And as the arrangement is an extremely complicated one, we seem justified in concluding that the similarity indicates affinity and common origin of those types rather than independent developments of this remarkable structure.

So far as at present known there are only two main types of the organ of Jacobson and its relations found in mammals: (1) the primitive or Marsupial type, which is a simplification of the type found in the Monotremes, and which is retained with slight modifications in such forms as *Dasypus*, *Orycteropus*, and the Rodents; and (2) the higher Eutherian type found in Ungulates, Carnivores, *Erinaceus*, the bat *Miniopterus*, *Lemur*, and *Procavia*.

In 1902 I examined the organ in *Macroscelides*, hoping, in view of Parker's discovery of marsupial characters in the skulls of the allied *Petrodromus* and *Rhynchocyon*, that I might find some type intermediate between that of the Marsupial and that of *Erinaceus*. To my great surprise I found that in its relations the organ in *Macroscelides* has no resemblance whatever to that of the typical Insectivore, but agrees in practically every detail with the type seen in the marsupial *Perameles*.

In my paper "On the Organ of Jacobson in the Elephant Shrew (*Macroscelides proboscideus*)" which appeared in the Proc. Zool. Soc. 1902, vol. i. p. 224, I came to the conclusion that, "from the fact that *Macroscelides* agrees with the Marsupials in every detail of the anatomy of this region, we are forced to the conclusion that it is a very near relative of the Marsupials,

* For explanation of the Plates see p. 162.

and has probably very little affinity with the more typical Insectivores."

When my paper was written I was in the Karroo, far from any libraries, and I was not aware that in 1864 Peters had divided the Insectivora into two groups: (A) those with an intestine with a large cæcum, including "Galeopitheci," "Tupayæ," and "Macroscelides"; and (B) those with intestine simple, without cæcum, including "Centetinæ," "Erinacei," "Talpina," and "Sorices."

Haeckel in 1866 definitely divided the Insectivora into two suborders: (1) Menotyphla, including the families Cladobatida, with *Cladobates* and *Tupaja*, and Macroscelidia, with *Macroscelides* and *Rhynchocyon*; and (2) Lipotyphla, including the families Soricida, Talpida, Erinaceidea, and Centetida.

Though most later workers have regarded the Insectivora as a single natural group, Leche (1884) has suggested separating the Menotyphla as a distinct order, and Gregory, in his recently published work on 'The Orders of Mammals' (1910), places the typical Insectivora in the Superorder Therictoidea, and the Menotyphla as an order of the Superorder Archonta, together with Dermoptera, Chiroptera, and Primates.

For some time I have been most anxious to examine the organ in *Tupaia* to see how far it agreed with *Macroscelides*, and fortunately I was able to obtain from the American Museum a very good specimen, preserved in formalin, of a young *Tupaia*, and for comparison a young specimen of *Gymnura*. Both specimens had been obtained in Borneo by Mr. C. W. Beebe. Prof. J. P. Hill's laboratory assistant, Mr. F. Pittock, has kindly sectioned for me by microtome the *Gymnura* snout, but owing to the extreme hardening of the *Tupaia* specimen the snout had to be cut by hand. Both specimens show all the desired characters satisfactorily.

The Organ of Jacobson in Tupaia.
(Plate I.)

The nose in *Tupaia*, unlike that of *Macroscelides*, does not extend very much in front of the premaxillary bone, and the nostrils are nearly terminal, but look more outwards than forwards.

A section passing through the nostril shows the nasal cartilages forming a median septum with a well-developed alinasal cartilage above and a small cartilaginous extension forming the nasal floor. A few sections further back, the anterior part of the inferior turbinal is seen in section, attached to the upper part of the nasal wall, and showing the opening of the naso-lacrimal duct on its side. Immediately behind the nostril the inferior turbinal is seen rising vertically from the nasal floor. The nasal-floor cartilage is still attached to the base of the septum but is small, and there is no cartilage in the external wall of the nasal passage.

Pl. I. fig. 1 shows a transverse section passing through the front of the premaxillary bone. Here the nasal-floor cartilage is seen detached from the septum, and forms not only the floor but the support for the inferior turbinal. The anterior part of the outer cartilaginous wall is also seen cut across.

Fig. 2 cuts through the first incisor and the anterior part of the papilla of the palate. The nasal-floor cartilage is seen connected with the cartilage of the lateral wall and forming the cartilaginous support of the inferior turbinal. The great size of the papilla is well seen. The appearance of the structures in this section resembles considerably a similar section through the snout of *Didelphys*, and also somewhat a similar section through the snout of *Dasypus*.

Fig. 3 represents a section nearly 1 mm. behind that represented in fig. 2. The papilla is seen occupied by a large papillary cartilage. The recurrent nasal-floor cartilage has the inner portion enlarged where it is about to become Jacobson's cartilage. The inferior turbinal is further up on the lateral nasal wall. This section resembles a corresponding section through the snouts of any of the Polyprotodont marsupials. In the structure of the nasal cartilages the resemblance is rather with *Dasyurus* and *Didelphys*; in the great development of the papilla and its cartilage the resemblance is more with *Perameles*.

Figs. 4–6 represent three sections close to each other, and only a short distance behind that shown in fig. 3. They illustrate the relations of the naso-palatine canal, and the opening of the organ of Jacobson into the nasal cavity. The peculiar structure which I have elsewhere called the outer bar of Jacobson's cartilage is well seen. In fig. 4 it is attached to the upper part of Jacobson's cartilage. In fig. 5 it is free, and in fig. 6 attached to the lower portion of Jacobson's cartilage. The structures in these sections are typically Polyprotodont marsupial and resemble those of *Perameles* as much as those of *Perameles* do those of *Dasyurus* or *Didelphys*, and considerably more than do those of any known Diprotodont marsupial.

The outer bar of Jacobson's cartilage is believed to represent the remains of the turbinal of Jacobson's organ in the Monotremata. It is present in all marsupials, in *Dasypus*, *Orycteropus*, *Macroscelides*, and some Rodents, but is unknown in any of the higher mammals.

Fig. 7 represents a section considerably further back than that shown in fig. 6. Here Jacobson's organ is seen well developed, with a single blood-vessel on its outer side and another on its inner, exactly as in *Perameles* and *Didelphys*. Jacobson's cartilage has the usual shape, and is supported internally and below by the palatine process of the premaxillary. Along the floor of the nasal cavity is a distinct posterior nasal-floor cartilage. This is the only structure in the snout that is not typically Polyprotodont marsupial. As the structure is well developed in *Echidna*, it is manifest that in this respect *Tupaia*, which retains it, is more primitive than the Polyprotodont marsupials which have lost it. It is very well developed in the Rodent, *Lepus*. In *Macroscelides* it is only slightly developed in the young specimens which I examined, but may be better developed in the adult.

Fig. 8 shows a section near the posterior end of the organ. The organ is still seen to be of large size, lying in the U-shaped cartilage which it nearly fills. Jacobson's cartilage rests on the palatine plate of the maxillary, and is supported internally and superiorly by the vomer.

If the figures here given of sections of the snout of *Tupaia* be compared with those I have given of sections of *Macroscelides*, it will be seen that the two are formed on exactly the same type, and that the differences are not greater than are seen in the different families of the Diprotodont marsupials or of the Artiodactyles. Both genera agree closely with the Polyprotodont marsupials, and, as will be seen from the study of the snout of *Gymnura*, differ in almost every feature from that typical Insectivore.

The Organ of Jacobson in Gymnura.
(Plate II.)

The specimen which I have examined is a very young animal, probably recently born and about one fourth adult size. From the snout to the base of the tail measures 90 mm. Except for a few small vibrissæ on the snout it is entirely hairless.

The nostrils are nearly terminal, but open laterally, and are completely protected in front by the front of the nasal cartilage.

A section through the middle of the nostril shows a narrow septum, with above a well-developed alinasal and below a large anterior nasal-floor cartilage. The anterior end of the inferior turbinal is cut across supported by a cartilage which is connected with the outer edge of the alinasal.

A section through the posterior border of the nostril shows the anterior nasal-floor cartilage as an outer part forming the floor of the nostril and an inner narrow piece attached to the base of the septum. The turbinal is large and has a large cartilage attached to the alinasal. The lacrimal duct is seen opening on the inner side of the turbinal.

A section a short distance behind the nostril is remarkable for the rather abrupt thickening of the nasal septum and the great reduction of the inferior turbinal. The anterior nasal-floor cartilage is still attached to the base of the septum. The alinasal cartilage does not pass down on the outer wall of the nasal passage, and the cartilage, which in more anterior sections protected this wall, is reduced to a small trough of cartilage along the furrow between the small turbinal and the other nasal wall.

A few sections further back a most remarkable condition presents itself, as is shown in Pl. II. fig. 9. The broad nasal septum splits up into a median part and two lateral splints.

These lateral recurrent cartilages are structurally continuous with the base of the nasal septum and with the anterior nasal-floor cartilages. The other parts of the section are as in that previously described, except that the alinasal is curving down to form the outer nasal wall.

On passing backwards the nasal septum is found to become completely detached from the anterior nasal-floor cartilages and from the recurrent flaps which remain united to form a pair of large recurrent cartilages. This condition is seen in fig. 10. The alinasal curves round to form a complete outer nasal wall.

Fig. 11, though representing a section only a very short distance behind that of fig. 10, shows the pair of large recurrent cartilages reduced to two pairs of very small structures. As will be seen in the later sections, the upper cartilage is continued backwards to form the upper part of Jacobson's cartilage. The lower cartilage, which lies in the nasal floor, ends abruptly. The section passes through the anterior part of the premaxillary.

Fig. 12, a short distance behind the section represented in fig. 11, shows a section through the anterior part of the papilla. The upper part of the section is fairly similar to that of the previous section figured, but below the premaxillary is seen the mode of opening of the naso-palatine ducts by the sides of the small papilla. Each duct is supported by a scroll of cartilage completely round it except at the opening, and a few sections further forward show that the cartilage also protects the duct in front.

On passing backwards the cartilaginous scroll becomes divided into an upper and inner, and a lower and outer part. The former becomes the lower part of Jacobson's cartilage; the latter the posterior nasal-floor cartilage. In the section represented by fig. 13 the anterior end of Jacobson's organ is seen opening into the naso-palatine duct.

Fig. 14 represents a section a short distance further back. The palatine process of the premaxilla is seen detached. Above it lies the upper part of Jacobson's cartilage. The lower part of Jacobson's cartilage has the typical U-shaped appearance on section. There is still seen a small posterior nasal-floor cartilage.

Fig. 15 represents a section behind the anterior palatine foramen. The palatine processes of the premaxillæ give support to the cartilages of Jacobson. The organ is here well developed, and the cartilage has the form seen in most higher mammals. The nasal-floor cartilage is no longer present, the floor being supported by the secondary palatal plates of the maxillary.

Fig. 16 represents a section far behind that represented by figure 15 and near the posterior end of the organ. The organ is still fairly large and the cartilage still of the typical shape. The palatine processes do not extend so far back, and the cartilages are now in part supported by the vomer and in part by the maxillaries.

If the sections of the snout in *Gymnura* be compared with those in *Tupaia*, it will be seen that the two differ so greatly in type that it is a little difficult to homologise some of the structures. While *Tupaia* agrees closely with the Marsupial type, *Gymnura* agrees equally well with the type found in most Eutherians. In my paper of 1897 I suggested the division of the Eutherians into two superorders—the Cœnorhinata to include those orders with the higher type of nose structure, and the Archæorhinata for those with the primitive type.

In the Cœnorhinata I placed the Carnivora, Insectivora, Artiodactyla, Perissodactyla, Chiroptera, Primates, with probably the Sirenia and Cetacea. We now know that the Hyracoidea also belong to this superorder. In the Archæorhinata were placed the Edentata and Rodentia.

Gymnura has the structures connected with Jacobson's organ almost exactly as in *Erinaceus*, as we should have expected, and very similar to those in *Felis*.

Tupaia and *Macroscelides* have the nasal structures formed, as in the Polyprotodont marsupials, on an entirely different type, and there can be no doubt whatever that they have no near relations with such types as *Erinaceus* and *Gymnura* and must be removed from them and placed in a distinct order, Menotyphla.

In Part II., which will deal with the structures in *Centetes*, *Chrysochloris*, and *Talpa*, will be discussed at greater length the relationships of the different groups.

EXPLANATION OF THE PLATES.

Lettering.

a.r.c., anterior recurrent cartilage; *I.t.*, inferior turbinal; *J.c.*, Jacobson's cartilage; *J.o.* Jacobson's organ; *l.d.*, lacrymal duct; *Mx.*, maxilla; *Na.*, nasal; *n.g.d.*, nasal-gland duct; *n.p.c.*, naso-palatine canal; *n.s.*, nasal septum; *o.b.J.o.*, outer bar of Jacobson's organ; *p.c.*, papillary cartilage; *Pmx.*, premaxilla; *p.n.f.c.*, posterior nasal-floor cartilage; *p.Pmx.*, palatine process of premaxillary; *Vo.*, vomer.

Plate I.

Fig. 1. Section through snout of *Tupaia* sp. across anterior part of premaxilla.
Figs. 2–6. Sections across the snout of *Tupaia* sp., through different regions of the palatine papilla.
Fig. 7. Section through the organ of Jacobson in *Tupaia* sp. a short distance behind the papilla.
Fig. 8. Section through the organ of Jacobson in *Tupaia* sp. towards the posterior part of the organ.

Plate II.

Figs. 9 & 10. Sections across the nose of *Gymnura* a short distance in front of the premaxilla.
Fig. 11. Section across the snout of *Gymnura* in the region of the anterior part of the premaxilla.
Figs. 12 & 13. Sections across the snout of *Gymnura* in the region of the palatine papilla.
Fig. 14. Section across the snout of *Gymnura* immediately behind the papilla.
Fig. 15. Section across the organ of Jacobson in *Gymnura* behind the anterior palatine foramen.
Fig. 16. Section across the posterior part of the organ of Jacobson in *Gymnura*.

All figures are 12 times enlarged.

14. On some new Carnivorous Therapsids in the Collection of the British Museum. By R. Broom, D.Sc., M.D., C.M.Z.S.

[Received January 27, 1915: Read April 13, 1915.]

(Text-figures 1–8.)

Index.

At the suggestion of Dr. C. W. Andrews I recently examined all the specimens of carnivorous Therapsid reptiles in the British Museum, and was fortunate in finding a considerable number of new types sufficiently well preserved to be worthy of description.

Simorhinella baini, gen. et sp. n. (Text-fig. 1.)

This new genus and species is founded on a small specimen obtained by Mr. T. Bain in the Gouph, S. Africa, and procured by the British Museum in 1878. From the nature of the matrix I think it probable that it is from the *Pareiasaurus* zone, but it may possibly be from the *Endothiodon* zone.

Text-figure 1.

Simorhinella baini.

A. Upper view of snout, nat. size. B. Side view of snout, nat. size.
B.M. 49422.

The specimen consists of the anterior half of the skull of a small carnivorous Therapsid, much weathered, and with the bones crackled after the manner of a septarian nodule. It is practically impossible to make out the limits of the various cranial elements, but the general structure can readily be seen.

The type is specially remarkable for the shortness and breadth of the snout and for the small size of the teeth.

The length from the front of the orbit to the premaxilla as preserved is 21 mm., and though the internasal process is lost, when allowance is made for the crushing, the original length was probably not more than 22 mm. The width of the snout at the plane of the front of the orbit is 28 mm.

The premaxillaries are small, and each has four small rounded incisors.

The septomaxillary is of the typical Therocephalian and Gorgonopsian type, a rounded foramen being found between it and the maxilla.

The nasals are large and fairly broad.

The frontals are moderately large, the interorbital measurement being 14·5 mm. as preserved. Originally the measurement was probably a little less.

The maxilla is well developed and largely overlaps the premaxilla in front. It carries two canines and probably three molars.

The mandible is not well preserved. The symphysis is broad and probably deep. There are apparently three incisors, one canine, and three molars.

The four upper incisors measure about 8 mm. The diastema between i^4 and c^1 is 3 mm. The two canines measure 3·5 mm., the larger c^2 being only 1·8 mm.

The lower incisors measure about 8 mm. The canine has a diameter of about 1·6 mm., and the three lower molars measure 4·5 mm. From i^3 to the back of m^3 is 9 mm.

If the above determinations are correct the dental formula would be $i\,\frac{4}{3},\ c\,\frac{2}{1},\ m\,\frac{3}{3}$.

The nearest affinities of *Simorhinella* are probably with *Ictidognathus* and *Scaloposaurus*, and with the next described form *Icticephalus*.

The type is a young animal in which there is clear evidence of dental succession.

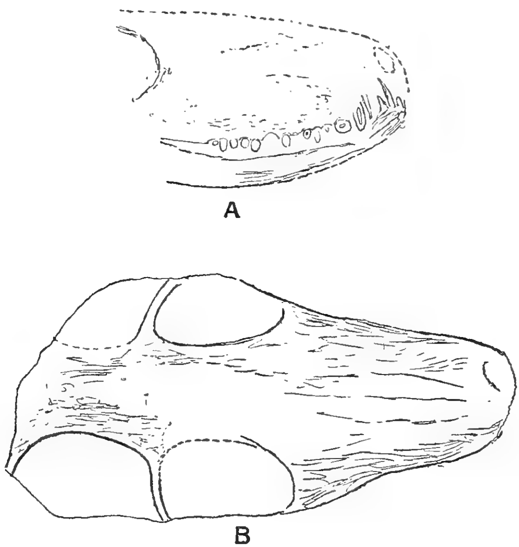
The specimen is registered No. 49422.

Icticephalus polycynodon, gen. et sp. n. (Text-fig. 2.)

This new genus and species is represented by one specimen in the British Museum, and one in the South African Museum, Capetown. The British Museum specimen is a fairly complete but very badly weathered skull: the Capetown specimen is the front half of the skull, also much weathered, but showing most of the maxillary teeth in fairly good condition. While I do not consider that there is the least doubt but that the two specimens belong to the same species, as the Capetown specimen has the teeth so much better preserved it will be better to regard it as the holotype, and the British Museum specimen as a paratype.

The British Museum specimen shows the skull to be at least 68 mm. in length. When complete it probably measured 75 mm. The greatest breadth was probably about 40 mm. The orbit looks upwards and outwards, and measures about 18 mm. in diameter. From the front of the orbit to the front of the snout is about 33 mm. The interorbital measurement is 18 mm., and the intertemporal about 8 mm. There is no pineal foramen. The postorbital arch is delicate but complete.

Text-figure 2.



Icticephalus polycynodon.

A. Side view of type in S. Afr. Mus. Coll. B. Upper view of skull in B.M. Coll. which forms a paratype. B.M. R. 4096. Both nat. size.

The upper incisors are lost from the Capetown specimen, but remains of most are seen in the British Museum specimen. There are apparently six, and together they measure 8 mm. Behind i^6 there is a diastema of 1·5 mm. There are three small canines. The first is less than 1 mm. in diameter, the other two have each an antero-posterior length of about 2 mm., and the third, nearly perfect on the left side, has a height of about 7 mm. The three canines together measure 6 mm. The first molar is less than 1 mm. behind the last canine. There are altogether eleven small, pointed, rounded, and unserrated molars, of which the 5th, 6th, and 7th are larger than the others. The whole series measures 16 mm.

The nearest ally of this type is *Scaloposaurus*. From this genus it differs in having 11 molars instead of 9, and in having the postorbital arches completely formed.

The British Museum specimen is registered R. 4096.

CERDODON TENUIDENS, gen. et sp. n. (Text-fig. 3.)

This new genus and species is founded on a specimen collected by Mr. T. Bain in the Gouph, S. Africa, in 1878. It consists of the greater part of the somewhat crushed and imperfect skull of a small Therocephalian. The specimen is in a hard nodule, and only the left side has been displayed. The front of the snout is for the most part weathered away, and the supra- and post-orbital portions of the skull are either hidden in the nodule or possibly missing. Still, the whole of the left maxilla and most of the left jugal are fairly well preserved, and most of the left dentary and a considerable part of the left angular.

From the front of the orbit to the front of the maxilla is 39 mm., and the measurement to the front of the snout was probably about 47 mm.

Text-figure 3.

Cerdodon tenuidens.

Side view of skull as preserved. Nat. size. B.M. 49420.
Ju. Jugal; *L.* Lacrymal; *Mx.* Maxilla.

The front of the snout is too imperfect to show the number of incisors. There probably were five. Those remaining are slender, pointed teeth. The canine is relatively small, measuring 4·5 mm. in length and about 12 mm. in height. The molars are not well preserved, but they are evidently numerous—possibly seven or eight. Two of these in the upper jaw are each over 2 mm. in diameter; but what are probably the posterior three in the lower jaw are small, and together occupy a space of only 4·5 mm.

The lower jaw is slender, with a low symphysis. There appear to be three incisors occupying a space of 6·5 mm. In the specimen it looks as if there were four incisors, but the front one is probably the first incisor of the right jaw. The canine is unusually small. The total length from the first incisor to the last molar is 30 mm.

The nearest ally to *Cerdodon tenuidens* is *Ictidosuchus primævus*, described by me fourteen years ago. I think there is little doubt but that the two belong to the same family of Therocephalians—the Ictidosuchidæ.

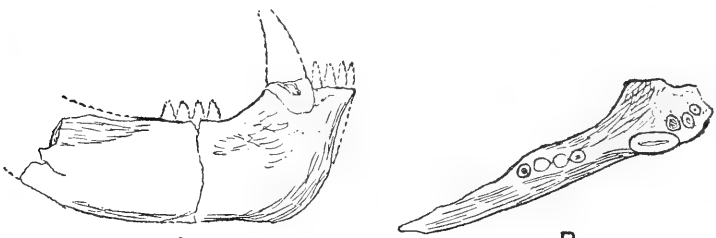
The British Museum Register number of the specimen is 49420.

Cyniscodon lydekkeri, gen. et sp. n. (Text-fig. 4.)

This new genus and species is founded on an imperfect right dentary discovered by Mr. T. Bain at "Palmietfontein, Cape Colony." There are many Palmietfonteins in the Karroo, but it is probable that the specimen is from the Palmietfontein in the Beaufort West district, and in the *Pareiasaurus* zone.

Associated with the jaw is much of the skeleton of a small *Dicynodon*. There is a large part of the skull, including most of the occiput, much of the left squamosal and most of the left orbital region, and much of one mandible. There are a series of vertebræ, the right scapula, parts of the sacrum, and much of the right side of the pelvis.

Text-figure 4.



A B

Cyniscodon lydekkeri.

A. Side view of right dentary. B. Upper view of right dentary. Both nat. size. B.M. 49409.

The specimens were examined by Lydekker and described by him in the British Museum Catalogue of Fossil Reptiles, vol. iv. p. 72, all the specimens being supposed to belong to one individual. The dentary with teeth is in the same matrix, and was probably picked up near the small *Dicynodon* skeleton, such an association of bones being by no means uncommon in the Karroo.

The dentary was thought by Lydekker to belong possibly to *Cynosuchus suppostus* Owen, to which it unquestionably has much superficial resemblance. As, however, it has a different dental formula and must be placed in a distinct genus, I have much pleasure in proposing for it the name *Cyniscodon lydekkeri*.

Cynosuchus suppostus, with which this new form has been confused, is known only by the imperfect type skull. It is a most remarkable form, having cusped molars and a secondary palate like the typical Cynodonts, but in other respects differing from all known Cynodonts and resembling more the Gorgonopsians. The dental formula is probably $i\,\frac{4}{3}$, $c\,\frac{1}{1}$, $m\,\frac{7}{7}$, and to whatever suborder a more complete skull may show it to belong, it must be placed in a distinct family—the Cynosuchidæ.

In *Cyniscodon lydekkeri* the dentary is considerably smaller than in *Cynosuchus suppostus*. It has the deep symphysis characteristic of the Gorgonopsians. In the specimen as preserved are the roots of three incisors which are probably i^2, i^3, and i^4. Together they measure 5 mm. The whole four probably measured 7 mm. The canine measures at its base 6 mm. × 3·2 mm. Behind the canine is a diastema of 7 mm., followed by four molars which together measure 9 mm. They are small and rounded, and about equal in size.

Cyniscodon in the general structure of the jaw resembles most the small Gorgonopsians such as *Ælurosaurus*, but differs from them in having a loose symphysis, and in being smaller than any of the known Gorgonopsians.

The specimens described by Lydekker have the Register number 49404, but as this is now seen to include two different animals the number 49404 will be retained for the type of *Cyniscodon lydekkeri*, and the small *Dicynodon* skeleton will be numbered 49404 *a*.

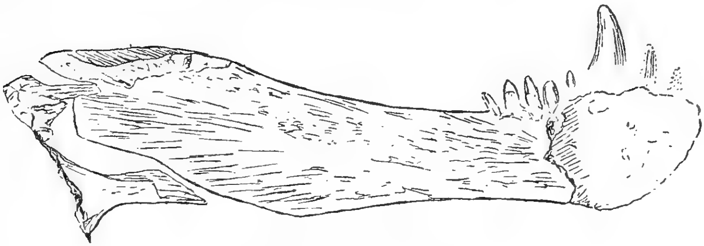
CERDOGNATHUS GREYI, gen. et sp. n. (Text-fig. 5.)

The type of this new genus and species is an imperfect lower jaw obtained by Sir G. Grey at Klippoort, in the Cradock district. The left dentary is nearly complete, and there is a fragment of the surangular and of the angular. The front portion of the dentary is represented only by an imperfect impression.

The contour of the jaw is unlike that of any previously described form. There were probably four incisors, of which there are preserved only the obscure impressions of two. There is a single moderately large canine and five molars. The molars are small and uncusped. The whole dentary is unusually straight, there being no great deepening of the symphysis, and the coronoid process does not rise greatly from the line of the horizontal ramus. From the symphysis to the point where the dentary meets the upper border of the surangular, the measurement is probably about 105 mm., and the depth at the last molar about 15 mm. From the upper side of the surangular to the notch in front of the descending wing of the angular the measurement is 23 mm.

The length of the canine is probably about 7·5 mm., and the height 13 mm. There is only a very short diastema of 1 mm. between *c* and m^1. The five molars measure 14 mm.

Text-figure 5.



Cerdognathus greyi.

Inner view of left mandible as preserved. Slightly reduced.
B.M. R. 2892.

The specimen is probably a Gorgonopsian, but differs from all known forms in having the first molar close to the canine and in the relatively shallow symphysis.

The specimen is registered No. R. 2892.

SCYMNOSAURUS WATSONI, sp. n. (Text-fig. 6.)

This new species is founded on a large skull discovered by Mr. T. Bain on the farm Uitkyk, in the Gouph.

Mr. D. M. S. Watson has recently published a restoration of the palate (P. Z. S. 1914, p. 1035), and has doubtfully referred the specimen to *Lycosuchus vanderrieti.* The skull has been considerably further developed by the British Museum preparator Mr. Hall, and it becomes quite manifest that it cannot belong to the genus *Lycosuchus.* Unfortunately the front part of the snout is missing, so that nothing is known of the incisors, but a large part of each canine is preserved and sufficient of the molars to indicate their number. Except for the missing premaxillary region, the skull shows all the main points of structure.

The principal characteristics of the skull are the great size of the temporal fossæ, the narrowness of the snout, and the presence of a narrow high parietal crest.

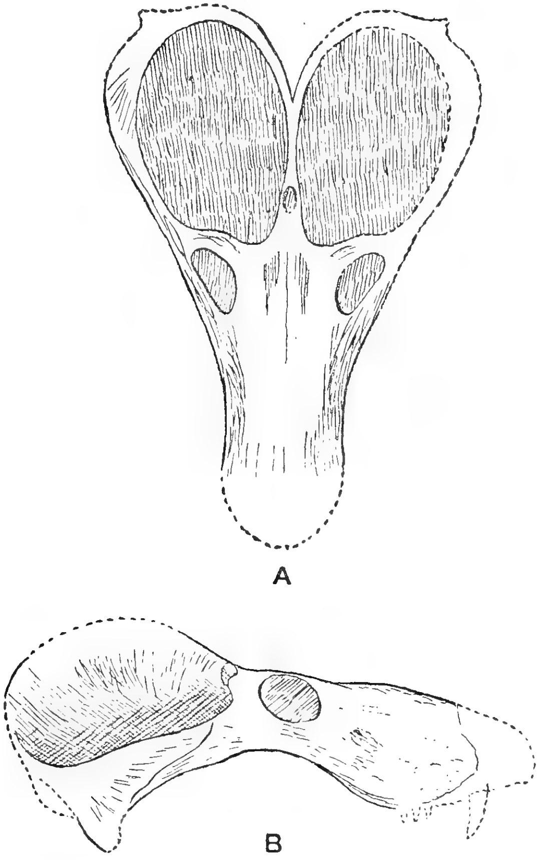
The following are the chief measurements:—

Greatest length of the skull .... (probably)	290 mm.
Greatest width	208
Front of temporal fossa to back of squamosal	128
Interorbital width	50
Back of canine to back of m^3 .... (probably)	32
Length occupied by the three molars	22

There are three small molars which have their crowns much flattened, and are probably serrated both in front and behind—

certainly in front. The palate, as shown by Watson, is of the Therocephalian type seen in *Scylacosaurus*, there being a pair of prevomers and large suborbital vacuities.

Text-figure 6.



Scymnosaurus watsoni.

A. Upper view of skull. B. Side view of skull. $\frac{1}{4}$ nat. size.
B.M. R. 4100.

It is difficult to make out the sutures in the preorbital region. In front of the orbit there is a marked depression. The postorbital bone forms a distinct crest along part of the anterior temporal border, but only passes a very short distance back on the parietal crest.

The parietal forms a deep and high narrow crest which extends back a considerable distance behind the pineal foramen, and then divides into a pair of crests which curve round behind the large temporal fossæ to meet the squamosals.

The squamosal is a large bone which forms much of the posterior surface of the skull. It passes well downwards, and covers most of the relatively small quadrate. Internally it meets the parietal above, and is closely articulated to the tabulare.

The tabulare is a moderate-sized element, but its lower and outer portions are not preserved. It articulates with the parietal above and the interparietal internally, and overlaps the squamosal externally.

The interparietal is a small median element.

As Watson has already described the palate, it will be unnecessary to say anything further about it.

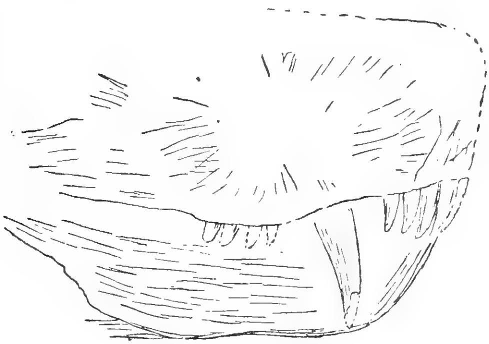
The genus *Scymnosaurus* was founded on a large snout in the South African Museum which was made the type of *S. ferox*. Some years later, a much smaller snout from Natal was named *S. warreni*. In both these species the dental formula is i^5, c^1, m^3. In the new species the formula is i^3, c^1, m^3, and though in the absence of the snout of *S. watsoni*, and knowing little except the snouts of the others, there is doubt about all belonging to the same genus, it seems safest at present to refer the new species to *Scymnosaurus*, to which in any case it is certainly closely allied.

The type is numbered R. 4100 in the British Museum Register.

Scymnognathus parvus, sp. n. (Text-fig. 7.)

The type of this new species is a specimen found by Mr. D. M. S. Watson at Kuilspoort, Beaufort West district, and probably from the upper part of the *Endothiodon* zone.

Text-figure 7.



Scymnognathus parvus.

Side view of snout. ½ nat. size. B.M. R. 4139.

The specimen consists of the nearly complete skull of a small Gorgonopsian and a few associated fragments. The skull is much crushed obliquely and the occiput is further crushed forwards, so that though the jaws with most of the teeth are in fairly good condition, little of the structure of the upper part of the skull can be satisfactorily made out.

As the teeth agree in number and structure with those of *Scymnognathus whaitsi* and other known species, and so far as can be seen the skull of this new form does not differ greatly, I refer the new species to this genus and call it *S. parvus*.

The total length of the lower jaw is about 170 mm., and the skull probably measured 190 mm.

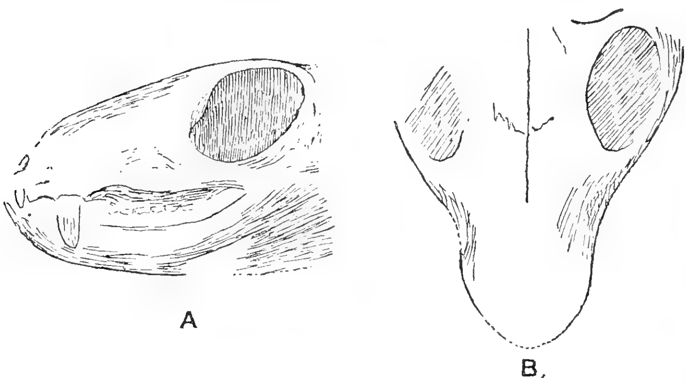
The five incisors measure 25 mm. Between i^5 and the canine is a diastema of 12 mm., and the canine measures 10 mm., followed by a diastema of 10 mm. The four molars measure 19 mm. In *S. minor*, the nearest allied species, the five incisors measure 33 mm., and the four molars 21 mm.

The specimen is numbered R. 4139 in the British Museum Register.

Triracнодон browni, sp. n. (Text-fig. 8.)

This new species is founded on the anterior two-thirds of a small skull discovered by Mr. Alfred Brown at Aliwal North. The skull is well preserved, but owing to the lower jaws being closely fixed to the upper, the crowns of all the molars are hidden.

Text-figure 8.



Trirachodon browni.

A. Side view of snout. B. Upper view of snout. Nat. size. B.M. R. 3307.

It is not improbable that when a specimen is discovered which shows the crowns of the molars, this species may have to be placed in a new genus, but as it is certainly a near ally of *Trirachodon* and possibly belongs to this genus, I have provisionally placed it so.

It certainly is a new species, and I have much pleasure in naming it after my old friend, Mr. Brown.

Only a very few of the sutures can be clearly made out, but so far as can be seen the structure of the skull is very similar to that of *Trirachodon kannemeyeri* Seeley.

The following are the principal measurements of the skull :—

Snout to front of orbit	27 mm.
Antero-posterior diameter of orbit	18
Interorbital measurement	16
Length of canine	4
Height of canine	10
Molar series (probably)	18

In *Trirachodon kannemeyeri* Seeley, the seven largest molars measure 21–22 mm. ; in *T. minor* Broom, they measure 18·5 mm. in *T. browni* they measure 14 mm.

The type skull is numbered R. 3307 in the B.M. Register.

15. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By Frank E. Beddard, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

[Received February 9, 1915: Read March 23, 1915.]

(Text-figures 1–8.)

XVI. On Certain Points in the Anatomy of the Genus *Amabilia* and of *Dasyurotænia*.

Index.

Although several observers, especially Cohn and Diamare (whose memoirs will be referred to later), have collected a large number of facts relating to the structure of the genus *Amabilia*, there still remain a few points upon which these authorities have not definitely pronounced, or concerning which their opinions differ. It is with these that I deal in the present communication to the Society. My notes are based upon numerous sections taken through different regions of the body of one example of the species (the only species) *Amabilia lamelligera*, which I was able to preserve in a satisfactory condition for microscopic purposes.

§ *Scolex.*

Concerning the *scolex* of *Amabilia lamelligera* some differences of opinion have been expressed in published accounts. These have been dealt with by Dr. Ludwig Cohn up to the period at which his own memoir on the species appeared *. The original describer of the species, Sir R. Owen, defined it † (*inter alia*) as "capite subgloboso, rostello cylindrico obtuso," as duly quoted by Cohn. Owen's paper, however, contains no further description of the scolex; nor is it represented in his figures of the worm ‡. The figure, however, illustrating the worm represents it as tapering gradually at the head end; the scolex therefore was doubtless quite visible—which was not the case with the specimen studied by myself until it was examined by sections.

von Linstow's § description of the worm is, according to Cohn, not of *Amabilia* at all, but of *Hymenolepis megalorchis*, known to be a parasite of the Flamingo. The first part of this statement seems to be undoubtedly correct; the rest is certainly probable.

* Zeitschr. f. wiss. Zool. lxvii. 1900, pp. 255, 256.
† Trans. Zool. Soc. vol. i. p. 386.
‡ Plate xli. figs. 21 & 22.
§ Würt. naturwiss. Jahrb. xxxv. 1879.

More recently* v. Linstow has described under the name of *Aphanobothrium catenata*, a worm which is really *Amabilia lamelligera*, as Fuhrmann was able to state † from an examination of the original material. It is clear from the figures and description given by v. Linstow, that the scolex of the individual represented by him was in the same retracted condition that it presented in my example. It is stated by this author that the "scolex [is] not visible externally," and that there are four suckers and a median fifth sucker which "opens outwards through a dorso-ventral slit." Hooks are stated to be absent. In spite of the correct description of four suckers and a median sucker (which is of course the retracted rostellum), this author states that the worm is "destitute of scolex"!

Diamare, the founder of the genus, in a communication ‡ dealing with *Amabilia*, published subsequently to Cohn's memoir, gave no further information about the scolex; in the earlier description § his examples had been stated to lack a scolex. There is thus no information ‖ about the scolex of *Amabilia* other than that contained in the memoirs of Cohn and v. Linstow. I find myself to be not absolutely in accord with either of those zoologists in every detail.

In my specimen the head (text-fig. 1) was so completely retracted as to have no external sign of its existence save a slit-like gap anteriorly. It was not until the head end of the Cestode had been investigated by horizontal sections that the scolex could be studied. The first remarkable fact about it is its very small size. It is hardly more than an eighth of a millimetre in breadth and is, as Owen said, of a subglobular shape. In view of the fact that the diameter of the widest segments is 8 or 9 millimetres, the minute size of the head is noteworthy. It can hardly form an effective anchor for the unwieldy body; and the condition of the rostellar armature, to which I shall refer immediately, bears out the same idea. While v. Linstow denies the existence of hooks, Cohn describes—not hooks it is true, but "Hakentaschen." It is on this authority, I imagine, that the genus *Amabilia* is defined by both Ransom and Fuhrmann as possessing an armed rostellum.

In my quite complete series of sections through the scolex, which was fully retracted, the outer sheath of the rostellum was composed of muscular fibres running in a direction transverse to the longitudinal axis of the rostellum. Between individual fibres were here and there spaces which seem to be the "Hakentaschen" of Cohn. Like Cohn, I could discover no evidence of hooks within these spaces, which certainly, as he says, must, if present, be

* Spolia Zeylanica, iii. 1906, p. 185.

† Zool. Jahrb. Suppl.-Bd. x. 1908, p. 88.

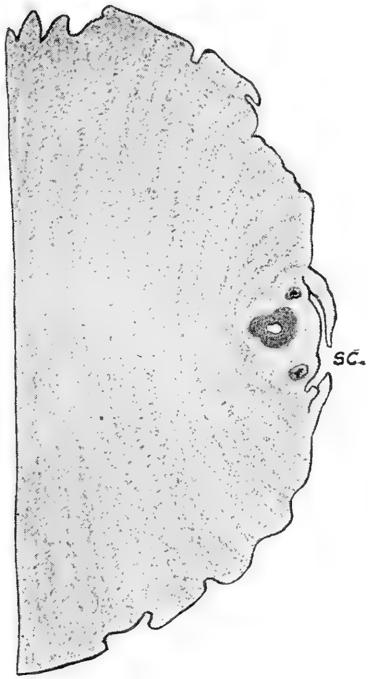
‡ CB. Bakt. u. Paras. xxvi. p. 780.

§ *Ibid.* xxi. p. 862.

‖ Assuming of course that *Tænia macrorhyncha* of Rudolphi (see Wedl, SB. Akad. Wien, xviii. 1856, p. 18) is not an *Amabilia* but, as generally held, a *Schistotænia*.

very small. I do not believe, however, that these spaces actually ever held hooks; their irregularity of form and size is against such a supposition. Nor is there so regular a ring or row of them as would suggest the implantation of hooks. Finally I have ascertained the presence of a chitinous structure which appears to me to represent the otherwise missing hooks, which, at any rate, is difficult to understand on any other hypothesis. This is shown in the accompanying figure (text-fig. 2). It will there be seen

Text-figure 1.



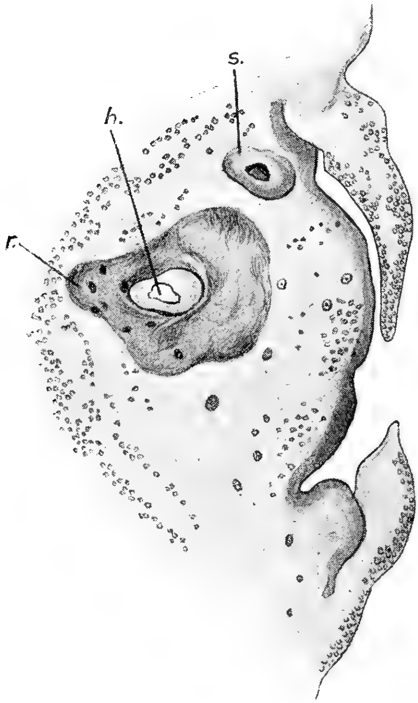
Horizontal section through anterior end of *Amabilia lamelligera*, to illustrate very small scolex, which is retracted.

sc. Scolex showing rostellum and two suckers.

that the interior part of the rostellum is occupied by a thick ring of apparently chitinous consistency. It is this part which would be external when the rostellum is fully protruded; and a circular ring suggests in this case a ring of hooks fused together. The armed suckers of the Davaineids present somewhat an approximation to this state of affairs. The minute hooks are so close that they give the collective appearance of a continuous chitinous ring; and it has, I believe, been described as such.

In the rostellum of *Amabilia*, however, there is no trace of any separate hooklets; the material of which the cup-like ring is formed is continuous throughout. I am inclined to believe that the shape of the entire ring is represented in the figure referred to. For it has the appearance of an unfractured body and there are no further traces in adjacent sections. It has, I think, been uncut by the razor and slightly displaced.

Text-figure 2.



More highly magnified view of horizontal section of *Amabilia*.

h. Chitinous ring, possibly representing a fused row or rows of hooks, lying within rostellum (*r.*). *s.* Sucker.

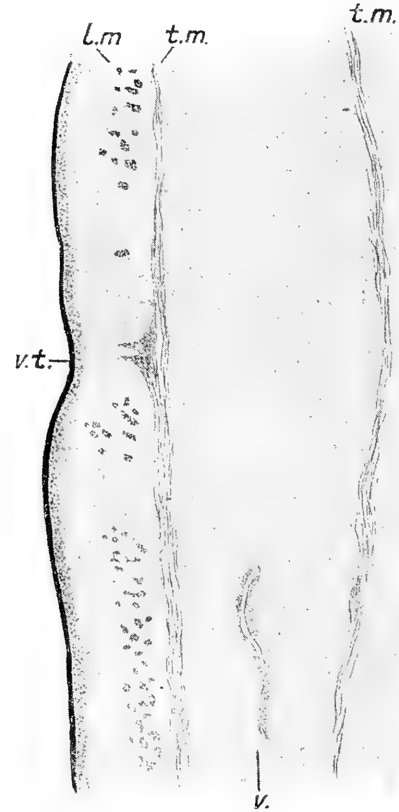
§ *Muscular Layers of Body.*

The longitudinal layers of the musculature are depicted by Cohn * as arranged in two series of bundles of fibres disposed with fair regularity, and as continuous right round the body. Here and there the row of longitudinal muscles consists of but a single

* *Loc. cit.* Taf. xiv. fig. 1.

bundle; in other places one might reckon three in a dorso-ventral row. So far as the more anterior proglottids are concerned, I agree on the whole with Cohn's representation of the facts. He is, I think, also correct in representing a rather thin cortical layer, which is exceeded in diameter by the

Text-figure 3.



Part of a transverse section through an anterior proglottid of *Amabilia*.

l.m. Longitudinal muscle-bundles not forming everywhere a continuous layer. *t.m.* Transverse muscles of dorsal and ventral sides of proglottid. *v.* Vagina. *v.t.* Near to dorsal opening of vertical tube of water-vascular system; the tube is shown and the superficial depression which bears the actual pore.

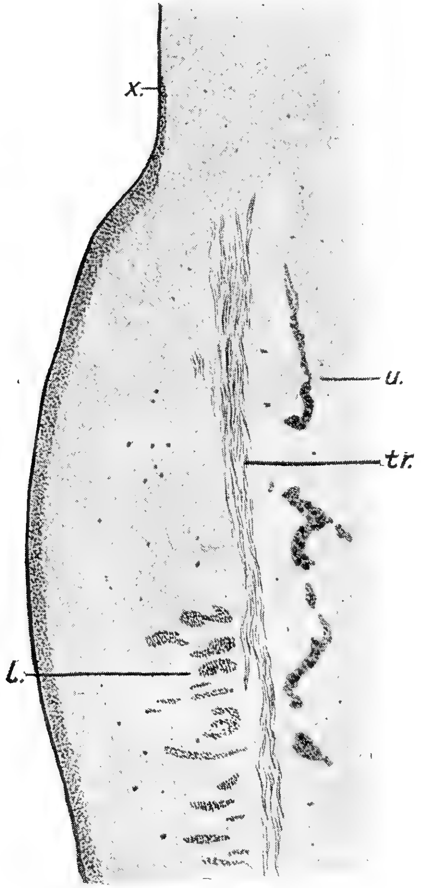
medullary portion. I find, however, that the regularity of the muscle-band is not absolute. In many sections (text-fig. 3) there are gaps or intervals where the muscle-bundles are absent; these are never large and, as a rule, the longitudinal muscular layer is continuous.

In the posterior and riper proglottids the muscular layers of the body differ from the same layers in the more anterior proglottids; and what is highly interesting to observe is the fact that the alterations in structure do not appear to be due to mere turgescence caused by the accumulation of ova in the uterus, but are a distinct modification associated with a ripe proglottid. The state of affairs in these proglottids is indeed comparable with the modification of generative segments in certain Annelids. One may frequently observe a degeneration of the muscular layers in ripe proglottids of tapeworms which seems to be a matter of pressure; but the anatomical features met with in *Amabilia* seem to me to belong to a different category. In transverse sections through such proglottids, it is to be noted that, though the uterus is well developed, it is not so huge as to occupy more space than is available in immature proglottids further forwards in the body. The network of tubes which constitute this organ are, in all the proglottids that I have studied, of quite small calibre, and though in places full of ova, are not over full, and indeed here and there empty; moreover, the eggs are not fully developed: the shell has not yet been formed. There is thus no tension at all, and no mechanical explanation to be advanced.

Moreover, the relative thickness of the medullary and cortical layers is not altered, as it would have to be under such circumstances. Instead of the cortical layer being thinned by expansive pressure from the medullary layer within, it is in places actually thicker in proportion, as may be seen by a comparison of text-figs. 3 & 4. It has in fact undergone an alteration which is quite the reverse of degeneration, though accompanied here and there by a disappearance of the bundles of longitudinal fibres, which may of course, in a sense, be termed degeneration. In addition to tracts from which the longitudinal muscle-bundles have disappeared, but—be it observed—without any thinning of the cortical layer as a whole, there are tracts where the cortical layer has undergone a remarkable reduction, and this reduction occurs rather suddenly as is shown in the accompanying figure (text-fig. 4).

Near the letter "*l*" in the figure the cortical layer is quite normal; the subcuticular layer, the bundles of longitudinal muscles, and the transverse muscular layer are all obvious and duly lettered in the figure. At a certain point there is a more or less sudden alteration in the cortical layer. The dorsoventral diameter is reduced to not more than one-quarter of its original diameter. The longitudinal muscles disappear a little before the cortical layer is more abruptly reduced, and at or about the same place the transverse muscular layer becomes slightly expanded and vanishes. The cortical layer is thus reduced to the subcuticular layer only. Later on, this layer itself apparently vanishes and the medullary layer appears to form the exterior of the body. I find, however, that the cortical layer is really continued on, at any rate for some way, as a fine nucleated lamella. Possibly this always covers the apparently naked medullary layer.

Text-figure 4.



Part of transverse section through a mature segment of *Amabilia*, to show changes in structure of cortex in these proglottids.

l. Longitudinal muscles suddenly ending. *tr.* Transverse muscles also suddenly disappearing before the point *x*, where cortex itself practically vanishes. *u.* Uterus.

On a hasty examination of such sections as are represented in text-fig. 4, it might be held perhaps that the absence of an obvious cortical layer was simply due to imperfect handling of the sections and tearing away of an outer layer. This, however, cannot be the case—for the reason that every section through one of these patches showed the same state of affairs, and for the additional reason that the gradual tapering away of the cortical layer is plain when followed by the microscope. It is not, however, easy to recognise everywhere in these bare patches the remnants of the cortical layer; this certainly may be a matter of inferior fixing of the material.

It is to be noted that in the ripe proglottids, where this remarkable condition of the cortical layer is effected, the patches may be both dorsal and ventral or dorsal or ventral; that is to say, both surfaces of the proglottid may be affected in the same region or only one. The space taken up by such a patch is very considerable, occupying the greater part of the segment in some cases. It accounts largely for the lack of intersegmental furrows remarked upon in this species by previous observers. The disposition of the cortical layer in the riper proglottids of *Amabilia* is very remarkable, and is not quite paralleled in any Cestode known to me.

In these mature proglottids the longitudinal layer, where fully developed, consists—as anteriorly—of two principal rows of bundles. That nearest to the transverse muscular layer is the largest, *i. e.*, each bundle is composed of a much larger number of fibres than the peripheral layer. There is, however, no great regularity in the arrangement of the bundles in two rows, nor in the form or size of the individual bundles. The transverse muscular layer is made up of about a dozen fibres in section, and is thus about as wide as a medium-sized bundle of the longitudinal layer. The two muscle-layers together are of about the same diameter as the cortical layer outside of the muscles.

The longitudinal muscular layer is continued into the lateral outgrowths of the proglottids. These appendages, so characteristic of the family Amabiliidæ, show in transverse section strands of muscle passing from side to side, which must permit of a considerable movement of the appendages. It may be that by these means the worm is permitted to fix itself to the wall of the intestine more securely, as well as to move from place to place; and their existence, as functional parapodia, may supplement the feeble scolex to which attention has been drawn.

§ *The Water-vascular System.*

Diamare, in his account of this genus, figures* the vertical canal with the internal water-vascular vessels opening into it, and rightly represents the place of opening as being near to the dorsal surface of the worm. He figures each of these as a single tube and describes them in the legend of the cut as "Can. deferens," and they are described in the text of the paper as the two vasa deferentia, and are represented in another figure † as

* Centralbl. f. Bakt. u. Paras. xxi. p. 869, fig. 8.
† *Ibid.* p. 864, figs. 3, 4.

communicating on each side with the cirrus-sac. This erroneous statement, however (made upon the examination of poor material), is corrected in accordance with the criticism of Cohn in a later note *.

A more correct account of the water-vascular system of *Amabilia* is given by Cohn in his memoir. This is also illustrated by three figures. In many respects I find myself in agreement with Cohn; but differ in some important respects. As he has stated, the dorsal vessel is of much less calibre than the ventral, a usual occurrence among the Cestodes; and between the two the cirrus-sac makes its way to the exterior. Thus the dorsal and ventral vessels are at opposite sides of the proglottid and are, in fact, respectively dorsal and ventral in position, as is also frequently, but by no means always, the case. The transverse vessel that is figured by Cohn is alleged by him to be a single vessel which on each side enters the vertical trunk (described originally, and correctly, by Diamare) near to the dorsal external pore of the latter. It bends upwards to reach this point on either side not far from its opening into the vertical tube. During the rest of the proglottid the transverse vessel is fairly median in position; it lies also near to the posterior boundary of the segment. There is not the least trace in Cohn's figure † of a double transverse vessel; nor does he describe such. But this tube is most obviously double.

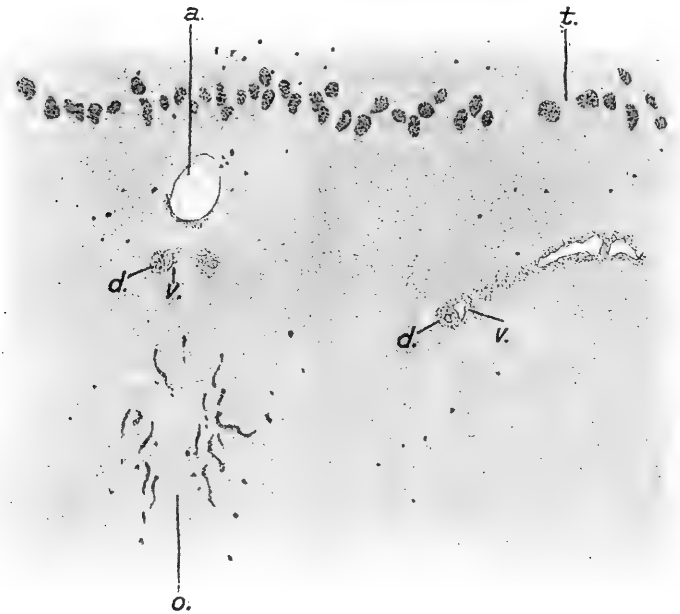
Cohn has described in the posterior region of each proglottid a union between the dorsal and ventral vessels; this "verbindende Kanal" is, he says, continued into the transverse vessel which ultimately opens into the vertical canal. My own preparations do not confirm this statement. There is certainly a communication between the dorsal and ventral lateral vessels where it is described by Cohn as occurring; but the larger ventral and the very much smaller dorsal vessels are in each case near the point of communication between them, continuous with a dorsally placed and narrower and a ventrally placed and wider transverse vessel. These lie (text-fig. 5) very close together and retain the same mutual position until they open into the vertical vessel. They do not, however, as would be inferred from Cohn's drawing ‡, enter this tube laterally, but on the posterior surface, as is indeed shown by Diamare, though, as I have already pointed out, he mistook at first the nature of the tubes in question. I should add that the dorsal and ventral separate moieties of the transverse vessel unite just before their opening into the vertical tube.

In their comprehensive works upon the genera of Tæniadæ, both Fuhrmann and Ransom accept with a query the statements of Cohn concerning the vertical tube. This doubt is, as I think, caused by the fact that Cohn in figuring that tube only indicates

* Centrabl. f. Bakt. u. Paras. xxv. p. 357.
† Zeitschr. f. wiss. Zool. Bd. lxvii. Taf. xiv. fig. 6.
‡ *Loc. cit.* Taf. xiv. fig. 6.

one orifice to the exterior, the dorsal. His statements in the text as to the double opening seem plain enough. I confirm these statements as to the presence of both a dorsal and ventral orifice of the vertical tube. Moreover, I may point out that there is no histological difference between the two. In both cases the actual orifice is small and guarded by an involution of the outer cellular layer of the body; it is obviously formed in fact by an involution from the exterior. The identity of structure shown by the two openings is a further proof of the truth of

Text-figure 5.

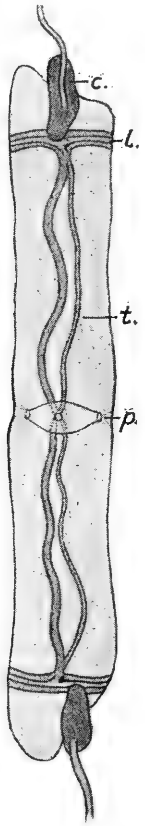


Part of a horizontal section through a proglottid of *Amabilia*.

a. Dorso-ventral tube of water-vascular system. *d.* & *v.* Dorsal and ventral transverse vessels. *o.* Ovary. *t.* Testes (forming in this particular proglottid a continuous band unbroken in the middle line).

the view that this tube is a part of the water-vascular system, and that its connection with the generative system is entirely secondary. It has, in fact, nothing to do with either a uterus or a vagina. Cohn has directed attention to the probability that this point of view is also supported by the fact that the vertical tube is fully developed in anterior segments where the generative system is either invisible, or if visible to be seen only in its earliest rudiments, as well as by the general structure of the walls of the tube, which is like that of the water-vascular vessels. I may add to these arguments the additional one that even in fully mature proglottids—proglottids at any rate in which the uterus is fully developed though not yet distended with ova—this vertical tube is of the same dimensions as in earlier segments. If a part of the generative system, some change would have been expected in this tube associated with the general maturity of the proglottid.

Text-figure 6.



Diagrammatic representation of water-vascular system of *Amabilia*, for purposes of comparison with a Ctenophore.

c. Cirrus-sacs (possibly comparable to tentacles of a Ctenophore). *l.* Lateral vessels. *t.* Transverse vessels. *p.* One of two pores of dorso-ventral tube.

I may finally point out in reference to the water-vascular system of *Amabilia*, but without going into further detail, the likeness shown by the vertical, radiating and lateral tubes to the canal-system of a Ctenophore, while recalling the views of Lang, Willey, and others as to the Ctenophoran affinities of the Platyhelminths; I illustrate this by the accompanying text-figure (text-fig. 6).

I have verified other facts in the anatomy of this genus which have been dealt with by Diamare and Cohn, but have not found it necessary to treat of them at length. Inasmuch as both Fuhrmann * and Ransom † query certain characters in their definitions of the genus *Amabilia*, I have thought it worth while to append a fuller definition, derived from my own first-hand knowledge of the Cestode, which is of course confirmatory in great part of Diamare and Cohn, but which contains some fresh characters described in the present paper. I do not distinguish between family and generic characters as I do not think that the systematic position of *Tatria* is yet fully settled. I am unable, of course, to differentiate between generic and specific definitions since but one species is known.

Genus **Amabilia** Diamare.

Scolex very small; rostellum armed with a chitinous ring; suckers four, unarmed. Proglottids with a lateral ridge on each side, not of great length, continuous dorsally and ventrally. Longitudinal muscle-layers disposed in two and occasionally three rows of bundles; modified in their arrangement in fully mature proglottids. Water-vascular system consists of a median stem opening by a pore both dorsally and ventrally, of two transverse vessels on each side connecting this with two lateral longitudinal vessels, one lying above the other; these communicate at the orifice of the transverse vessels; there is no network of small tubes. Testes one or two horizontal rows, four to six deep, disposed in two groups separated by ovary, rarely forming a continuous row. Cirrus-sac large and muscular, two in each proglottid, opening on each side of body between lateral water-vessels and dorsal to nerve-cord; cirrus armed with numerous spinules ‡. Vas deferens short, without coil, opening into an oval vesicula seminalis connected by a short duct with cirrus-sac. Ovary single, consisting of fine filamentous threads radiating out from base where oviduct arises. Vagina opens into an anteriorly placed diverticulum of vertical water-vascular tube. Uterus consists of a dorsal and a ventral network connected by vertical tubes. Ripe eggs long and spindle-shaped §.

* Zool. Jahrb. Suppl.-Bd. x. 1908, p. 88.

† Bull. U.S. Nat. Mus. No. 69, 1909, p. 103.

‡ When the cirrus-sac is protruded in ripe segments it is accompanied by the intervening cortical layer which forms a sheath.

§ *Fide* Lühe. I have not been able to observe ripe eggs.

§ *On the Uterus and Uterine Pore of* Dasyurotænia.

Three years ago I described to the Society the general anatomy of a new genus and species of Cestode from the Tasmanian Devil (*Dasyurus ursinus*), which I named *Dasyurotænia robusta* *. Since that date I have examined the intestines of several examples of the same Marsupial without finding any more examples of that worm until December of last year, when a specimen was found to contain a number of fragments of a worm which I believe to be of the same species. They were associated with a few examples of *Anoplotænia dasyuri*, which latter was also described by myself as a new genus and species in the year 1911 †. Since that date I have found *Anoplotænia dasyuri* to be a not uncommon parasite of the Dasyure, and to be present in the majority of the examples examined for parasites. But the two genera have only occurred together in the one specimen of the Dasyure referred to above. It may be useful to state certain particulars of the Dasyures examined with a view to gathering such facts as they reveal with regard to infection by these worms. Out of nine examples of the Dasyure, only two were without the tapeworm. One of these had been four years and four months in the Gardens and might have got rid of them; the other had lived less than three weeks, and thus might not have contracted the helminthiasis. But the fact that the infected Dasyures died after being in the Gardens for only 9 days, 7 months, or 14 months, etc., seems to argue that the parasites are Australian.

I cannot be positive as to the identity of the worms to be described here with *Dasyurotænia robusta*. But I feel confident that they are of the same species, by reason of the general correspondence of internal structure of the two series of worms. The second lot of worms, however, had among them no scolices, and the scolex of *Dasyurotænia* is, as I have duly pointed out in my memoir, a highly characteristic feature of the genus and one indeed which quite prevents its confusion with any other genus hitherto described. But even without this important means of identification there are some other features which, collectively at any rate, leave no doubt upon my mind that the specimens which I found more recently are the same species as that which I formerly described. I rely more particularly upon the following facts of structure, which I take this opportunity of confirming as they are of importance:—The unilateral genital pores; the very large water-vascular vessel on either side with septa running across: the absence (or, if present, minute size) of the usually present smaller dorsal vessel. The total absence of the transverse vessel in each segment. The existence of at any rate four rows of longitudinal muscular bundles, all separated from each other by transverse strands of muscle. These facts are as it

* P. Z. S. 1912, p. 677. † P. Z. S. 1911, p. 1003.

appears to me of sufficient weight to imply generic, if not specific identity.

I have now to direct attention to a few additional facts in the anatomy of this species. With reference to the water-vascular system, I confirm my former statements as to the numerous folds which project now from this side and now from the other into the lumen of the large ventral tube. It is to be noted, however, that when the segments are more stretched—as they are in individuals which I have just finished examining—the depth of these folds is diminished. Nevertheless, they are still present, and I have never seen the tube to be bounded for any considerable length by straight parallel lines such as are usually seen in most Cestode worms. I have omitted to mention in my earlier paper, that at the boundary line of each proglottid the tube is much dilated; it is just at this point that the transverse tube might be expected to arise, were it present, at any rate judging from the conditions figured by Braun (after Zschokke in Bronn's "Thierreichs" *), where the dilatation appears to that author to be the physiological equivalent of a valve. I have ascertained that there is also a valve present in this situation in *Dasyurotænia robusta*. I have mentioned in the paper referred to that a closed septum occludes the lumen at these points. This statement is partly true, for such a septum can readily be seen. But when followed out through its whole superficies the diaphragm is seen to be free in the middle region, and thus to form a flapping valve which arises from the internal side of the tube (as usual but not universal), and to rest against the opposite side in such a fashion that it entirely occludes the lumen of the water-vascular tube in this area. In parts it is, as already said, a veritable fixed diaphragm. In view of the existence of the swelling upon the course of the ventral water-vascular tube and the presence of a valve, I looked very carefully to ascertain whether a transverse vessel might not be found; but I have quite failed to make out such a tube, although there is in the proper position a slight process of the tube directed inwards.

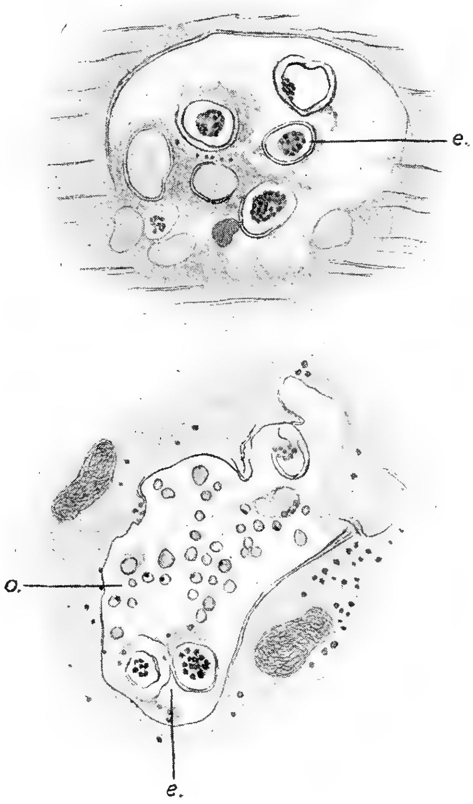
In connection with the above remarks upon the water-vascular system of this Cestode, it should be mentioned that the recent specimens examined by myself show that the ripe proglottids are longer relatively to their breadth than I originally described. They attain to a length rather greater than their breadth.

The uterus in the more fully ripe proglottids has not the simple form which I found and described in the first specimens of this worm which I investigated and reported upon. As the proglottids grow in length the uterus grows into outgrowths and completely but irregularly fills the available room in the proglottid. It does not appear to form a network, but merely an irregularly shaped sac. The generic definition of *Dasyurotænia* must therefore be slightly amended. The mature uterus contained mature ova,

* Bd. iv. Abth. I.B. taf. li. fig. 6.

i.e. with embryos, and fully formed egg-shell. These ripe eggs are spherical, and the contained embryo lies in the centre at some distance from the shell which is moderately thick. A fine layer may surround the embryo, constituting a second inner shell; but I can find no evidence of a third shell lying between this and the

Text-figure 7.



Compartments of ovary of *Dasyurotænia*.

e. Ripe eggs. *o.* Immature ova.

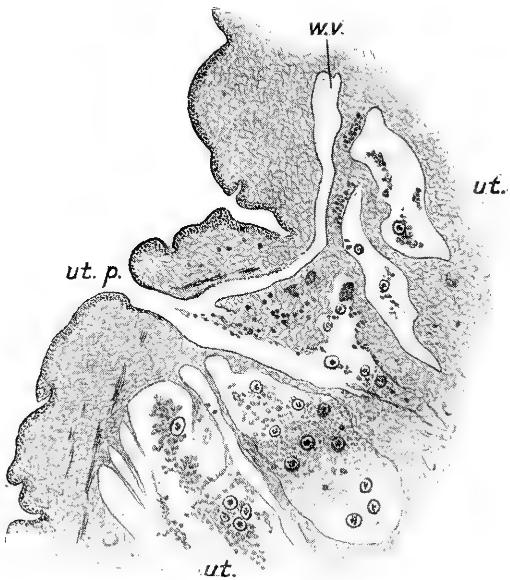
obvious outer shell. To make one among many possible comparisons, the eggs of the present genus resemble those of *Oochoristica marmosæ* and differ so far from those of *Linstowia ameivæ* *. And finally, they are in no way remarkable for a worm which

* See Beddard, P. Z. S. 1914, p. 268, fig. 3; p. 278, fig. 8.

is undoubtedly very abnormal as a Cyclophyllidean Cestode in the form of its scolex.

It is a circumstance to be noted, that in this tapeworm (see text-fig. 7) the apparently fully mature uterus containing abundant fully mature ova is nevertheless not entirely filled by these ova. In fact, among the ripe ova are many cells which are, as I believe, immature ova. Inasmuch as there is not to be observed a series connecting the two extremes, it would appear that the immature ova do not become mature, but perhaps serve as nutriment for a

Text-figure 8.



Uterine pore (*ut.p.*) of *Dasyurotænia*.

ut. Uterus. *w.v.* Lateral water-vascular tube.

few cells destined to ripen fully. One does not see in this tapeworm what is so usual, namely the uterus filled simply by a densely packed mass of fully mature ova ready to be shed. The ripe eggs are scattered, now frequently, now more sparsely, among a mass of small cells. This circumstance may be connected with the method of evacuating the ripe eggs. It is a commonplace of knowledge, that among the Cyclophyllidea the uterus does not communicate with the exterior through a "preformed" orifice, but that the eggs are finally liberated by the decay of the ripe and detached proglottids, or are never liberated at all, but swallowed while yet within the proglottid by the intermediate host. There is no known exception to this, if we exclude the Ichthyotæniids from the Cyclophyllidea *.

I direct attention to the annexed text-figure (text-fig. 8), which represents a portion of a horizontal section through a ripe proglottid of *Dasyurotænia robusta.* It will there be seen that a very definite orifice on to the exterior runs from the uterus and also from the adjacent ventral water-vascular tube. There is here no question whatever of a rupture due to pressure and the consequent formation of a lateral orifice. The inflection of the layers of the body, and the mode of communication with both the water-vascular tube and the uterus, seem to me to be decisive upon the matter. It is possible that the numerous obstructions upon the course of the water-vascular vessels which I have referred to above, permits of an opening of this kind without undue pouring out of the fluid contained in those vessels; besides, any opening of the uterus on to the exterior in this region would seem necessarily to involve the vascular tubes. As to the uterine opening, we note that it is lateral instead of dorsal or ventral as is the case in those Cestodes where a separate uterine orifice occurs. In view of the remarkable characters of the scolex of *Dasyurotænia* which render its inclusion in any of the recognised groups of the Cestodes difficult (as I have already pointed out in my original paper upon the genus), it is interesting to observe this difference.

The uterine orifice lies on the side remote from that which bears the genital orifice; these latter orifices are unilateral. While there can be, as I think, no doubt that the uterine pore is a preformed orifice, and not an accidental tear such as occurs, but on the ventral surface, in various tapeworms belonging to the Tetraphyllidea, I have not by any means been able to prove its universal occurrence in mature proglottids. Indeed I have only twice found these lateral orifices. In three other pieces of the same tapeworm (whether of different or the same individual I have no means of knowing) I have seen no such openings, at most a process of the lateral water-vascular vessel deflected towards the periphery. But, on the other hand, I have observed them in one segment in two other pieces of worm. This, however, is not necessarily an argument against the normality of the occurrence, though it does not fully prove that the formation of these pores is normal. It is at least clear that they may be formed.

* See Beddard, P. Z. S. 1913, p. 256 *et seq.*

16. A List of the Snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola. By G. A. Boulenger, F.R.S., F.Z.S.*

[Received March 3, 1915: Read April 13, 1915.]

(Text-figures 1 and 2.)

Index.

Some years ago I drew up a list of the Reptiles of Africa south of Angola and the Zambesi †, accompanied by keys to the identification of the genera and species. These keys have proved very useful, and I have been urged to prepare similar means of easy identification for the Reptiles, especially the Snakes, of other parts of Africa. Having recently had to name large series of Reptiles from the Belgian Congo, in which work I have been helped by my excellent attendant Mr. F. Kingsbury, it has occurred to me to use the occasion for making a complete list of the Snakes hitherto recorded from that large Colony and, in order to connect this list with the one alluded to above, to include also Angola, the Portuguese Congo, and Northern Rhodesia. On other occasions I hope to compile similar lists of the Snakes of Madagascar, of East Africa north of the Zambesi, of West Africa north of the Congo, and of North Africa, so as to embrace the whole Snake-fauna of this part of the world.

In the preparation of the present list I have been assisted not only by Mr. Kingsbury, but also by my young friend M. Gaston de Witte, both of whom have made many suggestions for the improvement of the keys and who have been of great service to me in testing them on unnamed material.

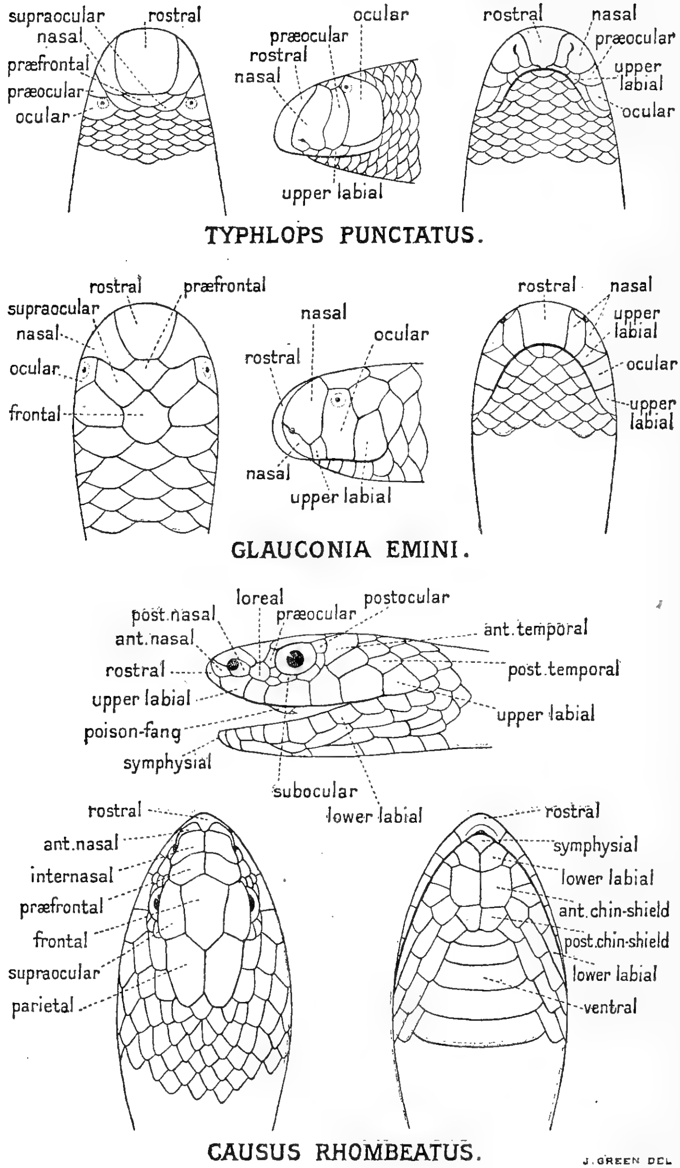
The name of each species is accompanied by a reference to the original description, to the Catalogue of Snakes in the British Museum (1893–1896), and to Barboza du Bocage's 'Herpétologie d'Angola et du Congo' (1895). Only such synonyms are added as have not been already mentioned in the Catalogue, to which the student is referred for the confirmation of the determination reached by means of the keys to the genera and species.

These keys are of the most artificial kind, and apply only to the Snakes known to inhabit the region embraced in this list. The most trivial characters are often selected, in order to ensure the identification of the genus and species with the least possible recourse to an examination of the dentition, which presents

* Published by permission of the Trustees of the British Museum.

† Ann. S. Afr. Mus. v. 1910, p. 455.

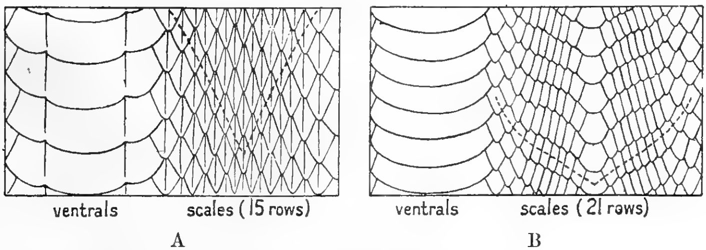
Text-figure 1.



such difficulties to the uninitiated in herpetology. For instance, a beginner may be in doubt whether the snake before him is an Aglyphous, an Opisthoglyphous or a Proteroglyphous Colubrid, or even a Viperid. In that case, confining his attention to the external characters, he may have to work through the four keys to the genera of the above-named groups; but these keys have been so constructed that he cannot alight on any name but the one he is seeking. To give an example, supposing he has before him a *Causus rhombeatus*, and, not having looked at the teeth, has no idea to what group it belongs. He will first try Colubridæ aglyphæ. His specimen will fall under division I. A of the key, but will be excluded from any further definition. Passing on to the Colubridæ opisthoglyphæ he will reach division II. B, and no further. The presence of a loreal shield in the snake before him will rule it out of the Colubridæ proteroglyphæ. Then trying the last key, Viperidæ, he will at once alight on *Causus*, and further on on *Causus rhombeatus*.

No further glossary is needed than the outline figures here appended to this list. I will only add that in giving the number of subcaudal shields, if in pairs, each pair is reckoned as one, and the conical or spine-like shield which caps the end of the tail is not included.

Text-figure 2.



Scaling of thickest part of body.

A. *Gastropyxis smaragdina*, with keeled scales and bicarinate ventral shields.
B. *Dipsadomorphus blandingii*, with oblique scales and enlarged vertebrals.

Synopsis of the Families.

I. Worm-like, with small inferior mouth, eyes hidden or visible under the head-shields, and body covered with uniform imbricate scales above and beneath.

Ocular shield not bordering the mouth; tail not or but little longer than broad .... TYPHLOPIDÆ.

Ocular shield bordering the mouth; tail at least three times as long as broad .... GLAUCONIIDÆ.

II. Mouth large, eyes distinct, body with enlarged shields beneath.

Ventral shields much narrower than the body; supraocular, if distinct, broken up into two or more shields .... BOIDÆ.

Ventral shields at least nearly as broad as the body; supraocular, if present, single; poison-fangs, if present, not in a very large sheath .... COLUBRIDÆ.

Ventral shields at least nearly as broad as the body; large poison-fangs in a very large sheath below the eye .... VIPERIDÆ.

Family TYPHLOPIDÆ.

A single genus.

1. TYPHLOPS.

Schneid. Hist. Amph. ii. p. 339; Bouleng. Cat. Sn. i. p. 7.

Synopsis of the Species.

I. Snout rounded, with or without obtusely angular horizontal edge.

A. Eye distinguishable.

Præfrontal more than 3 times as large as supraocular, forming a very narrow suture with the nasal; snout rounded; 28 scales round middle of body .... *T. boulengeri.*
Præfrontal not more than twice as large as supraocular, forming a very broad suture with the nasal; snout with obtuse horizontal edge; 24 to 30 scales round middle of body .... *T. punctatus.*
Præfrontal scarcely larger than supraocular; snout with obtuse horizontal edge; 34 scales round middle of body .... *T. viridiflavus.*

B. Eye not distinguishable; snout with obtuse horizontal edge.

Nasal cleft proceeding from the first labial; 26 scales round middle of body; diameter of body 28 to 33 times in total length .... *T. congicus.*
Nasal cleft proceeding from the lower lateral border of the rostral; 30 to 32 scales round middle of body; diameter of body 24 times in total length .... *T. anchietæ.*

II. Snout with a more or less sharp horizontal edge.

A. Eye distinguishable; præocular present.

1. Præocular in contact with one or two upper labials.

28 to 30 scales round middle of body; diameter of body about 20 times in total length .... *T. anomalus.*
30 to 38 scales round middle of body; diameter of body 25 to 37 times in total length .... *T. mucruso.*
40 to 44 scales round middle of body; diameter of body 25 to 30 times in total length .... *T. schlegelii.*

2. Præocular separated from the upper labials, the ocular being in contact with the nasal; 24 to 26 scales round middle of body; diameter of body 67 times in total length .... *T. præocularis.*

B. Eye not distinguishable.

Præocular present, in contact with two upper labials; 22 scales round middle of body; diameter of body 70 to 74 times in total length .... *T. cæcus.*
No præocular; 24 scales round middle of body; diameter of body 60 times in total length .... *T. graueri.*

1. TYPHLOPS BOULENGERI Bocage, Jorn. Sc. Lisb. (2) iii. 1893, p. 117, and Herp. Ang. p. 64; Bouleng. Cat. Sn. iii. p. 586.

Interior of Benguela.

2. TYPHLOPS PUNCTATUS.

Acontias punctatus Leach, in Bowdich, Miss. Ashantee, p. 493.

Typhlops punctatus Bouleng. Cat. Sn. i. p. 42; Bocage, Herp. Ang. p. 65.

West and Central Africa, from Senegambia to Angola.

3. Typhlops viridiflavus Peracca, Annuar. Mus. Zool. Univ. Napoli (2) iii. 1912, no. 25, p. 3.

Lake Bangwelu.

4. Typhlops congicus Boettg. Zool. Anz. 1887, p. 650, and Ber. Senck. Ges. 1888, p. 44, pl. i. fig. 5; Bouleng. t. c. p. 40; Bocage, Herp. Ang. p. 63.

Congo (Banana, Leopoldville).

5. Typhlops anchietæ Bocage, Jorn. Sc. Lisb. xi. 1886, p. 172, and Herp. Ang. p. 63; Bouleng. t. c. p. 40.

Benguela, Transvaal.

6. Typhlops anomalus.

Onychocephalus anomalus Bocage, Jorn. Sc. Lisb. iv. 1873, p. 248, pl. i. fig. 3.

Typhlops anomalus Bouleng. t. c. p. 47; Bocage, Herp. Ang. p. 70.

Angola, Loango (?).

7. Typhlops mucruso.

Onychocephalus mucruso Peters, Mon. Berl. Ac. 1854, p. 621.

Typhlops mucruso Peters, Reise Mossamb. iii. p. 95, pl. xiii. fig. 3; Bouleng. t. c. p. 46; Bocage, Herp. Ang. p. 67.

Typhlops humbo Bocage, op. cit. p. 66.

Typhlops petersii Bocage, op. cit. p. 68.

Typhlops hottentotus Bocage, op. cit. p. 69.

Tropical Africa south of the Equator.

8. Typhlops schlegelii Bianconi, Spec. Zool. Mossamb. p. 13, pl. iii. fig. 2; Bouleng. t. c. p. 44.

East Africa, L. Tanganyika, and S. Rhodesia.

9. Typhlops præocularis Stejneger, Proc. U.S. Nat. Mus. xvi. 1894, p. 709; Bouleng. op. cit. iii. p. 590.

Congo (Leopoldville).

10. Typhlops cæcus.

Onychocephalus cæcus A. Dum. Rev. et Mag. Zool. 1856, p. 462.

Typhlops cæcus Bouleng. op. cit. i. p. 55.

Congo, Gaboon, Sierra Leone.

11. Typhlops graueri, Sternf. Wiss. Ergebn. Deutsch. Z.-Afr. Exped., Zool. ii. p. 264.

Congo, N.W. of L. Tanganyika.

Family Glauconiidæ.

A single genus.

1. Glauconia.

Gray, Cat. Liz. p. 139; Bouleng. Cat. Sn. i. p. 59.

Synopsis of the Species.

I. Snout hooked in profile, with angular horizontal edge; diameter of body about 65 times in total length .... *G. rostrata.*

II. Snout rounded.

A. Rostral not or but little broader than nasal.

Supraocular nearly twice as broad as long; diameter of body 50 to 55 times in total length .... *G. emini.*
Supraocular small; diameter of body 40 to 53 times in total length .... *G. nigricans.*
Supraocular small; diameter of body 70 times in total length...... *G. longicauda.*

B. Rostral more than twice as broad as nasal.

Supraocular not larger than præfrontal; diameter of body 60 to 80 times in total length .... *G. scutifrons.*
Supraocular much larger than præfrontal; rostral extending above to between eyes; diameter of body 50 times in total length .... *G. lepezi.*
Supraocular larger than præfrontal; rostral extending to beyond level of eyes; diameter of body 55 times in total length .... *G. latirostris.*

1. Glauconia rostrata.

Stenostoma rostratum Bocage, Jorn. Sc. Lisb. xi. 1886, p. 179, and Herp. Ang. p. 71.
Glauconia rostrata Bouleng. t. c. p. 62.
Angola.

2. Glauconia emini Bouleng. t. c. p. 64, pl. iii. fig. 8.

East and Central Africa (Lakes Kivu and Tanganyika, Nyassaland).

3. Glauconia nigricans.

Typhlops nigricans Schleg. Abbild. p. 38, pl. xxxii. figs. 21–24.
Glauconia nigricans Bouleng. t. c. p. 67.
South Africa and Northern Rhodesia.

4. Glauconia longicauda.

Stenostoma longicauda Peters, Mon. Berl. Ac. 1854, p. 621.
Glauconia longicauda Bouleng. t. c. p. 66.
Northern Rhodesia and Portuguese East Africa.

5. Glauconia scutifrons.

Stenostoma scutifrons Peters, l. c.; Bocage, Herp. Ang. p. 71.
Glauconia scutifrons Bouleng. t. c. p. 68.
Angola and South Africa.

6. Glauconia lepezi Bouleng. Ann. Mus. Congo, Zool. ii. 1901, p. 8, pl. iii. fig. 2.

Lower Congo (Zambi).

7. Glauconia latirostris Sternf. Wiss. Ergebn. Deutsch. Z.-Afr. Exped., Zool. ii. p. 264.

N.W. of L. Tanganyika.

Family Boidæ.

Two genera:—

Head distinct from neck; rostral and anterior upper labials with deep pits; scales in more than 50 rows; tail prehensile, tapering to a point, with paired subcaudals.. *Python.*
Head not distinct from neck; rostral large, not pitted; scales in 29–32 rows; tail short, rounded at the end, with single subcaudals .... *Calabaria.*

1. Python.

Daud. Hist. Rept. v. p. 266; Bouleng. Cat. Sn. i. p. 85.

Two species:—

Two upper labials pitted; scales in 81–93 rows; subcaudals 63–77. *P. sebæ.*
Five upper labials pitted; scales in 57–59 rows; subcaudals 46–47. *P. anchietæ.*

1. Python sebæ.

Coluber sebœ Gmel. S. N. i. p. 1118.
Python sebœ Bouleng. t. c. p. 86.
Python natalensis Bocage, Herp. Ang. p. 72.
Tropical and South Africa.

2. Python anchietæ Bocage, Jorn. Sc. Lisb. xii. 1887, p. 87, and Herp. Ang. p. 73, pl. ix. fig. 1; Bouleng. t. c. p. 88.
Angola (Catumbella).

2. Calabaria.

Gray, P. Z. S. 1858, p. 154; Bouleng. Cat. Sn. i. p. 92.

1. Calabaria reinhardti.

Eryx reinhardti Schleg. Bijdr. tot de Dierk. i. p. 2, pl. —.
Calabaria reinhardti Bouleng. l. c.
West Africa, from Liberia to the Congo.

Family Colubridæ.

Three parallel series:—

No poison-fangs; all the teeth solid .... A. Aglypha.
Poison-fangs behind .... B. Opisthoglypha.
Poison-fangs in front .... C. Proteroglypha.

A. Aglypha.

I. Loreal present (occasionally absent in *Homalosoma*, recognisable by the combination of a single nasal shield, paired subcaudals, and a low number of ventral shields, 113–144).
  A. Snout without angular horizontal edge.
    1. Pupil round; a single anterior temporal; scales in 17 to 23 rows; ventrals less than 165.
      a. No groove on side of head.
        α. Two internasals .... *Tropidonotus.*
        β. A single internasal.

Scales smooth, in 19 rows .... *Helicops.*
Scales keeled, in 23 or 25 rows .... *Hydræthiops.*

b. A deep groove on side of head, above the upper labials; scales smooth, in 23 rows .... *Glypholycus.*

2. Pupil round; 2 or 3 superposed anterior temporals; scales in 21 rows or more; ventrals 175 or more.

A deep groove between posterior nasal and præocular; scales keeled, in 23 rows .... *Bothrophthalmus.*
No groove on side of snout; scales smooth or very obtusely keeled, in 25 to 31 rows .... *Pseudaspis.*
No groove on side of snout; scales smooth, in 21 rows .... *Coronella.*

3. Pupil vertically elliptic.

a. Scales smooth, of vertebral row not enlarged; subcaudals less than 73.

Scales in 25 to 33 rows; subcaudals single or paired........... *Boodon.*
Scales in 15 or 17 rows; subcaudals paired .... *Lycophidium.*

b. Scales of vertebral row enlarged; subcaudals 73 or more.

Scales strongly keeled, vertebrals bicarinate, in 21 rows ...... *Gonionotophis.*
Scales strongly keeled, vertebrals bicarinate, in 15 or 17 rows. *Simocephalus.*
Scales smooth, in 15 rows; head very distinct from neck; eye large; body compressed .... *Hormonotus.*

4. Pupil round; body usually very slender (tree-snakes), with the scales in 13 to 19 rows.

a. Scales in 13 or 15 rows, of vertebral row not enlarged.

α. Lateral scales as long as dorsals; colour green or black and green.

** Scales smooth.

Subcaudal shields not keeled .... *Chlorophis.*
Subcaudal shields keeled and with a notch corresponding to the keel, same as on the ventrals .... *Philothamnus.*

** Scales keeled.

Subcaudal shields keeled and notched; a single anterior temporal .... *Gastropyxis.*
Subcaudal shields not keeled; usually two superposed anterior temporals .... *Hapsidophrys.*

β. Lateral scales much shorter than dorsals, which are keeled; a single anterior temporal; eye very large .... *Thrasops.*

b. Scales in 17 or 19 rows, very narrow; a single anterior temporal; eye very large .... *Rhamnophis.*

5. Pupil round; nostril in a single or semidivided nasal; scales not oblique, short and smooth, in 15 to 19 rows.

Nostril directed upwards, nasal semidivided; two superposed anterior temporals.. *Grayia.*
Nostril lateral, nasal entire; a single anterior temporal ...... *Homalosoma.*

B. Snout with angular horizontal edge.

Eye in contact with labials; internasal and præfrontal single; scales in 15 or 17 rows; ventrals less than 170 .... *Prosymna.*
Suboculars separate the eye from the labials; scales in 19 to 25 rows; ventrals more than 170 .... *Scaphiophis.*

II. No loreal, nasal in contact with præocular; pupil vertically elliptic: scales strongly keeled, some of the laterals very oblique.................................... ...... *Dasypeltis.*

1. Tropidonotus.

Kuhl, Bull. Sc. Nat. ii. 1824, p. 81; Bouleng. Cat. Sn. i. p. 192.

Two species:—

Scales smooth, in 17 rows; ventrals 119–135; anal entire (rarely divided) .... *T. fuliginoides.*
Scales smooth, in 19 rows; ventrals 131–150; anal divided......... *T. olivaceus.*

1. Tropidonotus fuliginoides.

Coronella fuliginoides Günth. Cat. Col. Sn. p. 39.
Tropidonotus fuliginoides Bouleng. t. c. p. 217.
Mizodon fuliginoides Bocage, Herp. Ang. p. 75.
West Africa, from the Gold Coast to the Congo.

2. Tropidonotus olivaceus.

Coronella olivacea Peters, Mon. Berl. Ac. 1854, p. 622.
Tropidonotus olivaceus Bouleng. t. c. p. 227.
Mizodon olivaceus Bocage, Herp. Ang. p. 74.
Grayia giardi Dollo, Bull. Mus. Belg. iv. 1886, p. 158, fig.
Tropical Africa, from the Soudan to Angola, Mashonaland, and Southern Rhodesia.

2. Helicops.

Wagler, Syst. Amph. p. 170; Bouleng. Cat. Sn. i. p. 272.

1. Helicops bicolor.

Limnophis bicolor Günth. Ann. & Mag. N. H. (3) xv. 1865, p. 96, pl. ii. fig. C.
Helicops bicolor Bouleng. t. c. p. 274; Bocage, Herp. Ang. p. 76.
Angola; N.W. Rhodesia.

3. Hydræthiops.

Günth. Ann. & Mag. N. H. (4) ix. 1872, p. 28; Bouleng. Cat. Sn. i. p. 280.

1. Hydræthiops melanogaster Günth. l. c. pl. iii. fig. G; Bouleng. t. c. p. 281; Bocage, Herp. Ang. p. 77.
West Africa, from Cameroon to the Congo.

4. Glypholycus.

Günth. P. Z. S. 1893, p. 629; Bouleng. Cat. Sn. iii. p. 615.

1. Glypholycus bicolor Günth. l. c. fig.; Bouleng. l. c.
Lake Tanganyika.

5. Bothrophthalmus.

Peters, Mon. Berl. Ac. 1863, p. 287; Bouleng. Cat. Sn. i. p. 324.

1. Bothrophthalmus lineatus.

Elaphis (*Bothrophthalmus*) *lineatus* Peters, l. c.
Bothrophthalmus lineatus Bouleng. l. c.; Bocage, Herp. Ang. p. 83.
West and Central Africa, from the Gold Coast and Uganda to the Congo.

6. Boodon.

Dum. & Bibr. Mém. Ac. Sc. xxiii. 1853, p. 460; Bouleng. Cat. Sn. i. p. 327.

Two species:—

Subcaudals paired	*B. lineatus.*
Subcaudals single	*B. olivaceus.*

1. Boodon lineatus Dum. & Bibr. Erp. Gén. vii. p. 363; Bouleng. t. c. p. 332; Bocage, Herp. Ang. p. 78.

Tropical and South Africa; Arabia.

2. Boodon olivaceus.

Holuropholis olivaceus A. Dum. Rev. et Mag. Zool. 1856, p. 466.

Boodon olivaceus Bouleng. t. c. p. 335; Bocage, op. cit. p. 81.

West and Central Africa, from Nigeria and Uganda to the Congo.

7. Lycophidium.

Dum. & Bibr. Mém. Ac. Sc. xxiii. 1853, p. 462; Bouleng. Cat. Sn. i. p. 336.

Synopsis of the Species.

I. Scales in 15 rows; ventrals 153–165; subcaudals 23–32; 8 upper labials, three entering the eye	*L. meleagris.*
II. Scales in 17 rows; ventrals 164–208; subcaudals 24–56.	
8 upper labials, seventh largest, two entering the eye	*L. laterale.*
8 upper labials, seventh largest, three entering the eye	*L. capense.*
7 upper labials, sixth largest, three entering the eye	*L. fasciatum.*

1. Lycophidium meleagris Bouleng. Cat. Sn. i. p. 337, pl. xxi. fig. 2; Bocage, Herp. Ang. p. 82.

Angola (Ambriz, Ambrizete).

2. Lycophidium laterale Hallow. Proc. Ac. Philad. 1857, p. 58; Bouleng. t. c. p. 338; Bocage, l. c.

West Africa, from the Gold Coast to the Congo.

3. Lycophidium capense.

Lycodon capensis A. Smith, S. Afr. Quart. Journ. (1) no. 5, 1831, p. 18.

Lycophidium capense Bouleng. t. c. p. 339; Bocage, op. cit. p. 81.

Tropical and South Africa.

4. Lycophidium fasciatum.

Alopecion fasciatum Günth. Cat. Col. Sn. p. 196.

Lycophidium fasciatum Bouleng. t. c. p. 342, pl. xxii. fig. 2.

West Africa, from Sierra Leone to the Gaboon, eastward to the Congo Forest west of Mt. Ruwenzori.

8. Gonionotophis.

Bouleng. Cat. Sn. i. p. 323.

Two species, which may perhaps have to be reduced to one :—

Temporals 2+2	*G. brussauxi.*
Temporals 1+2	*G. vossii.*

1. Gonionotophis brussauxi.

Gonionotus brussauxi Mocquard, Bull. Soc. Philom. (8) i. 1889, p. 146.

Gonionotophis brussauxi Bouleng. l. c.

Loudinia-Niari, French Congo.

2. Gonionotophis vossii.

Gonionotus vossii, Boettg. Zool. Anz. 1892, p. 418.

Gonionotophis vossii Bouleng. l. c.

Cameroon to Congo.

9. Simocephalus.

Günth. Cat. Col. Sn. p. 194; Bouleng. Cat. Sn. i. p. 344.

Synopsis of the Species.

I. Three labials entering the eye.

Scales strongly keeled, with strong striation directed obliquely towards the keel; subcaudals 51–70	*S. guirali.*
Scales feebly keeled; subcaudals 65	*S. baumanni.*

II. Two labials entering the eye.

Scales strongly keeled, with lateral keels and strong striation; subcaudals 53	*S. lamani.*
Scales strongly keeled; secondary keels feebly marked or absent; subcaudals 75–124	*S. poensis.*

1. Simocephalus guirali.

Heterolepis guirali Mocquard, Bull. Soc. Philom. (7) xi. 1887, p. 23, pl. ii. fig. 3.

Simocephalus guirali Bouleng. t. c. p. 346.

West Africa, from Cameroon to the Congo.

2. Simocephalus baumanni Sternf. Mitth. Zool. Mus. Berl. 1908, p. 214, fig. 1.

Aruwimi, Togoland.

3. Simocephalus lamani.

Mehelya lamani Lönnb. Ark. f. Zool. vii. 1911, no. 8, fig. 1.

Lower Congo.

4. Simocephalus poensis.

Heterolepis poensis A. Smith, Ill. Zool. S. Afr., Rept. i.

Simocephalus poensis Bouleng. t. c p. 346.

West Africa, from Sierra Leone to the Congo; Uganda.

10. Hormonotus.

Hallow. Proc. Ac. Philad. 1857, p. 56; Bouleng. Cat. Sn. i. p. 344.

1. Hormonotus modestus.

Lampropeltis modestus Dum. & Bibr. Erp. Gén. vii. p. 429.
Hormonotus modestus Bouleng. l. c.

West Africa, from the Gold Coast to the mouth of the Chiloango.

11. Pseudaspis.

Cope, Proc. Ac. Philad. 1864, p. 168; Bouleng. Cat. Sn. i. p. 373.

1. Pseudaspis cana.

Coluber canus Linn. Mus. Ad. Frid. i. p. 31, pl. xi. fig. 1.
Pseudaspis cana Bouleng. l. c.; Bocage, Herp. Ang. p. 100, pl. x. fig. 1.

Angola, Nyassaland, East and South Africa.

12. Chlorophis.

Hallow. Proc. Ac. Philad. 1857, p. 52; Bouleng. Cat. Sn. ii. p. 91.

Synopsis of the Species.

I. No trace of ventral keels; ventrals 147–190.

9 upper labials, 4th, 5th, and 6th entering the eye; subcaudals 103–123	*C. emini.*
8 upper labials, 3rd, 4th, and 5th entering the eye; subcaudals 85–99; a brown vertebral stripe edged with yellowish	*C. ornatus.*
8 upper labials, 4th and 5th entering the eye; subcaudals 82–105.	*C. hoplogaster.*

II. Ventrals with a more or less distinct lateral keel.

A. Anal divided; scales in 15 rows.

1. Two upper labials entering the eye; ventrals 148–169; subcaudals 71–114.

Loreal twice as long as deep	*C. neglectus.*
Loreal scarcely longer than deep	*C. angolensis.*

2. Three upper labials entering the eye.

Præocular separated from frontal; body very slender anteriorly; ventrals 175–190; subcaudals 115–190	*C. heterolepidotus.*
Præocular in contact with or narrowly separated from frontal; ventrals 150–182; subcaudals 90–133	*C. irregularis.*

B. Anal entire; ventrals 141–162; subcaudals 75–96.

Scales in 15 rows	*C. heterodermus.*
Scales in 13 rows	*C. carinatus.*

1. Chlorophis emini.

Ahætulla emini Günth. Ann. & Mag. N. H. (3) xi. 1863, p. 285.
Chlorophis emini Bouleng. t. c. p. 92.

Eastern Soudan to Uganda and Ruwenzori.

2. CHLOROPHIS ORNATUS.

Philothamnus ornatus Bocage, Jorn. Sc. Lisb. ii. 1872, p. 80, and Herp. Ang. p. 93, pl. xii. fig. 1.
Chlorophis ornatus Bouleng. t. c. p. 93.

Angola and Portuguese Guinea.

3. CHLOROPHIS HOPLOGASTER.

Ahætulla hoplogaster Günth. Ann. & Mag. N. H. (3) xi. 1863, p. 285.
Chlorophis hoplogaster Bouleng. t. c. p. 93.

Central, East, and South Africa.

4. CHLOROPHIS NEGLECTUS.

Philothamnus neglectus Peters, Mon. Berl. Ac. 1866, p. 890.
Chlorophis neglectus Bouleng. t. c. p. 94.

East and Central Africa.

5. CHLOROPHIS ANGOLENSIS.

Philothamnus angolensis Bocage, Jorn. Sc. Lisb. ix. 1882, p. 7.
Chlorophis angolensis Bouleng. t. c. p. 95.

Angola.

6. CHLOROPHIS HETEROLEPIDOTUS.

Ahætulla heterolepidota Günth. Ann. & Mag. N. H. (3) xi. 1863, p. 286.
Chlorophis heterolepidotus Bouleng. t. c. p. 95, pl. v. fig. 3.
Philothamnus heterolepidotus Bocage, Herp. Ang. p. 88.

Tropical Africa, from the Gold Coast to Angola, eastwards to the Coast of Zanzibar.

7. CHLOROPHIS IRREGULARIS.

Coluber irregularis Leach, in Bowdich, Miss. Ashantee, p. 494.
Chlorophis irregularis Bouleng. t. c. p. 96.
Philothamnus irregularis Bocage, op. cit. p. 85, pl. xii. fig. 2.

Senegambia and Uganda to Angola and Southern Rhodesia.

8. CHLOROPHIS HETERODERMUS Hallow. Proc. Ac. Philad. 1857, p. 54; Bouleng. t. c. p. 97.

Philothamnus heterodermus Bocage, op. cit. p. 89.

Sierra Leone to Congo, eastwards to L. Tanganyika.

9. CHLOROPHIS CARINATUS Anderss. Bih. Sv. Ak. Handl., xxvii. iv. no. 5, 1901, p. 9.

Cameroon, Belgian and Portuguese Congo.

13. Philothamnus.

A. Smith, Ill. Zool. S. Afr., Rept.; Bouleng. Cat. Sn. ii. p. 98.

Two species:—

At least 3 temporals (1+2), usually more (2+2 or 2+2+2); green above, with or without black spots or bars .... *P. semivariegatus.*
3 temporals (1+1+1, rarely 1+2); a dark vertebral stripe; snout yellowish or reddish brown .... *P. dorsalis.*

1. Philothamnus semivariegatus A. Smith, op. cit. pls. lix., lx. & lxiv. fig. 1; Bouleng. t. c. p. 99; Bocage, Herp. Ang. p. 90, pl. xiii. fig. 2.*

Tropical and South Africa.

2. Philothamnus dorsalis.

Leptophis dorsalis Bocage, Jorn. Sc. Lisb. i. 1866, p. 69.
Philothamnus dorsalis Bouleng. t. c. p. 101; Bocage, Herp. Ang. p. 92, pl. xiii. fig. 3.

Gaboon, Congo, Angola.

14. Gastropyxis.

Cope, Proc. Ac. Philad. 1860, p. 556; Bouleng. Cat. Sn. ii. p. 102.

1. Gastropyxis smaragdina.

Dendrophis smaragdina Schleg. Phys. Serp. ii. p. 237.
Gastropyxis smaragdina Bouleng. t. c. p. 103.
Hapsidophrys smaragdina Bocage, Herp. Ang. p. 96.

Tropical Africa, from Sierra Leone and Uganda to the Congo and Northern Angola.

15. Hapsidophrys.

Fischer, Abh. Nat. Ver. Hamb. iii. 1856, p. 110; Bouleng. Cat. Sn. ii. p. 103.

1. Hapsidophrys lineata Fisch. l. c. p. 111, pl. ii. fig. 5; Bouleng. t. c. p. 104; Bocage, Herp. Ang. p. 97.

West Africa, from the Gold Coast to the Congo, eastwards to Uganda.

16. Thrasops.

Hallow. Proc. Ac. Philad. 1857, p. 67; Bouleng. Cat. Sn. ii. p. 104.

1. Thrasops flavigularis.

Dendrophis flavigularis Hallow. Proc. Ac. Philad. 1852, p. 205.
Thrasops flavigularis Bouleng. t. c. p. 105; Bocage, Herp. Ang. p. 97.

West Africa, from Sierra Leone to the Congo.

* The synonymy of this species should probably include *Ph. nitidus* Gthr. and *Ph. lagoensis* Gthr.

17. Rhamnophis.

Günth. Ann. & Mag. N. H. (3) ix. 1862, p. 129; Bouleng. Cat. Sn. iii. p. 632.

Two species :—

Scales smooth, in 17 rows; a pair of large shields behind the parietals	*R. æthiops.*
Scales more or less distinctly keeled, in 19 rows; no large shields behind the parietals	*R. jacksonii.*

1. Rhamnophis æthiops Günth. l. c. pl. x.; Bouleng. l. c.

West Africa, from Sierra Leone to the Congo.

2. Rhamnophis jacksonii.

Thrasops jacksonii Günth. Ann. & Mag. N. H. (6) xv. 1895, p. 528.

Rhamnophis jacksonii Bouleng. l. c.

Tropical Africa (French Guinea, Gold Coast, Uganda, Kasai).

18. Coronella.

Laur. Syn. Rept. p. 84; Bouleng. Cat. Sn. ii. p. 188.

1. Coronella semiornata Peters, Mon. Berl. Ac. 1856, p. 622; Bouleng. t. c. p. 195.

N. Rhodesia; East Africa.

19. Grayia.

Günth. Cat. Col. Sn. p. 50; Bouleng. Cat. Sn. ii. p. 286.

Synopsis of the Species.

I. Scales in 17 or 19 rows; ventrals 143–168.	
Lower anterior temporal longer than its distance from the loreal; 7 upper labials (rarely 8); subcaudals 89–102	*G. smythii.*
Lower anterior temporal not longer than its distance from the loreal; 8 or 9 upper labials; subcaudals 71–84	*G. ornata.*
II. Scales in 15 rows; ventrals 125–149.	
Eye much shorter than snout; subcaudals 100–128	*G. tholloni.*
Eye as long as snout; subcaudals 125–161	*G. cæsar.*

1. Grayia smythii.

Coluber smythii Leach, in Tuckey's Explor. R. Zaire, App. p. 409.

Grayia smythii, part., Bouleng. l. c.

Grayia triangularis Bocage, Herp. Ang. p. 102.

West and Central Africa and Uganda.

2. Grayia ornata.

Macrophis ornatus Bocage, Jorn. Sc. Lisb. i. 1866, p. 67.

Grayia smythii, part., Bouleng. l. c.

Grayia ornata Bocage, Herp. Ang. p. 104 ; Bouleng. P. Z. S. 1909, p. 944, fig. 295.

West Africa, from Cameroon to Angola.

3. GRAYIA THOLLONI Mocquard, Bull. Soc. Philom. (8) ix. 1897, p. 11 ; Bouleng. P. Z. S. 1909, p. 951, fig. 299.

French Congo, Katanga, Uganda, Egyptian Soudan.

4. GRAYIA CÆSAR.

Xenurophis cæsar Günth. Ann. & Mag. N. H. (3) xii. 1863, p. 357, pl. vi. fig. C ; Bouleng. Cat. Sn. ii. p. 288.

West Africa, from Cameroon to the Congo.

20. HOMALOSOMA.

Wagl. Syst. Amph. p. 190 ; Bouleng. Cat. Sn. ii. p. 273.

1. HOMALOSOMA LUTRIX.

Coluber lutrix Linn. S. N. i. p. 375.
Homalosoma lutrix Bouleng. t. c. p. 274.

East, Central, and South Africa.

21. PROSYMNA.

Gray, Cat. Sn. p. 80 ; Bouleng. Cat. Sn. ii. p. 246.

Synopsis of the Species.

Two postoculars ; frontal more than half width of head ; scales in 17 rows ; ventrals 131–153	*P. ambigua.*
One postocular ; præfrontal entering the eye ; frontal more than half width of head ; scales in 15 rows ; ventrals 167......	*P. bocagii.*
One postocular ; præfrontal separated from the eye by the præocular ; frontal not half width of head ; scales in 15 rows ; ventrals 145–163	*P. angolensis.*

1. PROSYMNA AMBIGUA, Bocage, Jorn. Sc. Lisb. iv. 1873, p. 218, and Herp. Ang. p. 99, pl. xi. fig. 1 ; Bouleng. t. c. p. 248.

Angola ; N. Rhodesia ; East Africa, from the Zanzibar Coast to Zululand.

2. PROSYMNA BOCAGII Bouleng. Ann. & Mag. N. H. (6) xix. 1897, p. 278, fig., and Ann. Mus. Congo, Zool. ii. 1901, p. 9, pl. iii. fig. 4.

Ubanghi.

3. PROSYMNA ANGOLENSIS, sp. n.

Prosymna frontalis (non Peters), Bocage, Herp. Ang. p. 98, pl. xi. fig. 2.

Angola.

22. Scaphiophis.

Peters, Mon. Berl. Ac. 1870, p. 644; Bouleng. Cat. Sn. ii. p. 254.

1. Scaphiophis albopunctatus Peters, t. c. p. 645, pl. i. fig. 4; Bouleng. l. c.; Bocage, Herp. Ang. p. 102.

Tropical Africa, from the Soudan to the Congo.

23. Dasypeltis.

Wagl. Syst. Amph. p. 178; Bouleng. Cat. Sn. ii. p. 353.

1. Dasypeltis scabra.

Coluber scaber Linn. Mus. Ad. Frid. p. 36, pl. x. fig. 1.

Dasypeltis scabra Bouleng. t. c. p. 354; Bocage, Herp. Ang. p. 106.

Tropical and South Africa, Egypt, South Arabia.

B. **Opisthoglypha.**

I. Eye moderate or large; head more or less distinct from neck; loreal present; no upper labials in contact with the parietal.

A. Pupil vertically elliptic; head short, very distinct from neck.

1. Subcaudals in two rows.

Vertebral scales not enlarged; scales in 19 rows; two superposed anterior temporals	*Tarbophis.*
Vertebral scales not enlarged; scales in 17 or 19 rows; a single anterior temporal	*Leptodira.*
Vertebral scales enlarged: scales in 19 to 25 rows	*Dipsadomorphus.*
2. Subcaudals single; scales in 17 rows	*Dipsadoboa.*

B. Pupil round.

1. Loreal not more than once and a half as long as deep; scales in 17 rows, not oblique.

Nostril in a semidivided nasal; anal entire	*Amplorhinus.*
Nostril between two nasals and the internasal; scales more or less distinctly concave; anal divided	*Trimerorhinus.*
Nostril between the nasals; snout acutely pointed or curved in profile; rostral large, hollowed ont beneath	*Rhamphiophis.*

2. Loreal at least once and a half as long as deep; scales more or less oblique.

A single anterior temporal; scales in 17 rows	*Dromophis.*
Usually two superposed anteiior temporals; scales in 11 to 17 rows; one or two middle maxillary teeth much enlarged.	*Psammophis.*
3. Loreal not more than once and a half as long as deep; nostril in an undivided nasal; scales very narrow, oblique, more or less strongly keeled, in 19 or 21 rows	*Dispholidus.*
C. Pupil horizontal; nostril in an undivided nasal; scales narrow, oblique, feebly keeled, in 19 rows	*Thelotornis.*

II. Eye rather small, small, or very small; head not at all distinct from neck; no loreal.

A. Subcaudals in two rows.

1. One or two upper labials in contact with the parietal; nasal in contact with the rostral.

Internasals present; nasal divided or semidivided; no præocular; scales in 19 or 21 rows	*Calamelaps.*
Internasals present, præfrontals absent; supraocular absent or fused with the postocular; snout much depressed, very prominent, pointed; rostral very large; scales in 17 or 21 rows........	*Xenocalamus.*
No internasals; nasal entire; a very small præocular; scales in 15 rows	*Apostolepis.*

2. Temporals separate the upper labials from the parietal; scales in 15 rows.

First upper labial in contact with the internasal........	*Miodon.*
Nasal in contact with the rostral	*Cynodontophis.*

B. Subcaudals single; scales in 15 rows.

1. Temporals separate the labials from the parietal; snout much depressed and very prominent; rostral very large, concave below	*Hypoptophis.*

2. One or two upper labials in contact with the parietal.

Posterior maxillary teeth large and strongly grooved........	*Aparallactus.*
Posterior maxillary teeth feebly enlarged and feebly grooved .	*Elapops.*

1. Tarbophis.

Fleischm. Dalm. nov. Serp. Gen, p. 17; Bouleng. Cat. Sn. iii. p. 47.

1. Tarbophis semiannulatus.

Telescopus semiannulatus A. Smith, Ill. Zool. S. Afr., Rept. pl. lxxii.

Tarbophis semiannulatus Bouleng. t. c. p. 51.

Crotaphopeltis semiannulatus Bocage, Herp. Ang. p. 122.

Central and East Africa, Angola, Rhodesia, Transvaal, Basutoland.

2. Leptodira.

Günth. Cat. Col. Sn. p. 165; Bouleng. Cat. Sn. iii. p. 88.

Two species:—

Ventrals 144–180; anal entire; subcaudals 32–54; body moderately elongate	*L. hotambœia.*
Ventrals 201–216; anal divided; subcaudals 94–113; body very slender........	*L. duchesnii.*

1. Leptodira hotambœia.

Coronella hotambœia Laur. Syn. Rept. p. 85.

Leptodira hotambœia Bouleng. t. c. p. 89.

Crotaphopeltis rufescens Bocage, Herp. Ang. p. 122.

Tropical and South Africa.

2. Leptodira duchesnii Bouleng. Ann. Mus. Congo, Zool. ii. 1901, p. 10, pl. iv. fig. 1.

Congo, Gaboon, Cameroon.

3. Dipsadomorphus.

Fitzing. in Tschudi, Faun. Per., Herp. p. 55; Bouleng. Cat. Sn. iii. p. 59.

Two species:—

Scales in 19 rows; ventrals 236–276; anal entire; subcaudals 96–132	*D. pulverulentus.*
Scales in 21–25 rows; ventrals 240–289; anal divided; subcaudals 122–147..........	*D. blandingii.*

1. Dipsadomorphus pulverulentus.

Dipsas pulverulenta Fisch. Abh. Nat. Ver. Hamb. iii. 1856, p. 81, pl. iii. fig. 1; Bocage, Herp. Ang. p. 123.

Dipsadomorphus pulverulentus Bouleng. t. c. p. 68.

West Africa, from the Coast of Guinea to the Congo.

2. Dipsadomorphus blandingii.

Dipsas blandingii Hallow. Proc. Ac. Philad. 1844, p. 170; Bocage, Herp. Ang. p. 124.

Dipsadomorphus blandingii Bouleng. t. c. p. 77.

West Africa, from Senegambia to the Congo, eastwards to British East Africa.

4. Dipsadoboa.

Günth. Cat. Col. Sn. p. 182; Bouleng. Cat. Sn. iii. p. 81.

1. Dipsadoboa unicolor, Günth. op. cit. p. 183; Bouleng. l. c.

Congo and West Africa as far north as Sierra Leone.

5. Amplorhinus.

A. Smith, Ill. Zool. S. Afr., Rept.; Bouleng. Cat. Sn. iii. p. 124.

1. Amplorhinus nototænia.

Coronella nototænia Günth. P. Z. S. 1864, p. 309, pl. xxvi. fig. 1.

Amplorhinus nototænia Bouleng. t. c. p. 125.

Psammophylax nototænia Bocage, Herp. Ang. p. 109.

Egyptian Soudan to Nyassaland, Angola.

6. Trimerorhinus.

A. Smith, Ill. Zool. S. Afr., Rept.; Bouleng. Cat. Sn. iii. p. 138.

1. Trimerorhinus rhombeatus.

Coluber rhombeatus Linn. Mus. Ad. Frid. p. 27, pl. xxiv. fig. 2.

Trimerorhinus rhombeatus Bouleng. l. c.; Bocage, Herp. Ang. p. 108.

Rhagerhis tritæniata Günth. Ann. & Mag. N. H. (4) i. 1868, p. 423, pl. xix. fig. H; Bocage, op. cit. p. 110, pl. x.[a] fig. 1.

Trimerorhinus tritæniatus Bouleng. t. c. p. 139.

Africa south of the Equator, East Africa as far north as Abyssinia.

I now regard *T. tritæniatus*, with 2 or 3 regular dark bands along the head and body, as a variety of *T. rhombeatus*.

7. Rhamphiophis.

Peters, Mon. Berl. Ac. 1854, p. 624; Bouleng. Cat. Sn. iii. p. 144.

Two species:—

Præocular in contact with frontal; subcaudals 53–63 .... *R. acutus.*
Præocular not in contact with frontal; snout with angular horizontal edge, curved in profile; subcaudals 90–110 .... *R. oxyrhynchus.*

1. Rhamphiophis acutus.

Psammophis acutus Günth. Ann. & Mag. N. H. (6) i. 1888, p. 327, pl. xix. fig. D.

Rhagerhis acuta Bocage, Herp. Ang. p. 111, pl. x.[a] fig. 2.

Rhamphiophis acutus Bouleng. t. c. p. 148.

Angola.

2. Rhamphiophis oxyrhynchus.

Psammophis oxyrhynchus Reinh. Vid. Selsk. Skrift. x. 1843, p. 244.

Rhamphiophis oxyrhynchus Bouleng. t. c. p. 146.

Tropical Africa.

8. Dromophis.

Peters, Mon. Berl. Ac. 1869, p. 447; Bouleng. Cat. Sn. iii. p. 149.

1. Dromophis lineatus.

Dryophylax lineatus Dum. & Bibr. Erp. Gén. vii. p. 1124.

Dromophis lineatus Bouleng. l. c.

Coast of Guinea to Eastern Soudan, Central Africa.

9. Psammophis.

Boie, Isis, 1827, p. 521; Bouleng. Cat. Sn. iii. p. 152.

Synopsis of the Species.

I. Scales in 17 rows.

A. Frontal, in the middle, much narrower than the supraocular.

Anal entire; 8 upper labials, 2 entering the eye........................ *P. notostictus.*
Anal divided; 8 (rarely 9) upper labials, 2 entering the eye......... *P. sibilans.*
Anal divided; 9 upper labials, 3 entering the eye .... *P. bocagii.*

B. Frontal, in the middle, not or but little narrower than the supraocular; 7 or 8 upper labials, 2 entering the eye. *P. brevirostris.*

II. Scales in 15 rows or less.

Scales in 15 rows; 7 upper labials .... *P. ansorgii.*
Scales in 11 rows; 8 upper labials .... *P. angolensis.*

1. PSAMMOPHIS NOTOSTICTUS Peters, Mon. Berl. Ac. 1867, p. 237; Bouleng. t. c. p. 156; Bocage, Herp. Ang. p. 116.

Lower Congo, Angola, S. Africa.

2. PSAMMOPHIS SIBILANS.

Coluber sibilans Linn. S. N. i. p. 383.
Psammophis sibilans Bouleng. t. c. p. 161; Bocage, Herp. Ang. p. 114 (part.).

Tropical and South Africa, Egypt.

3. PSAMMOPHIS BOCAGII Bouleng. t. c. p. 161, pl. viii. fig. 1.

Psammophis sibilans, var. A, Bocage, Herp. Ang. p. 115.

Katanga, Rhodesia, Angola, Bechuanaland.

4. PSAMMOPHIS BREVIROSTRIS Peters, Sitzb. Ges. Naturf. Fr. Berl. 1881, p. 89; Bouleng. t. c. p. 166.

Angola, South Africa.

5. PSAMMOPHIS ANSORGII Bouleng. Ann. & Mag. N. H. (7) xvi. 1905, p. 113, pl. iv. fig. 4.

Angola.

6. PSAMMOPHIS ANGOLENSIS.

Amphiophis angolensis Bocage, Jorn. Sc. Lisb. iv. 1872, p. 82, and Herp. Ang. p. 113, pl. xi. fig. 3.
Psammophis angolensis Bouleng. t. c. p. 170.

Angola, Katanga, Nyassaland, East Africa, Orange River Colony.

10. DISPHOLIDUS.

Duvernoy, Ann. Sc. Nat. xxvi. 1832, p. 150; Bouleng. Cat. Sn. iii. p. 186.

1. DISPHOLIDUS TYPUS.

Bucephalus typus A. Smith, Zool. Journ. iv. 1829, p. 441.
Dispholidus typus Bouleng. t. c. p. 187.
Bucephalus capensis Bocage, Herp. Ang. p. 121.

Tropical and South Africa.

11. THELOTORNIS.

A. Smith, Ill. Zool. S. Afr., Rept.; Bouleng. Cat. Sn. iii. p. 184.

1. THELOTORNIS KIRTLANDII.

Leptophis kirtlandii Hallow. Proc. Ac. Philad. 1844, p. 62.

Thelotornis kirtlandii Bouleng. t. c. p. 185.
Dryiophis kirtlandii Bocage, Herp. Ang. p. 119.
Tropical and South Africa.

12. Calamelaps.

Günth. Ann. & Mag. N. H. (3) xviii. 1866, p. 26; Bouleng. Cat. Sn. iii. p. 245.

Two species :—

Scales in 19 or 21 rows; second upper labial not in contact with præfrontal	*C. polylepis.*
Scales in 19 rows; second upper labial in contact with præfrontal...	*C. mellandi.*

1. Calamelaps polylepis Bocage, Jorn. Sc. Lisb. iv. 1873, p. 216, and Herp. Ang. p. 126, pl. ix. fig. 2; Bouleng. t. c. p. 246.
Angola, Nyassaland.

2. Calamelaps mellandi, sp. n.*
Lake Bangwelu.

13. Xenocalamus.

Günth. Ann. & Mag. N. H. (4) i. 1868, p. 414; Bouleng. Cat. Sn. iii. p. 247.

Two species :—

Nasal divided; 6 upper labials, 3rd and 4th entering eye; scales in 17 rows	*X. mechovii.*
Nasal entire; 5 upper labials, 2nd and 3rd entering eye; scales in 21 rows	*X. michelli.*

1. Xenocalamus mechovii Peters, Sitzb. Ges. Naturf. Fr. Berl. 1881, p. 147; Bouleng. t. c. p. 248.
Congo, Angola.

2. Xenocalamus michelli L. Müller, Zool. Anz. xxxviii. 1911, p. 359.
Kituri (Katanga).

14. Apostolepis.

Cope, Proc. Ac. Philad. 1861, p. 524; Bouleng. Cat. Sn. iii. p. 232.

1. Apostolepis gerardi Bouleng. Rev. Zool. Afr. iii. 1913, p. 103, fig.
Katanga at Kikondja.

* No postocular; parietal forming a suture with the fourth upper labial; ventrals 181. Uniform blackish.—A single male specimen from Chirini Id., Lake Bangwelu, presented by Mr. F. H. Melland.

15. Miodon.

A. Dum. Arch. Mus. x. 1859, p. 206; Bouleng. Cat. Sn. iii. p. 249.

Synopsis of the Species.

I. Anal entire; ventrals 190–216 .... *M. acanthias.*

II. Anal divided.

Internasals considerably shorter than the præfrontals; ventrals 201–228; nasal divided .... *M. collaris.*

Internasals as long as or slightly shorter than the præfrontals; ventrals 214–249; nasal entire or incompletely divided .... *M. gabonensis.*

Internasals as long as or slightly shorter than the præfrontals; ventrals 181–214; nasal divided .... *M. notatus.*

1. Miodon acanthias.

Urobelus acanthias Reinh. Vidensk. Meddel. 1860, p. 229, pl. iii.

Miodon acanthias Bouleng. t. c. p. 250.

? *Microsoma collare*, var. D, Bocage, Herp. Ang. p. 126.

Guinea; Congo (?).

2. Miodon collaris.

Microsoma collare Peters, Sitzb. Ges. Naturf. Fr. Berl. 1881, p. 148; Bocage, op. cit. p. 124, pl. xiv. figs. 1 & 2.

Miodon collaris Bouleng. t. c. p. 251.

West Africa, from Old Calabar to Angola.

3. Miodon gabonensis.

Elapomorphus gabonensis A. Dum. Rev. et Mag. Zool. (2) viii. 1856, p. 468.

Miodon gabonensis Bouleng. t. c. p. 252.

West Africa, from Old Calabar to the Congo.

4. Miodon notatus.

Microsoma notatum Peters, Sitzb. Ges. Naturf. Fr. Berl. 1882, p. 127.

Miodon notatus Bouleng. t. c. p. 252.

Cameroon, Congo.

16. Cynodontophis.

Werner, Verh. zool.-bot. Ges. Wien, lii. 1902, p. 345.

1. Cynodontophis æmulans Werner, t. c. p. 346.

Congo.

17. Hypoptophis.

Bouleng. Ann. & Mag. N. H. (8) ii. 1908, p. 92.

Michellia L. Müller, Zool. Anz. xxxviii. 1911, p. 358.

1. Hypoptophis wilsonii Bouleng. l. c.

Michellia katangæ L. Müller, l. c.

Congo (Kasai Province and Katanga).

18. Aparallactus.

A. Smith, Ill. Zool. S. Afr., Rept., App. p. 15; Bouleng. Cat. Sn. iii. p. 255.

Synopsis of the Species.

I. Third and fourth upper labials entering the eye.

A. Subcaudals 49–59; nasal divided.

First lower labial in contact with its fellow behind the symphysial; frontal as long as parietals .... *A. lunulatus.*
Symphysial in contact with the anterior chin-shields; frontal a little shorter than parietals .... *A. guentheri.*

B. Subcaudals 35–53; nasal entire; symphysial in contact with the chin-shields.

Ventrals 175–191 .... *A. bocagii.*
Ventrals 138–166 .... *A. capensis.*

C. Subcaudals 38–40; nasal divided; first lower labial in contact with its fellow behind the symphysial.

1. Frontal a little longer than broad.

Sixth upper labial not in contact with the parietal............ *A. dolloi.*
Sixth upper labial forming a short suture with the parietal... *A. ubangensis.*
Sixth upper labial forming a long suture with the parietal ... *A. flavitorques.*

2. Frontal nearly twice as long as broad .... *A. congicus.*

II. Second and third upper labials entering the eye; nasal entire; symphysial in contact with the anterior chin-shields; subcaudals 36–41 .... *A. punctatolineatus.*

1. Aparallactus lunulatus.

Uriechis lunulatus Peters, Mon. Berl. Ac. 1854, p. 623.

Aparallactus lunulatus Bouleng. t. c. p. 258.

Eastern Central Africa (L. Tanganyika, N. Rhodesia, and Nyassaland) and Mozambique.

2. Aparallactus guentheri Bouleng. Ann. & Mag. N. H. (6) xvi. 1895, p. 172, and Cat. Sn. iii. p. 259, pl. xi. fig. 2.

Angola, Central and East Africa.

3. Aparallactus bocagii Bouleng. tt. cc. pp. 173, 259.

Angola.

4. Aparallactus capensis A. Smith, Ill. Zool. S. Afr., Rept., App. p. 16; Bouleng. Cat. Sn. iii. p. 259.

Katanga, East and South Africa.

5. Aparallactus dolloi Werner, Verh. zool.-bot. Ges. Wien, lii. 1902, p. 346.

Ubanghi.

6. Aparallactus ubangensis Bouleng. Ann. & Mag. N. H. (6) xix. 1897, p. 279, fig., and Ann. Mus. Congo, Zool. ii. 1901, p. 11, pl. iv. fig. 2.

Ubanghi.

7. Aparallactus flavitorques Bouleng. Ann. Mus. Congo, Zool. ii. 1901, p. 11, pl. iv. fig. 3.

Kasai.

8. Aparallactus congicus Werner, Verh. zool.-bot. Ges. Wien, lii. 1902, p. 346.

Congo (Lingunda).

9. Aparallactus punctatolineatus Bouleng. Ann. & Mag. N. H. (6) xvi. 1895, p. 173, and Cat. Sn. iii. p. 261.

Angola and Nyassaland.

19. Elapops.

Günth. Ann. & Mag. N. H. (3) iv. 1859, p. 161; Bouleng. Cat. Sn. iii. p. 262.

1. Elapops modestus Günth. l. c.; Bouleng. l. c.

West Africa, from Liberia to the Congo.

C. Proteroglypha.

Synopsis of the Genera.

(Loreal absent in all the genera.)

I. Head short, snout broader than long; body cylindrical; subcaudals less than 95.

Scales not at all oblique; ventrals 192–221; subcaudals 67–80 ...	*Boulengerina.*
Scales more or less oblique, sometimes very slightly; ventrals 141–172; subcaudals 13–36	*Elapechis.*
Scales oblique; ventrals 180–228; subcaudals 50–92	*Naia.*

II. Head long, narrow, snout not broader than long; body slightly compressed; scales very oblique; ventrals 202–270; subcaudals 97–121 .... *Dendraspis.*

1. Boulengerina.

Dollo, Bull. Mus. Belg. iv. 1886, p. 159; Bouleng. Cat. Sn. iii. p. 357.

Synopsis of the Species.

Scales in 23 or 25 rows: temporals 1+2	*B. annulata.*
Scales in 21 rows; temporals 1+2	*B. stormsi.*
Scales in 17 rows; temporals 2+2 or 2+3	*B. christyi.*

1. Boulengerina annulata.

Naia annulata Buchh. & Peters, Mon. Berl. Ac. 1876, p. 119; Bocage, Herp. Ang. p. 137.

Boulengerina annulata Bouleng. P. Z. S. 1900, p. 455, pl. xxxii.

Cameroon to Congo.

2. BOULENGERINA STORMSI Dollo, t. c. p. 160, fig.; Bouleng. l. c. Lake Tanganyika.

3. BOULENGERINA CHRISTYI Bouleng. Ann. & Mag. N. H. (7) xiv. 1904, p. 14.

Congo (near Leopoldville).

2. ELAPECHIS.

Bouleng. Cat. Sn. iii. p. 358.

Synopsis of the Species.

A. Scales in 13 rows; subcaudals 13–25.

First lower labial in contact with its fellow behind the symphysial; internasals much shorter than the præfrontals	*E. guentheri.*
First lower labial in contact with its fellow behind the symphysial; internasals three-fourths the length of the præfrontals	*E. niger.*
Symphysial in contact with the anterior chin-shields	*E. hessii.*

B. Scales in 15 rows; subcaudals 31–36; first lower labial in contact with its fellow behind the symphysial.

No suboculars; ventrals 150	*E. duttoni.*
Two suboculars; ventrals 172	*E. multifasciatus.*

1. ELAPECHIS GUENTHERI.

Elapsoidea guentheri Bocage, Jorn. Sc. Lisb. i. 1866, p. 70, pl. i. fig. 3, and Herp. Ang. p. 129, pl. xiv. fig. 3.

Elapechis guentheri Bouleng. t. c. p. 359.

Tropical Africa, from the Gaboon and Uganda to Angola and Nyassaland.

2. ELAPECHIS NIGER.

Elapsoidea nigra Günth. Ann. & Mag. N. H. (6) i. 1888, p. 332.

Elapechis niger Bouleng. t. c. p. 359, pl. xx. fig. 1.

Congo, N. Rhodesia, East Africa.

3. ELAPECHIS HESSII.

Elapsoidea hessei Boettg. Zool. Anz. 1887, p. 651.

Elapechis hessii Bouleng. t. c. p. 360.

Congo (Banana).

4. ELAPECHIS DUTTONI Bouleng. Ann. & Mag. N. H. (7) xiv. 1904, p. 15.

Congo (near Leopoldville).

5. Elapechis ? multifasciatus.

Naia multifasciata Werner, Verh. zool.-bot. Ges. Wien, lii. 1902, p. 347.

Congo (Upper Maringa).

3. Naia.

Laur. Syn. Rept. p. 90; Bouleng. Cat. Sn. iii. p. 372.

Synopsis of the Species.

I. 19 to 29 scales across the neck, which is dilatable.

Sixth upper labial largest and deepest, in contact with the lower postocular; temporals 1+2 or 3	*N. melanoleuca.*
Third upper labial deepest, sixth not in contact with postoculars; temporals 2 or 3+4 or 5	*N. nigricollis.*

II. 15 or 17 scales across the neck, which is not dilatable.

Eye separated from labials by suboculars; scales in 17 rows on body; subcaudals 52–62	*N. anchietæ.*
Fourth or third and fourth upper labials entering the eye; scales in 13 or 15 rows on body; subcaudals 88–92	*N. goldii.*

1. Naia melanoleuca.

Naia haie, var. *melanoleuca* Hallow. Proc. Ac. Philad. 1857, pp. 61 & 72; Bocage, Herp. Ang. p. 132.

Naia melanoleuca Bouleng. t. c. p. 376.

Tropical Africa, from the Gold Coast and Uganda to Angola and Nyassaland.

2. Naia nigricollis Reinh. Vid. Selsk. Skrift. x. 1843, p. 269, pl. iii. figs. 5–7; Bocage, Herp. Ang. p. 135; Bouleng. t. c. p. 378.

Senegambia and Upper Egypt to Bechuanaland and Natal.

3. Naia anchietæ Bocage, Jorn. Sc. Lisb. vii. 1879, pp. 89 & 98, and Herp. Ang. p. 133, pl. xvi. fig. 2; Bouleng. t. c. p. 387.

Angola and Ovamboland.

4. Naia goldii Bouleng. Ann. & Mag. N. H. (6) xvi. 1895, p. 34, and Cat. t. c. p. 387, pl. xx. fig. 2.

Naia guentheri Bouleng. Cat. t. c. p. 388, pl. xxi.

Sierra Leone to Congo (Kasai).

4. Dendraspis.

Schleg. Versl. Zool. Gen. Amsterd. 1848; Bouleng. Cat. Sn. iii. p. 434.

Two species:—

A large upper temporal, in contact with the whole outer border of the parietal; scales in 15 to 19 rows	*D. jamesonii.*
Two upper temporals in contact with the outer border of the parietal; scales in 19 to 23 rows	*D. angusticeps.*

1. Dendraspis jamesonii.

Elaps jamesonii Traill, in Schleg. Phys. Serp., Engl. Transl. p. 179, pl. ii. figs. 19 & 20.

Dendraspis neglectus Bocage, Herp. Ang. p. 138, pl. xv. fig. 2.

Dendraspis jamesonii Bouleng. t. c. p. 436.

Tropical Africa, from Nigeria and Uganda to the Congo and Angola.

2. Dendraspis angusticeps.

Naia angusticeps A. Smith, Ill. Zool. S. Afr., Rept. pl. lxx.

Dendraspis angusticeps Bocage, Herp. Ang. p. 140, pl. xv. fig. 3; Bouleng. t. c. p. 437.

East and Central Africa, Angola, South Africa.

Family Viperidæ.

Synopsis of the Genera.

I. Eye moderate or large, separated from the upper labials by suboculars; ventrals less than 180.

Upper sursace of head covered with large symmetrical shields; pupil round .... *Causus.*

Upper surface of head covered with scales; pupil vertical; subcaudals in two rows .... *Bitis.*

Upper surface of head covered with scales; pupil vertical; subcaudals single; tail prehensile .... *Atheris.*

II. Eye minute, with round pupil; upper surface of head covered with large symmetrical shields; no loreal; a small præocular usually present; ventrals 178–356 .... *Atractaspis.*

1. Causus.

Wagl. Syst. Amph. p. 172; Bouleng. Cat. Sn. iii. p. 465.

Synopsis of the Species.

I. Scales in 17 rows or more; subcaudals all or greater part in two rows.

Snout obtuse, moderately prominent; ventrals 120–155 .... *C. rhombeatus.*

Snout prominent, often more or less distinctly turned up at the end; scales in 19 to 22 rows; ventrals 134–152 .... *C. resimus.*

Snout prominent, more or less turned up at the end; scales in 17 rows; ventrals 110–125 .... *C. defilippii.*

II. Scales in 15 rows; subcaudals single .... *C. lichtensteinii.*

1. Causus rhombeatus.

Sepedon rhombeatus Licht. Verz. Doubl. Mus. Berl. p. 106.

Causus rhombeatus Bouleng. t. c. p. 467: Bocage, Herp. Ang. p. 145.

Tropical and South Africa.

2. Causus resimus.

Heterophis resimus Peters, Mon. Berl. Ac. 1862, p. 277, pl. —, fig. 4.

Causus resimus Bouleng. t. c. p. 468; Bocage, op. cit. p. 148.

East and Central Africa, Angola.

3. Causus defilippii.

Heterodon defilippii Jan, Arch. Zool. Anat. Phys. ii. 1862, p. 225.

Causus defilippii Bouleng. t. c. p. 469.

East and Central Africa, S. Rhodesia, Transvaal.

4. Causus lichtensteinii.

Aspidelaps lichtensteinii Jan, Rev. et Mag. Zool. 1859, p. 511.
Causus lichtensteinii Bouleng. t. c. p. 470.

Tropical Africa, from the Gold Coast and Uganda to the Congo.

2. Bitis.

Gray, Zool. Miscell. p. 69; Bouleng. Cat. Sn. iii. p. 492.

Synopsis of the Species.

I. One or two series of scales between the nasal and the rostral.

Nostrils directed entirely upwards; scales in 29 to 41 rows .... *B. arietans.*
Nostrils directed upwards and outwards; scales in 25 or 27 rows . *B. peringueyi.*
Nostrils directed upwards and outwards; scales in 22 to 29 rows; an erect horn-like scale above the eye (rarely absent)............... *B. caudalis.*

II. Four or five series of scales between the nasal and the rostral; scales in 33 to 41 rows.

A single enlarged, sometimes horn-like scale above the internasal, in contact with its fellow.. *B. gabonica.*
Two or three enlarged, horn-like scales above the internasal, usually with small scales between them and their fellows......... *B. nasicornis.*

1. Bitis arietans.

Vipera arietans Merr. Tent. p. 152; Bocage, Herp. Ang. p. 149.

Bitis arietans Bouleng. t. c. p. 493.

Tropical and South Africa; Southern Arabia.

2. Bitis peringueyi.

Vipera peringueyi Bouleng. Ann. & Mag. N. H. (6) ii. 1888, p. 141.

Vipera heraldica Bocage, Herp. Ang. p. 151, pl. xvi. fig. 1.

Bitis peringueyi Bouleng. t. c. p. 495.

Angola, Damaraland, Kalahari.

3. Bitis caudalis.

Vipera caudalis A. Smith, Ill. Zool. S. Afr., Rept. pl. vii.; Bocage, Herp. Ang. p. 450.

Bitis caudalis Bouleng. t. c. p. 498.

Angola and South Africa.

4. Bitis gabonica.

Echidna gabonica Dum. & Bibr. Erp. Gén. vii p. 1428, pl. lxxx. *b*.

Bitis gabonica Bouleng. t. c. p. 499.
Vipera rhinoceros Bocage, Herp. Ang. p. 149.
Tropical Africa.

5. BITIS NASICORNIS.

Coluber nasicornis Shaw, Nat. Miscell. iii. pl. xciv.
Bitis nasicornis Bouleng. t. c. p. 500.
Tropical Africa.

3. ATHERIS.

Cope, Proc. Ac. Philad. 1862, p. 337; Bouleng. Cat. Sn. iii. p. 508.

Two species:—

Scales in 15 to 25 rows; gular scales strongly keeled .... *A. squamiger*.
Scales in 25 to 32 rows; gular scales smooth or very feebly keeled... *A. nitschei*.

1. ATHERIS SQUAMIGER.

Echis squamigera Hallow. Proc. Ac. Philad. 1854, p. 193.
Atheris squamiger Bouleng. t. c. p. 509; Bocage, Herp. Ang. p. 152.
West Africa, from Calabar to Angola, Central Africa and Uganda.

2. ATHERIS NITSCHEI Tornier, Zool. Jahrb., Syst. xv. 1902, p. 589, fig.

Atheris woosnami Bouleng. Ann. & Mag. N. H. (7) xviii. 1906, p. 37.
Belgian Congo, N.W. of L. Tanganyika, Mt. Ruwenzori, western parts of German East Africa.

4. ATRACTASPIS.

A. Smith, Ill. Zool. S. Afr., Rept.; Bouleng. Cat. Sn. iii. p. 510.

Synopsis of the Species.

I. Anal divided; all or most of the subcaudals paired; snout rounded.

A. Second lower labial separated from its fellow by the chin-shields.

Scales in 19 to 21 rows; ventrals 200–235 .... *A. congica*.
Scales in 23 to 27 rows; ventrals 217–257 .... *A. irregularis*.

B. Second lower labial forming a suture with its fellow; scales in 21 to 23 rows; ventrals 336–356 .... *A. heterochilus*.

II. Anal entire; all or most of the subcaudals single.

A. Postocular in contact with a large temporal.

1. First lower labial forming a suture with its fellow behind the symphysial.

Snout very prominent, cuneiform; second lower labial very large, forming a suture with its fellow; scales in 23–27 rows; ventrals 178–193 .... *A. corpulenta*.
Snout prominent, subcuneiform; third lower labial very large; ventrals 221–260 .... *A. bibronii*.

2. Symphysial in contact with the chin-shields; snout rounded; scales in 23 to 25 rows; ventrals 240–242.

A præocular .... *A. katangæ.*
No præocular .... *A. coarti.*

B. Temporals small, 2 or 3 superposed in front; snout prominent, subcuneiform; scales in 29 to 37 rows; ventrals 212–245 .... *A. microlepidota.*

1. Atractaspis congica Peters, Mon. Berl. Ac. 1877, p. 616, pl. —, fig. 2; Bocage, Herp. Ang. p. 142; Bouleng. t. c. p. 513.

Congo, Angola.

2. Atractaspis irregularis.

Elaps irregularis Reinh. Vid. Selsk. Skrift. x. 1843, p. 264, pl. iii. figs. 1–3.

Atractaspis irregularis Bouleng. t. c. p. 513; Bocage, op. cit. p. 143.

West and Central Africa, from the Gold Coast and Uganda to the Congo.

3. Atractaspis heterochilus Bouleng. Ann. Mus. Congo, Zool. ii. 1901, p. 13, pl. v. fig. 1.

Lake Tanganyika; Cameroon.

4. Atractaspis corpulenta.

Brachycranium corpulentum Hallow. Proc. Ac. Philad. 1854, p. 99.

Atractaspis corpulentus Bouleng. Cat. Sn. iii. p. 514.

West Africa, from Liberia to the Congo.

5. Atractaspis bibronii A. Smith, Ill. Zool. S. Afr., Rept. pl. lxxi.; Bouleng. t. c. p. 515; Bocage, Herp. Ang. p. 141.

Congo, Angola, and South Africa.

6. Atractaspis katangæ Bouleng. Ann. Mus. Congo, Zool. ii. 1901, p. 13, pl. v. fig. 2.

Katanga; German E. Africa.

7. Atractaspis coarti Bouleng. t. c. p. 14, pl. v. fig. 3.

Lake Tanganyika.

8. Atractaspis microlepidota Günth. Ann. & Mag. N. H. (3) xviii. 1866, p. 29, pl. vii; Bouleng. Cat. Sn. iii. p. 517.

East and Central Africa (Lake Tanganyika).

17. The Artificial Formation from Paraffin Wax of Structures resembling Molluscan Shells. By J. T. Cunningham, M.A., F.Z.S.

[Received January 26, 1915: Read March 23, 1915.]

(Text-figures 1–5.)

In December last Mr. R. H. Burne exhibited before this Society some specimens of forms assumed by paraffin-wax when cooled, which resembled in a striking way in shape and markings the shells of Molluscs. These specimens were presented to Mr. Burne by Herr C. U. Ariens Kappers, of the Senckenbergisches Institut, Frankfurt a. M., and they are described by him in a paper published in the Zeitschrift für Allgemeine Physiologie in 1907. In that paper no information is given concerning the conditions under which these structures are formed, it being merely stated that they are produced when the melted paraffin-wax solidifies. The shells imitated are stated to be Lamellibranchs, Gastropods (operculum of *Turbo*), and Brachiopoda. Seeking the explanation of these resemblances, Herr Kappers adopts the conclusion of Harting and Bedermann that the form and characters of molluscan shells, as well as those of otoliths, egg-shells, and the skeletons of Foraminifera, Alcyonaria, and Echinoderma, are due to the aggregation of crystals of calcium salts formed within a colloid medium, the crystals being of a special kind called sphæro-crystals or calcosphærites. He maintains that paraffin-wax shares with calcium salts the property of forming sphærocrystals, and that the formation of crystals from a solution takes place in essentially the same way as in the solidification of a molten mass. Moreover, there is a further resemblance in the viscosity of the mother liquid, the form which a crystal assumes being more or less influenced by the resistance which its particles encounter in its formation. In molten substances unequal terminal surfaces of the crystals, causing bending and distortion of the forms of the larger crystals formed by means of the smaller, also occur as in viscous solutions.

Kappers believes that the rapid cooling which is specially effected for histological purposes is favourable to the production of the forms under discussion, because the crystals are then formed in the viscous medium of the cooling substance, whereas in slow cooling normal crystals have time to form. It will be seen below that my experiments are in contradiction to this, for if the melting-point of the paraffin is high it is more difficult to obtain shell-like masses.

In the discussion that followed Mr. Burne's exhibition and description of the specimens exhibited, I expressed the conclusion from the appearance of the specimens that their form and markings were not to be explained by any effect of crystallization, but were due, as in the case of molluscan shells, to the successive addition of accretions in a particular direction. The resemblance to molluscan shells consisted in (*a*) external form, (*b*) markings. In form the plates of paraffin resembled in some cases Lamellibranch shells, varying as these do in the proportion of breadth to length, and the narrower ones were more like Brachiopod shells. In all cases there was a prominence corresponding to the umbo of a shell. One specimen had a spiral twist like that of a Gastropod, only flatter; Kappers compares it with the spiral operculum of *Turbo*. With regard to markings, all the specimens showed parallel or rather concentric lines or striæ, having in the Lamellibranch-like forms the umbo for a common focus, in the spiral forms being parallel to the edge. These lines are closely similar to the lines of growth in molluscan shells, except that they are slighter, not forming such projecting ridges as in true shells, and never as in the latter furnished with spines or processes. One important difference between the paraffin simulacra and real shells, was that while one surface in the former was convex and bore the concentric markings, the other was in all cases flat, though not smooth, in fact was precisely similar to the free surface always formed when a mass of molten paraffin-wax is cooled in a vessel or a mould. In a shell the inner surface is always concave and smooth.

It seemed to me that the paraffin plates or simulacra of shells consisted of successive layers superimposed one on another, each succeeding one being larger in area than the one below, and the lines on the convex surface being the edges of the successive layers. If this were the case, there would be a real, though not an exact, resemblance between the paraffin masses and molluscan shells, for it is well known that in the growth of the latter additions are made both to the edge and to the inner surface; the mantle secretes over its whole surface, and as it grows each successive layer is larger than the preceding and extends beyond its edge.

Something was said by Mr. Burne about the paraffin simulacra having been formed by cooling with water, and I therefore made experiments by pouring molten paraffin-wax into water. The success was immediate: the wax is lighter than water and therefore floats, and when the cooled mass was taken out it was in all respects similar to the specimens obtained by Kappers. The exact shape of the mass depended on the way in which the molten mass was poured into the water. If it was poured down the side of the basin the mass remained attached to the latter, and the flow extended away from it: then the shape resembled that of a Brachiopod shell. When the wax was poured on to the free surface of the water, it spread out more evenly and took the form of a cockle or pecten. The first wax to touch the water forms the umbo, that which follows flows over it and spreads out in ever widening layers. The stream of wax must always be kept running on to the mass already on the surface of the water, otherwise a long irregular band is produced which has no particular interest. I have not been able to make the wax flow equally all round the umbo, to produce a resemblance to the limpet shell, because such a mode of flow would be a case of unstable equilibrium; the force of the flow is never perfectly vertical to the surface of the water, but always tends in one direction or another and drives the mass away from the point of contact with the stream.

In order to produce spiral forms precisely similar to those described by Kappers and exhibited by Mr. Burne, I took a round jar full of water and stirred the latter so that it revolved, and then poured the wax on to the surface near the centre. As the mass is rather flat, the wax being much lighter than water, the form produced resembles, as Kappers mentions, a spiral operculum like that of *Turbo*, and not an ordinary Gastropod shell. When the water is stirred in a right-handed direction, the spiral is right-handed, and when the water is stirred in the opposite way the spiral of the paraffin plate is left-handed. This alone is sufficient to prove that the resemblance to a shell has nothing to do with crystallization, since the direction of the spiral merely depends on the direction in which the water is revolving. It is to be noted that as one looks down on the paraffin plate, the direction of its spiral is opposite to that of the water, for when the water is moving in a right-handed revolution the movement of the water carries the wax that first falls to the right, and the additions are made to the left; but the form of the spiral shows on the *lower* surface of the plate of wax, and, of course, when the plate is reversed after it has solidified the spiral appears right-handed. In some cases I obtained spiral forms which closely resembled the internal surface of the operculum of *Turbo*. The outer surface of this structure is smooth and flat, though it shows the spiral direction of growth, but the inner surface bears a prominent spiral ridge. By pouring the wax at the outer edge of the revolving mass on the water, I obtained plates with a similar prominent spiral ridge.

The concentric lines on the convex surface of the mass are, as in the molluscan shell, lines of growth or accretion, but their formation requires explanation, since a continuous flow over a smooth surface like that of water, while it would account for the shape, would not be expected to show any lines on the surface in contact with the water. The lines are due probably to the combined effect of surface tension and the slight contraction of the edges of the solidified layer in contact with the water. The molten wax is unable to flow immediately over the edge of the solidified layer, but is heaped up above it until its pressure is too great for the surface tension, when it flows over and comes into contact with the water, and then the process is repeated. The vibration of the water caused by the fall of the wax may have some effect in determining the rhythm of these successive flows, but when the wax falls from a slightly greater height the effect of the vibrations is seen in a series of large knobs on the lower surface of the paraffin mass.

Although, as remarked above, Kappers does not describe in his paper how the shell-like masses were formed, he gives some information on this question in a private letter to Mr. Burne, which that gentleman has kindly sent to me. In this letter Kappers states that since he obtained the specimens by accident he has from time to time tried to make them purposely, but always failed. They were formed by molten wax that escaped between the embedding mould and the zinc table on which it rested, the molten wax "coming soon in contact with water (aqueduct water)." I presume that aqueduct water means what we call tap-water. He goes on to say that it must be possible to make the shapes purposely, that he tried to do this in watch-glasses floating on water, and got some "which showed the principle very clearly but were not nearly as nice as those obtained by accident." The paraffin he used was a mixture of 2 parts melting at 58° C. and 1 part melting at 42° C. That which I used melted at 52° C.

From these remarks of Herr Kappers it seems to me quite certain that the specimens he obtained were formed in the same way as mine, namely from molten wax flowing on to the surface of water. He gives a sketch showing the embedding mould resting on the metal table, but I presume from his remark about water that the edge of the zinc table overhung a vessel of water, such as a sink, and that the escaping wax flowed from the edge of the table on to the surface of the water. It is certain that no shell-like forms are produced by the wax cooling on a solid surface; I have tried this, and the only result is a plate of wax of fairly uniform thickness of rounded outline and no special markings either on the upper or lower surface.

I have also tried the effect of pouring the wax into watch-glasses floated in water, and found that concentric lines are produced on the surface in contact with the glass. The lines in this case are more circular round a centre in the middle of the watch-glass, but they are not so distinct and regular as when the wax is poured on to water. Their explanation is I believe the same as in the latter case.

Although I think it is quite evident from the facts and experiments above discussed that the form and markings of the shell-like masses have nothing at all to do with crystallization or the forms of crystals, I have made some investigation of the crystalline structure of the solidified wax, and give here the results of this investigation. The crystals of the wax can be seen in thin sections cut from a block, and have the form of elongated prisms. A simple way of obtaining these crystals is to melt a little of the wax on a microscope-slide and allow it to cool of its own accord, and then examine it with the microscope. The prisms are then seen to be aggregated in star-like clusters, very much like snow-crystals, or the crystals of ice formed on a frosted window-pane. A diagram of this arrangement is shown in text-fig. 1. This is the arrangement assumed by the crystals after slow cooling, when no special methods are used to accelerate the cooling. I have carefully compared by means of sections cut vertically or parallel to the free surfaces, (1) one of my shell-specimens, (2) a block formed by pouring the molten wax into a metal mould, the block being about $\frac{3}{4}$ in. long by $\frac{1}{2}$ in. wide, and cooled

Text-figure 1.

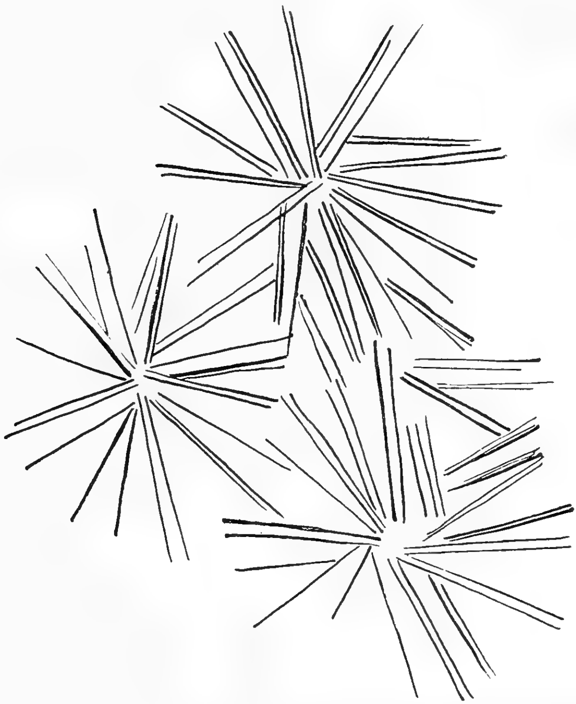


Diagram of stellate arrangement of prismatic crystals of paraffin-wax in the superficial portion of a spontaneously cooled mass.

spontaneously. I find that in a vertical section from the shell-specimen taken about the middle of the mass, the same stellate arrangement of crystals can be seen. The same arrangement also occurs in a section from the exposed surface. A portion of the lower surface, *i. e.* that which is suddenly cooled by contact with water, however, shows a different appearance, namely, a number of short irregular lines at angles to one another, marking out polygonal areas which may be the bases of crystals extending vertically into the interior (text-fig. 2). These lines and areas have no relation whatever to the concentric lines or markings which resemble those of molluscan shells, these markings consisting of ridges and depressions on the surface, while the others are microscopic and in the substance of the wax.

In a vertical section from the central part of the block cooled slowly in a metal mould, the stellate arrangement of the crystals is visible near the free surface, and a portion of the surface shows the same structure. When a superficial section of one of the lateral surfaces, or the base is examined no such structure can be seen, in fact crystals cannot be made out distinctly at all, the whole appearance is granular and compact.

Text-figure 2.

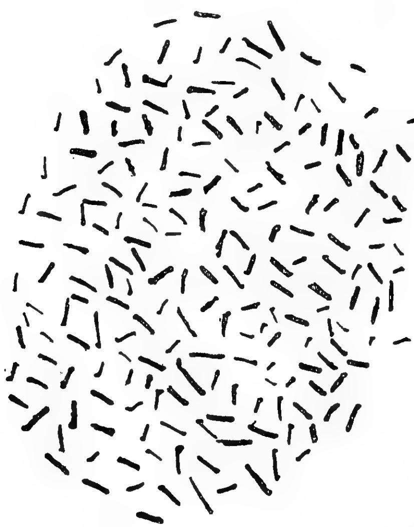


Diagram of appearance under microscope of portion of the lower surface of a shell-like plate of paraffin-wax, cooled by contact with water.

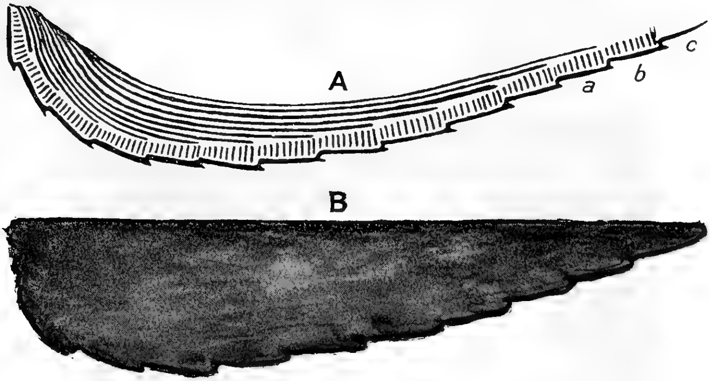
My conclusions from these observations is that the large prismatic crystals are formed where the cooling is slow and that they assume the stellate arrangement where there is most freedom of movement, *i.e.* near or at the free surface, as on a glass slide or at the surface of a block, or floating shell-like mass. On the other hand, where the cooling is rapid, as at the surface in contact with water or in contact with the metal of the mould, neither large crystals nor stellate arrangement is to be seen, the structure is more compact, apparently because the wax becomes solid at numerous closely crowded points at the same time, and crystals if formed at all are very minute. I have not been able to see any indications of crystals having any approximation to a spherical form, which I presume is the meaning of sphæro-crystals. I am inclined to think that the surface of a block of paraffin-wax in contact with a metal mould is cooled as quickly or even more so than that in contact with water, at least in a cold room in January, for the metal is a better conductor of heat than water, and is at a low temperature to start with. If the form assumed by the block was determined by the form of crystals the effect should be visible on the free surface of either a block in a mould, or a mass on the surface of water, for here the wax is free to take any form, whereas elsewhere it takes the form of the surface in contact with it. It is to be noted that Kappers gives no observations on the form of crystals in paraffin-wax, and makes no attempt to show that the form of his shell-like masses corresponded to the form or aggregation of the crystals of which they were composed.

With regard to the view that the forms in question are dependent on rapidity of cooling, certain experiments which I made with substances of a higher melting-point are important. It is evident that the greater the difference of temperature between the cooling medium and the melting-point of the molten substance, the more rapid and sudden will be the solidifying of the latter. Now I tried making the shell-like structures with hard paraffin, that is with paraffin-wax of a high melting-point, namely about 60° C., poured on to cold water, and the attempt was a failure. The wax cooled so rapidly that the edge of the cooled lower surface projected above the water and the molten wax flowing on to the cooled portion was piled up on it and then overflowed irregularly; finally, as cooling proceeded further, after the pouring was finished, the edges of the cooling mass curled rapidly inwards owing to rapid contraction, and the shape was entirely spoiled. By pouring the same paraffin on to *warmed* water, shell-like forms were produced, thus showing that rapid cooling was not the essential condition. I also experimented with bees'-wax, of which the melting-point is over 100° C., and with this material nothing resembling the shell-like structures could be obtained, simply because when poured on to water the wax became at once solid all through and only irregular masses were produced: the wax would not flow evenly over the solidified layer in contact with the water, but formed a tangle of solidified cords.

The causes of the assumption by paraffin-wax of these shell-like forms are, as I think I have shown, purely physical, and in itself the subject may seem to be of slight importance and to have little bearing upon zoology. But the subject acquires considerable zoological importance from the fact that the phenomena have been adduced in support of the view that the forms of molluscan shells are determined by the form and behaviour of the crystals of which their inorganic part is composed. For such a view the phenomena discussed in this paper afford no support whatever, and the doctrine itself has no scientific foundation. Considering the diversity of molluscan shells in general, the different shapes of Lamellibranch shells, the torsion of the Gastropod shell, and the variety of the spirals shown among the Gastropoda, the third type and included diversity in the shells of Cephalopoda, etc., it is impossible to suppose that crystals or sphæro-crystals should aggregate themselves in modes of corresponding diversity of type and detail merely because they were formed in a colloid medium. Moreover, we know that the form of the shell is determined by the mantle, the border of which secretes an organic layer of conchiolin, and this has the specific form of the shell before calcification takes place in it at all. Lastly, no reason has been given why the form or aggregation of crystals should produce the characteristic parallel or concentric markings on molluscan shells, which correspond to the edge at which growth takes place, each of which has, in fact, at some previous moment in the growth of the shell been its extreme edge. These markings are in fact evidence that the growth of the shell is not perfectly continuous but intermittent, although we do not know fully the causes of this rhythmical periodicity in the growth except in the annual markings. That the forms of spicules such as the three-, four-, or six-rayed spicules of sponges, may be determined by the form and aggregation of crystals, seems probable enough, but this is quite a different question from that of the form and markings of molluscan shells, which are determined by the extent and the physiological activities of the shell-secreting epithelium.

In text-figs. 3 & 4 I have given diagrams which show on an enlarged scale the mode in which growth takes place in a molluscan shell, and in one of the imitation shells of paraffin-wax, respectively. In the mollusc the edge of the mantle secretes conchiolin only, the periostracum; and for reasons, not so far as I know discovered, the growth of this edge is not uniform and continuous, but is stationary for a time, and then starts again not quite in the same direction, but the mantle leaves the extreme edge of the periostracum projecting and secretes a new band starting from the lower surface of the preceding band. In certain cases, as is well known, the edge of a band at certain intervals may be fringed with long spines or processes, as in *Cardium echinatum*. When the extreme border of the mantle has extended to a certain distance beyond its former limit, the next internal band of the mantle comes into contact with the band of periostracum just secreted, and forms on the inner surface of this an addition to the prismatic layer of the shell. When the next growth-movement of the mantle takes place, the prismatic-forming region passes out to the new border of periostracum, and the prismatic band just formed becomes covered by the region of the mantle which secretes the nacreous layer. The successive processes of secretion are shown in text-fig. 3 A, where *c* is the extreme band of periostracum in process of secretion, *b* the preceding band with the prismatic layer added to it, *a* the band preceding *b*, to which a single layer of nacreous shell-substance has been added. It is to be noted that in the true shell, as also in the wax imitation, between the more conspicuous lines of growth, which alone are indicated in the

Text-figure 3.

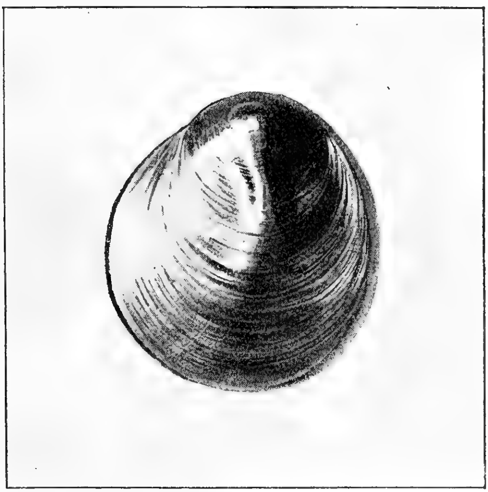


Comparison of form, markings, and structure in a molluscan shell, and artificial mitation of the same in paraffin-wax.

A. Diagram of section of a Lamellibranch shell. The outer line represents the periostracum which is uncalcified, and usually worn away except near the growing edge, which is on the right of the diagram. The layer indicated by vertical strokes is the prismatic layer, the curved continuous lines represent successive layers of the nacreous substance which lines the inner surface of the shell.

B. Section of a shell-like plate of paraffin-wax. The convex surface marked with depressions at regular intervals, is the lower surface in contact with the water; the horizontal surface is the upper surface, exposed to the air.

Text-figure 4.



Photograph of a 'shell' in paraffin-wax resembling a Lamellibranch shell, such as a cockle.

diagrams, there are numerous minor or secondary lines, so that each band, or wave of growth, is made up of a number of smaller bands, just as on the sea the larger wave has smaller waves on its surface.

Text-figure 5.

Photograph of a spiral 'shell' in paraffin-wax, resembling a Gastropod, but much flatter: more similar to the operculum of *Turbo*.

In the wax imitation of the shell the markings are purely superficial, as shown in text-fig. 3 B. If the layer of wax on the surface of the water at each successive moment of time were solidified before the next were added, the mass would consist of superimposed layers corresponding to the lines of 'growth' on the surface; but this is not the case, only the marginal increments are solidified, the internal mass remains as a quantity of liquid wax without structure and cools into a single mass.

In conclusion it may be pointed out that the only resemblance between the real shells and their wax counterparts, is that they are both formed by successive accretions to the edge: the marks of the boundaries of these accretions are due, in the case of the wax to interruptions of the flow by cooling of the lower layer and surface tension, in the case of the real shell to 'waves' of growth of the causes of which we are quite ignorant.

The photographs in text-figs. 4 & 5 were taken by my honorary assistant, Mr. H. G. Billinghurst, to whom also I am much indebted for assistance in carrying out the experiments.

18. The True Coracoid.

By the late R. Lydekker, F.R.S., F.Z.S.

[Received February 10, 1915: Read March 23, 1915.]

(Text-figures 1 & 2.)

Morphology.

In view of the long-standing existence of two diametrically opposite interpretations of the homology of the ventral elements or element * in the shoulder-girdle of vertebrates other than fishes, it is high time that morphologists should decide which they will adopt. It may be premised that the element (whichever it be) in the shoulder-girdle of the monotreme mammals and Permo-Triassic mammal-like reptiles entitled to bear the designation coracoid must be the one corresponding to the coracoid process of the human scapula, which is the type of that element. By anatomists generally the posterior ventral bone in the monotreme shoulder-girdle has been regarded as representing the true coracoid, and the anterior bone consequently considered as a superadded element, under the designation of precoracoid or epicoracoid; the single ventral element in the shoulder-girdle of birds and post-Triassic reptiles being identified with the one termed coracoid in the monotremes.

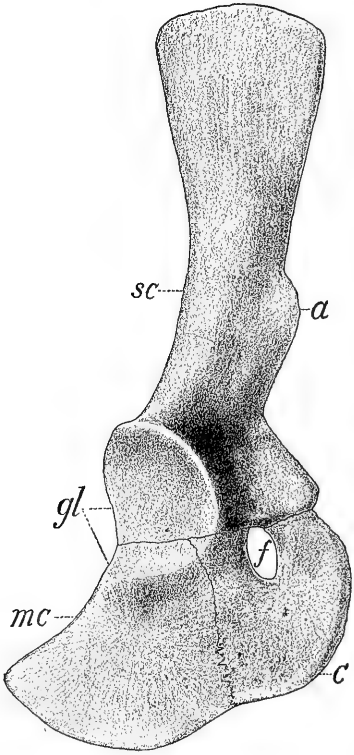
These identifications were disputed by myself in the Society's Proceedings for 1893 (pp. 172–4), where, upon the evidence of a distinct coracoidal element in the shoulder-girdle of a sloth, it was held that the so-called epicoracoid of the monotremes and mammal-like reptiles corresponds to the coracoid process of the human scapula, and is thus the true coracoid. Consequently, the bone in the aforesaid groups to which the latter name had been applied must receive a new designation, and the name metacoracoid was suggested for use in this sense. These homologies will be apparent from my original figure, of which a portion (text-figure 1) is herewith reproduced. A further inference was that when only a single ventral element is present in the shoulder-girdle, as in birds and post-Triassic reptiles, this, on account of having been identified with the posterior element in the monotreme shoulder-girdle, must also be a metacoracoid.

Among the great majority of naturalists these identifications have failed to gain acceptance. Recently, however, Prof. S. W. Williston, of Chicago University, who has devoted special attention to the osteology of the mammal-like reptiles, has accepted in his 'Water Reptiles of the Past and Present,' † my interpretation of the homology of the elements in the shoulder-girdle

* When the singular is used, reference is to one side only of the body.
† Chicago, 1914.

of monotremes and mammal-like reptiles, as is made clear by the accompanying diagrammatic illustration (text-fig. 2), reproduced from his fig. 19, p. 36. His researches, however, indicate that when one of the two ventral elements in the shoulder-girdle disappears, it is the posterior (and not, as previously supposed, the anterior) bone which is lost. This degeneration—as a preliminary

Text-figure 1.

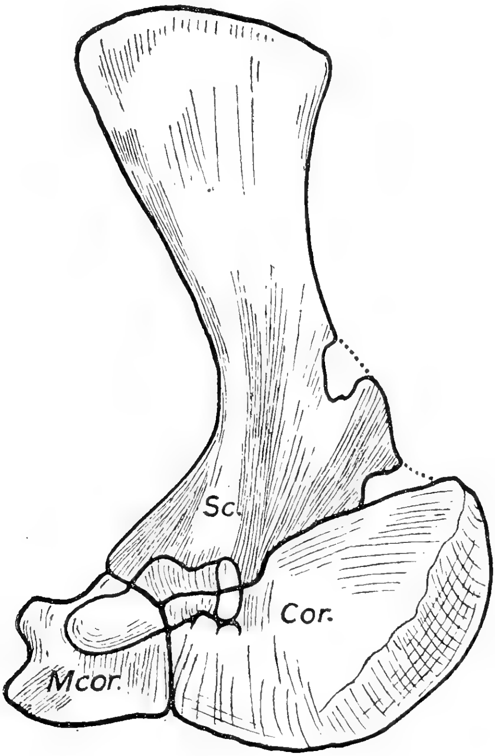


The right side of the shoulder-girdle of *Dicynodon*.

sc, scapula; *a*, acromion of scapula; *c*, coracoid; *mc*, metacoracoid; *f*, coraco-scapular foramen; *gl*, glenoid cavity.

to the ultimate disappearance—of the hinder element is exhibited in his figure, which illustrates a type in which the degeneration of that element has already become conspicuous, whereas in my original figure (text-fig. 1) the hinder element is fully as large as the front one. Consequently the element in birds and post-Triassic reptiles universally known as the coracoid is entitled to retain that designation, as being the homologue of the human coracoid process and its equivalent the true coracoid of the monotremes and mammal-like reptiles; and the more extensive change of nomenclature advocated in my original article thereby avoided.

Text-figure 2.



The right side of the shoulder-girdle of a Mammal-like Reptile (*Dimetrodon*).

Sc., scapula; *Cor.*, coracoid; *Mcor.*, metacoracoid. (From Williston.)

19. A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia. By Geo. E. Nicholls, D.Sc., F.L.S., late Professor of Biology, Agra College, Agra, India *.

[Received January 20, 1915: Read April 13, 1915.]

(Text-figure 1.)

Morphology.

It is, I believe, generally supposed that the neural canal in the Anura ends blindly in the urostyle. That this is not true of *Rana temporaria*—at any rate, in the young animal—I ascertained so far back as 1910, when examining sections (cut sagittally) through small frogs. In these sections the filum terminale is seen lying uncovered (except for connective tissue) upon the dorsal surface of the urostyle.

At that time, however, I paid no further attention to the matter, assuming that this was merely a transient condition in the young animal in which the absorption of the terminal portion of the filum terminale was not yet completed. I imagined that the resorption of tissues, which causes the disappearance of the tadpole-tail, would continue, and that, finally, what remained of the terminal filament would become entirely encased in bone. Unaccountably, it did not then occur to me to examine the adult urostyle.

While in India, however, I had occasion to examine closely the urostyle of *Rana tigrina*, the type commonly dissected in my laboratory there.

The urostyle of this species differs from that of *Rana temporaria* in the exceedingly variable occurrence of the paired perforations, which, in the latter species, admit of the exit of the tenth pair of spinal nerves. These perforations are, in *Rana tigrina*, frequently absent (text-fig. 1, *a*, *c*, *d*). When present (text-fig. 1, *b*, *X*.) they are extremely minute, and commonly, upon one side or the other, the external opening leads only into a blindly-ending canal.

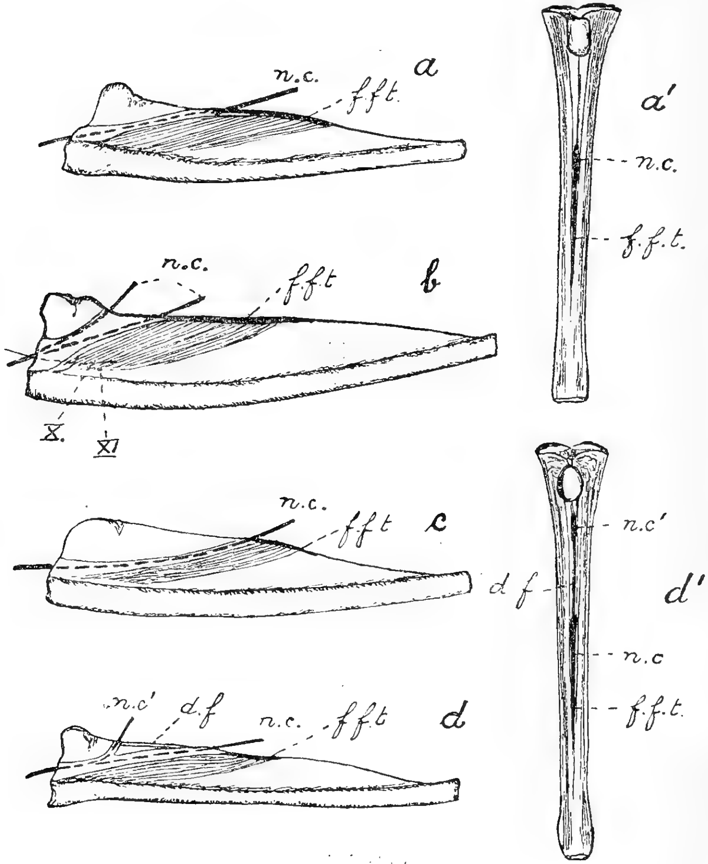
It was while engaged in studying the urostyle in connection with this matter that I noticed that the neural canal turned upwards very sharply, and apparently extended quite to the dorsal margin of the bone. The position and extent of this passage is clearly indicated (in the fresh condition), through the thin translucent bone, by the deeply pigmented meningeal sheath of the filum terminale and its related blood-vessels.

A recollection of the perforated condition of the urostyle which I had observed in the young *R. temporaria* led me to examine the upper margin of the urostyle with the aid of a powerful lens.

* Communicated by Prof. Arthur Dendy, D.Sc., F.R.S., F.Z.S.

The examination immediately revealed the fact that for a considerable distance upon the narrow crest of the bone there

Text-figure 1.



In *a* the position and extent of the neural canal, as seen typically in lateral view, of the urostyle of *Rana tigrina* are represented, $\times 1\frac{1}{2}$; *b*, *c*, *d* represent variations not infrequently found, also $\times 1\frac{1}{2}$. In *a′*, *d′* the urostyles *a* and *d* are represented as seen from above, but the size of the dorsal opening of the neural canal and the width of the dorsal furrow (in which lies the free end of the filum terminale) are greatly exaggerated.

n.c. indicates a bristle inserted in the neural canal and emerging dorsally. (In *b* the neural canal within the urostyle is short and wide, and the extreme positions, forward and backward, of the bristle are shown.) Actually, within the canal, the bristle is indicated by an interrupted line.

The black line *f.f.t.* indicates the extent of the dorsal furrow (the uncovered posterior extension of the neural canal) which lodges the end of the filum terminale; in *d* (and *d′*) a part of this furrow has been roofed in, leaving above it only a very shallow groove, *d.f.*, connecting an anterior opening of the neural canal, *n.c.′*, with the more posterior opening, *n.c.*

was a well-marked furrow. This furrow, which was deepest anteriorly, began at a point just in front of the place where the neural canal appeared to reach the dorsal surface (text-fig. 1, *a*, *a'*).

The passage of a bristle definitely established the further fact that the neural canal in the specimen studied did not end blindly, but, near the end of the first third of the length of the bone, opened out into this groove or furrow upon the dorsal surface. Thence it was continued nearly to the end of the middle third of the urostyle as the open groove referred to (text-fig. 1, *f.f.t.*). In the fresh condition this groove is occupied (as I afterwards determined by means of serial sections) by the extremity of the filum terminale, which thus has a position precisely similar to that which it occupies in the young *R. temporaria*. The open groove, extending approximately along the middle third of the dorsal surface of the urostylar crest, is thus a posterior uncovered extension of the neural canal.

An examination of a large number of urostyles (34) of specimens of *R. tigrina* showed that this terminal opening of the neural canal was an absolutely constant feature, occurring even in specimens showing marked abnormality of the vertebral column.

A point of difference noted, however, was that in some specimens the dorsal furrow was of much greater extent than in others. In all it ended at approximately the same point, but in some the furrow began nearly at the anterior extremity of the bone (text-fig. 1, *b*, *d*, *d'*). In some instances the dorsi-ventral diameter of the neural canal was unusually large, and the canal then extended to the dorsal margin of the urostyle at a point much nearer to its anterior end (text-fig. 1, *b*). In other examples the neural canal, though not of larger calibre than usual, passed dorsalwards much more abruptly. In these latter the dorsally situated (exposed) groove for the filum terminale was, relatively, much longer. A condition, varying in a manner precisely opposite to this, also occurs in which the filum terminale passes backwards in a direction much more nearly approaching the horizontal. In this case the uncovered extremity of the neural canal is, relatively, extremely short (text-fig. 1, *c*). In those examples, however, in which the neural terminal filament runs for a considerable distance in this groove upon the upper margin of the urostyle, it is not always uncovered for the whole of that distance. Not infrequently a delicate layer of bone roofs in a portion of the groove anteriorly. In a single specimen there was a small dorsal aperture leading into the neural canal and situated far anteriorly, separated from the open stretch of groove by an intervening bony roof (text-fig. 1, *d*, *d'*).

Such variation in the extent of the dorsal open groove may perhaps indicate that the number of fused vertebræ in this region, in which the neural arch is incomplete, is quite variable. Behind the furrow the urostyle must, presumably, be regarded as composed of fused centra only.

On account of the severity of the drought prevailing at the time, I was unable to obtain specimens of other locally occurring species of Anura, except a single specimen of *Bufo melanostictus*. Subsequently, just as I was leaving India, however, I received other specimens of *Bufo melanostictus* (2) from Professor Woodland of Allahabad, and of *Bufo melanostictus* (4) and *B. andersoni* (2) from Professor Youngman of Lucknow. From London, Mr. Biddolph sent me the hinder parts of the vertebral column of *Rana esculenta* (2), *R. temporaria* (2), and *Bufo vulgaris* (1).

I have also examined a number of skeletons of the two latter species since my return to England.

In every case a careful examination of the urostyle showed that the condition of the neural canal was precisely similar to that described above as obtaining in *R. tigrina*. In the case of certain of the smaller specimens (e. g. *R. temporaria*), the aperture through which the filum terminale emerged from the tubular part of the neural canal is extremely fine, and the succeeding dorsal furrow is represented by a very narrow crevice. In several cases, although the opening could be made out, it was too fine even for the passage of a hair.

I have sectioned also the decalcified urostyle of a single specimen of *Hyla arborea*. The sections establish indubitably that, in this specimen also, the filum terminale extends on to the dorsal surface of the urostyle, upon which it lies altogether uncovered by bone, exactly as in the similar sections of *R. temporaria* and *R. tigrina*.

There can be, I think, no doubt, therefore, but that this condition of the urostyle and filum terminale will prove to be normal for the Anura generally.

20. On Two New Tree-Frogs from Sierra Leone, recently living in the Society's Gardens. By Edward G. Boulenger, F.Z.S., Curator of Reptiles.

[Received April 9, 1915: Read April 27, 1915.]

Index.

Among a collection of Reptiles and Batrachians collected by Mr. Guy Aylmer, F.Z.S., in Sierra Leone last year and presented by him to the Society, I found two frogs of the genus *Rappia* which have not hitherto been recorded. I propose for the one the name of *Rappia aylmeri*, after its discoverer, for the other *Rappia chlorostea*, from the green colour of its bones, visible through the skin, a character well known in many species of *Hyla* and *Pseudis*, but which has not been observed in any of the numerous representatives of the genus *Rappia*.

Rappia aylmeri, sp. n.

Head as broad as long. Snout rounded, equal in length to the diameter of the eye. Tympanum hidden. Fingers very slightly webbed at the base. Toes half-webbed. The hind-limb being carried forward along the body, the tibio-tarsal articulation reaches slightly past the eye. Skin smooth, granular on the belly and under the thighs. Pale brownish above, uniform.

Rappia chlorostea, sp. n.

Head as broad as long. Snout squarely truncate, as long as the diameter of orbit. Loreal region almost vertical. Nostril near the end of the snout. Tympanum distinct, about half the diameter of the eye. Outer fingers one-third webbed, toes two-thirds webbed. The hind-limb being carried forward along the body, the tibio-tarsal articulation reaches to the tip of the snout. Tibia a little more than half the length of the head and body. Skin smooth, except on the belly which is feebly granular.

Green above; a silvery dark-edged streak running down the sides, passing through the eye, extends from the snout to nearly the end of the body.

The bones which are visible through the skin are of a bright green colour.

21. On Two New Species of *Polyplax* (Anoplura) from Egypt. By Bruce F. Cummings *, British Museum (Natural History) †.

[Received January 26, 1915; Read March 23, 1915.]

(Text-figures 1–16.)

Index.

Introduction.

The following descriptive paper on two species of *Polyplax* is based on a large supply of spirit material collected on *Acomys cahirinus* Geoff. (Family Muridæ), at Assiût, in Egypt, and forwarded by the Department of Public Health in Egypt to the Lister Institute of Preventive Medicine, by whom they were subsequently presented to the British Museum through Mr. A. W. Bacot and Dr. G. F. Petrie. Both these species, which are new, were fortunately collected in large numbers in all stages of development, and it has been possible to present an account of the larvæ and also of several features of interest in the internal anatomy of the imagines; unfortunately, the specimens were so badly preserved as to make a study of the soft parts out of the question.

It is to be hoped that in future collectors will bear in mind the extreme value to systematists of a long series of specimens of the same species, particularly in the case of ectoparasites like the Anoplura and Mallophaga, where so little is yet known of the morphology, metamorphosis, and variation.

Polyplax oxyrrhynchus was the more numerous species, there being 918 adults besides numerous immature forms, as compared with only 360 *P. brachyrrhynchus*, of which 75 were immature. Both these species, which are quite distinct, were collected on the same host.

Associated in the tubes with these, and, according to the label, collected on the same host, were several fleas, one or two Psocids, many mites, and a Muscid fly.

The Hon. N. C. Rothschild has kindly identified the flea for me as *Xenopsylla cheopis* Roths., and my colleague, Mr. A. S. Hirst, refers the mite to *Dermanyssus ægypticus* Hirst.

The fly and the Psocids are probably only accidental inclusions.

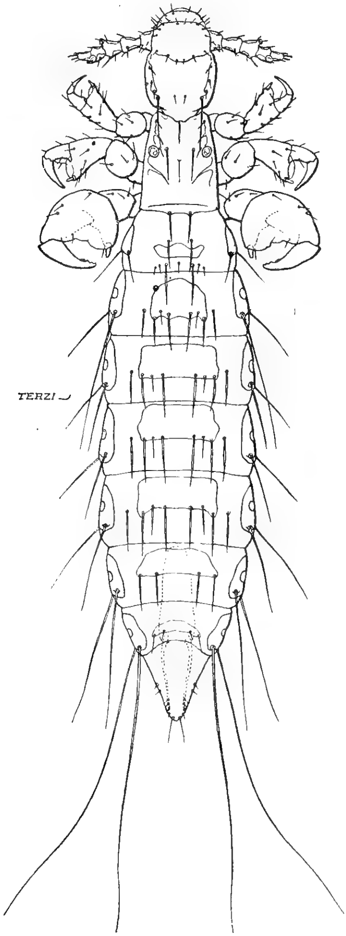
* Communicated by the Secretary.
† Published by permission of the Trustees.

POLYPLAX BRACHYRRHYNCHUS, sp. n. (Text-figs. 1–3.)

Proportion of the sexes. ♂♂ 57, ♀♀ 228, 75 immature. Percentage of males = 20.

External Form. MALE. (Text-fig. 1.)—*Head*: The preantennal area is quite short, broad, a little rounded. Postantennal area parallel-sided, a little broader than the preantennal area and

Text-figure 1.



Polyplax brachyrrhynchus. Male. × 69.

broader also than the thorax. A small bay behind the antenna. Before entering the thorax, temples show a pronounced postero-lateral angle. *Antennæ* stout and relatively long. Second segment longest, third with distal preaxial angle produced a little and carrying a sensorium. Another larger sensorium between segments 4 and 5. The *mouth* opens on the ventral surface.

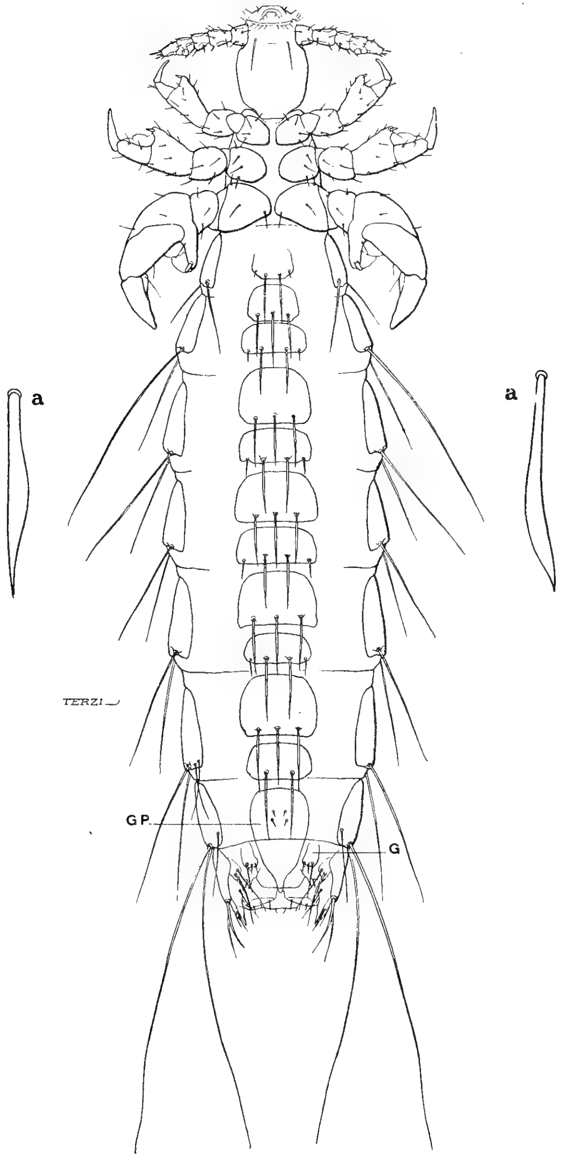
Thorax of an unusual shape. Narrower than the head and very elongate. Lateral margins almost parallel-sided. Mesothoracic spiracles on the extreme margin. *Legs*: First pair very small. Third pair relatively immense.

Abdomen: Last segment ends in a cone. Lateral margins parallel-sided. Pleurites are elongate plates with the spiracle in the centre, lower margin straight, lateral margins indefinite, converging anteriorly. Each segment with a single broad tergite and sternite. Genital plate is long and covers the three terminal segments, which are, therefore, without separate sternites.

External Form. FEMALE. (Text-fig. 2.)—*Antennæ* with third segment normal. *Abdomen*: There are two tergites and two sternites on each of segments 4 to 7. On segment 2 only a single tergite and sternite each. On segment 3 there are two sternites and one tergite. On segments 8 and 9 only a single tergite. The genital plate on sternum of segment 8 is illustrated in text-fig. 2, which also shows the two small plates on each side of the plate—the representatives of the gonopods. End of the abdomen broad, truncate.

Chætotaxy. MALE.—*Head*: On the dorsal surface, preantennal area, a transverse row of four or five minute hairs. On the anterior margin four larger hairs, widely spaced. Behind the antennæ a transverse row of six minute hairs, the two middle ones the smallest. A single stout, elongate bristle at each posterior lateral angle of the head. In front of this, inside the lateral margin, a minute hair, and in front of this again, and well spaced, three more minute hairs, one behind the other. On the ventral surface just in front of the antennæ there is a transverse row of about a dozen small hairs in a semicircle. Behind this, near the base of each antenna, a single strong bristle. *Thorax*: A large hair on the inside of each mesothoracic spiracle and a small one just in front. Along posterior margin of metanotum two hairs. *Abdomen*: Each pleurite with two hairs on lower margin. These are both small on segments 2, 4, 5, and 6. One of the two (the dorsal one) is longer than the other in segment 3, while on segments 7 and 8 they are both very long. On tergite 1 there are two flattened spines, spear-shaped, with sharp tips. On tergite 2 there are two more spines of the same character, and near the base of each of these two minute hairs. On each of tergites 3 to 6 is a row of flattened spines and hairs mixed and arranged along an irregular transverse line (see text-fig. 1). On tergite 7 are only four spines, of which the outer one on each side is broadest and most lanceolate. On tergite 8 are four minute hairs, the two inside ones being the smallest. At the extreme conical tip of the terminal segment two small hairs in large alveoli. On all sternites except no. 3, which has three, and the last, which is bare, are two lanceolate spines.

Text-figure 2.



Polyplax brachyrrhynchus. Female. Ventral surface. × 67·4.

GP. Genital plate. *G.* Gonopod. *a.* Two spines from a sternite, enlarged.

Chætotaxy. Female.—*Abdomen*: Pleurites each with two hairs of much about the same length in each segment. The outline of the tergites at the base of the abdomen is ill-defined, and it is therefore difficult to be certain of the exact segmental distribution of the chætotaxy. It is easier and safer to say that at the base of the abdomen, upper surface, up to segment 2 inclusive, there are two parallel longitudinal rows of well-spaced spines, three in each row. The anterior spine of each row is probably metanotal (*vide* Chætotaxy, Thorax). On the outer side of each of the two posterior spines is a minute hair. Tergite 3 with a single row of six flattened lanceolate spines. Tergite 4 with two rows (five in the first row, six in the second). Tergites 5 and 6 with two rows each (six in each row). In tergite 7 there are five in the first row, four in the second. Tergite 8 has only one row of four. Sternite 2 with two spiny hairs; sternite 3 with two rows (three in the first, two in the second), similarly in sternites 4 to 7. The two spines in row 2 are the strongest; on each side of these, except in segment 7, a small minute hair. Sternite 8, which is the genital plate, is bare except for four minute hairs with large alveoli. A group of short spiny hairs and one larger spine on each side of the genital opening. Three small hairs on each gonopod.

Male Copulatory Apparatus. (Text-fig. 3.)—This is long and narrow, occupying the three terminal segments of the abdomen. The *basal plate*, narrow and elongate, broadens elegantly in its posterior half. It lies in segments 7 and 8. The lateral margins are strongly chitinised and rod-like. The *paramera* lying in segment 9 are bowed outwards at the base but nearly meet each other at the tip. Beyond the point of its articulation with the basal plate, the base of each parameron projects as a process into the intraparameral space. These two processes approach each other but do not meet. Midway the paramera broaden and meet each other beneath the mesosome * so as to join a cavity in which the latter is contained. The *penis* is a narrow rod with a forked base. The basal forked part may, however, be a separate piece, as there is a distinct transverse line of division between it and the rod of the penis. The *mesosome* consists of two pieces, a posterior and an anterior.

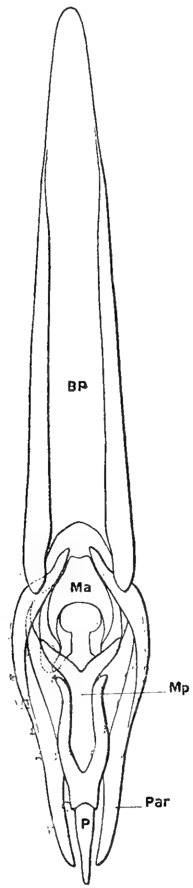
Mouth-parts.—For a description of the infra-buccal plate, see Ann. Mag. Nat. Hist. ser. 8, vol. xv. Feb. 1915.

Notes on the Tracheal System.—The description is taken from an immature specimen in Stage III. There is a pair of spiracles on each of segments 3 to 8 and a pair of larger ones on the mesothorax. The tracheal tubes are very fine and difficult to see through the integument. There are the usual two cardinal trunks, one on each side, joined by a commissure in the last abdominal segment. There is another commissure in segment 4. A lateral diverticulum runs out to each spiracle, and each

* For the explanation of the use of these terms, see Waterston (**1**), p. 279.

diverticulum gives off a posterior root. On the sixth there is also an anterior root. In segment 2, where there are no spiracles, a diverticulum nevertheless exists and runs out on each side as a small twig.

Text-figure 3.



Polyplax brachyrrhynchus. Male copulatory apparatus. × 433.

BP. Basal plate. *Par.* Parameron. *P.* Penis. *Ma.* Mesosome (anterior piece). *Mp.* Mesosome (posterior piece).

The course of the tracheals in head and thorax was too uncertain to justify description.

Measurements of Polyplax brachyrrhynchus (*in millimetres*).

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Head	·20	·13	·21	·17
Thorax	·20	·11	·20	·18
Abdomen	·98	·29	1·37	·41 (across segment 6)
Total	1·38		1·78	

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Legs: 1st pair ...	·15	·04	·15	·05
2nd „ ...	·20	·06	·22	·07
3rd „ ..	·20 (with closed claw)	·09	·21 (with closed claw)	·10

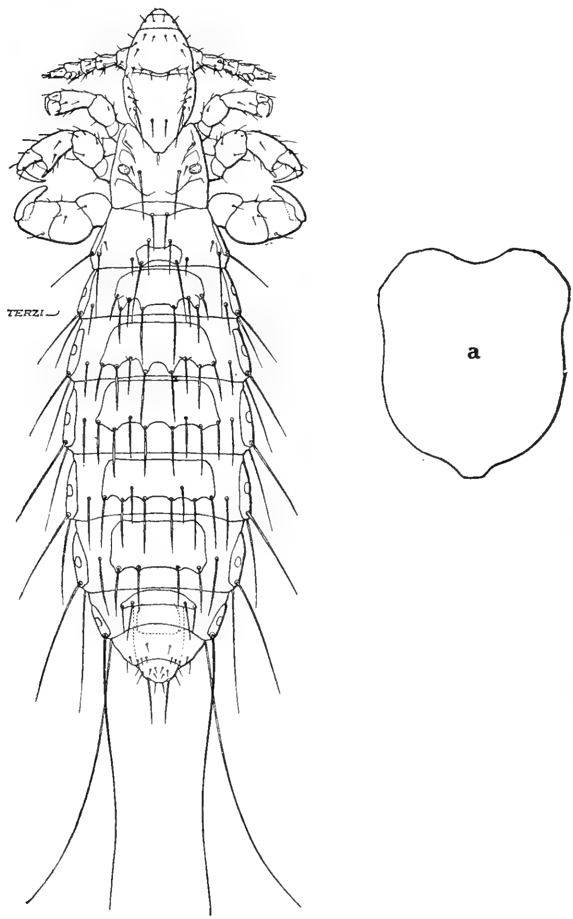
	♂.	♀.
Length of antenna	·16	·16

Polyplax oxyrrhynchus, sp. n. (Text-figs. 4–6, 8, 9, 11–13.)

Proportion of the Sexes. ♂♂ 243, ♀♀ 675, besides numerous immature forms. Percentage of males=26.

External Form. Male. (Text-fig. 4.)—*Head* elongate; preantennal area long, conical; postantennal bay small; temple-margins converge a little towards the thorax. On the ventral surface is a raised diamond-shaped area with its long axis longitudinal and running from the mouth to the thorax. *Antennæ*: First segment broad, squat, second longest. A large sensorium at the postaxial distal angle of segment 4, extending across the joint into segment 5. *Thorax* small, shorter than the head, with convex lateral margins. Sternal plate as in figure 4 *a*. *Legs*: First pair slender, third pair very powerful. Coxæ of first pair close to each other, those of the second pair separated by a space, those of the third pair large and contiguous at their inner angles. *Abdomen* very long (for measurements see p. 260). On segment 2 a small tergite, broader than long, with possibly a second one weakly chitinised and ill-defined. On each of segments 3, 4, 5, 6, and 7 there is a single tergite, broad and deep. The chitin, on the dorsal surface of segments 8 and 9, is thin and transparent. The sternites on segments 2 to 7 are of the same form and disposition as the tergites, excepting that on each of segments 2 and 3 there are two sternites, the first in segment 3

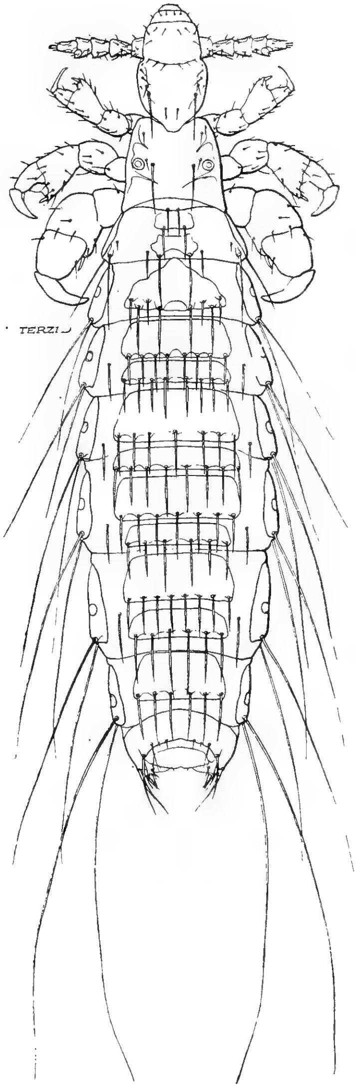
Text-figure 4.



Polyplax oxyrrhynchus. Male. × 67·5. *a.* Sternal plate.

being of a triangular shape. The sternum of segment 8 is occupied by the genital plate, which, on each side behind, is produced into a narrow band of chitin connecting the plate with the thickened margin of the terminal segment. The pleurites of segment 2 are small and delicate, the rest strongly developed, without processes, longer than broad, lower margin straight.

Text-figure 5.



Polyplax oxyrrhynchus. Female. × 56·5.

External Form. FEMALE. (Text-fig. 5.)—*Abdomen* elongate, truncate at the terminal end. On segment 2 there is one tergite and indications of a second in front of it. On segment 3 there is a single tergite, broad at the base, narrowing rapidly in front. On segments 4 to 7 there are two tergites, each being broad and long but broader than long, the first the longer of the two. Only one tergite on each of segments 8 and 9. The sternites show the same disposition and arrangement as the tergites, excepting that in segment 2 there are no vestiges of a second sternite; in segment 3 two sternites, as opposed to the single tergite, while the sternum of segment 8 is occupied by the genital plate, which in its anterior part is rectangular and in its posterior part triangular, the apex pointing backwards. The apex is minutely pectinate. A dentate fringe runs on each side from this apex towards the lateral margins of the abdomen. The pleurites differ from those in the male. In segment 2 they are small and thinly chitinised. In segments 3, 4, and 5 the lower angle on the ventral surface is produced into a short process.

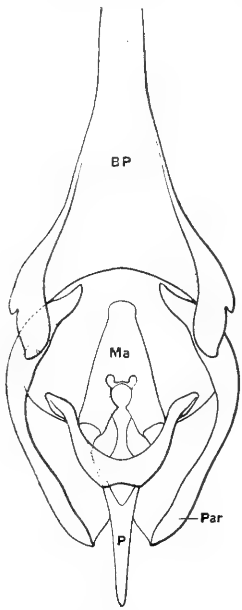
Chœtotaxy. MALE.—*Head*: On preantennal area, dorsal surface, several minute hairs. At the rostrum two minute hairs. Just in front of the antennæ, dorsal surface, a transverse row of hairs. Behind the antennæ, situated along a well-marked transverse groove, another row of small hairs. Along the temples a longitudinal row of four hairs, the most posterior being large and spiny. At about the level of these two posterior bristles, but situated nearer the middle line of the dorsal surface, two small hairs. On the ventral surface two small hairs on each side of the mouth-parts in front of the antennæ. A bristle at the base of each antenna, lower surface. *Thorax*: A long bristle and a minute hair on the inside of each spiracle. *Abdomen*: On the lower margin of each pleurite two hairs; these, as usual, are very long on segments 7 and 8. On the dorsal surface segment 1 * has two hairs. On segment 2 there are two rows of spine-like hairs, two in the first row and four in the second; in the latter row the two middle hairs are much the largest and equal in size the two in row 1. Along the lower margin of tergite 3 are eight hairs, the two middle ones the largest, the remaining six flanking each side in two groups of three. Tergites 4, 5, and 6 each have a row of eight flat spines, the two middle ones the largest. There is also a smaller spine on each side in the space between the pleurites and tergites. On tergite 7 is one row of only four spines; another smaller spine on each side in the space between tergites and pleurites. On tergite 8 there are only four spines, the middle ones occupying a position one on each side of the basal plate. At the extreme end of the abdomen are two small stiff hairs. On the under surface there are five hairs in the first row and six in the second on the sternite of segment 2; in segment 3 five in the first, and in the second six, with another one on each side. The sternites of segments 4, 5, and 6 each carry a row of six hairs, with another one on each side. On sternite of no. 7

* As is ordinarily the case in the Order, segment 1 is small and almost obsolete.

only four, with one on each side, and on no. 8 only 2, one on each side of the basal plate.

Chætotaxy. FEMALE.—*Abdomen*: On tergum of segment 1 are two hairs; in segment 2 there are two hairs on tergite 1 and four on tergite 2. Of the latter the two middle ones are the largest. On the single tergite of segment 3 is an irregular row of eight spines. In segment 4 each of the tergites has a row of eight powerful spines, with another hair on each side between the pleurites and tergites. On segment 5 tergite 1 has seven spines, tergite 2 has eight, with one on each side. On both tergites of segment 6 there are seven spines, with one on each side. On segment 7 tergite 1 has eight and tergite 2 has six spines, with one on each side. On the tergite of segment 8 there are six spines. Ventrally segment 2 has six hairs. On segment 3 sternite 1 has five and sternite 2 has six, with one on each side.

Text-figure 6.



Polyplax oxyrrhynchus. Male copulatory apparatus. × 500.

BP. Basal plate. *Par.* Parameron. *P.* Penis. *Ma.* Mesosome (anterior piece). The piece labelled *MP.* in text-figure 3 is apparently unrepresented or very small.

On segments 4, 5, 6, and 7 there are five hairs on sternite 1 and six on sternite 2, with one on each side. On the genital plate is a row of four minute hairs in large alveoli. On each side of the terminal segment is a group of hairs and one large spine.

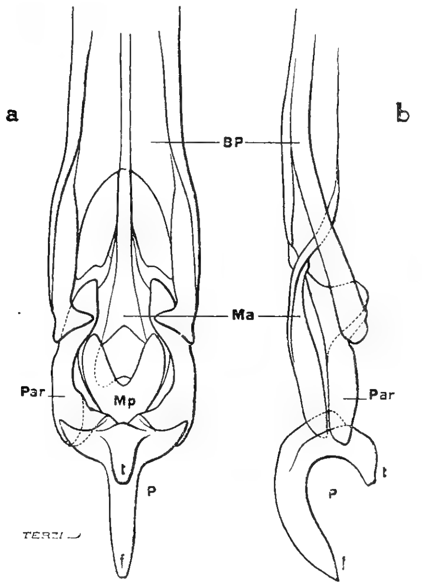
Male Copulatory Apparatus. (Text-fig. 6.)—This is of the same type as that described for *P. brachyrrhynchus*. It differs, however, in details.

The *basal plate* is small. Anteriorly it is very narrow, being little more than a rod or band. Lower down, towards the paramera, it broadens rapidly, and its two lower lateral angles are produced so that the whole plate somewhat resembles an inverted catapult as used by schoolboys.

The *paramera* articulate with the produced angles of the basal plate. Beyond the point of articulation the base of the parameron projects into the intraparameral space. Towards the extremity each parameron broadens out and meets the other distally beneath the mesosome, for which they form a basin-shaped cavity.

The *penis* is a curved, pointed, narrow rod with a forked base. As in *P. brachyrrhynchus*, the forked basal part may be a separate piece. The limbs of the fork enclose the lower part of the rest of the mesosome, as shown in the figure.

Text-figure 7.



Polyplax spinulosa. Male copulatory apparatus:—*a.* Dorsal view. *b.* Side view. × 350.

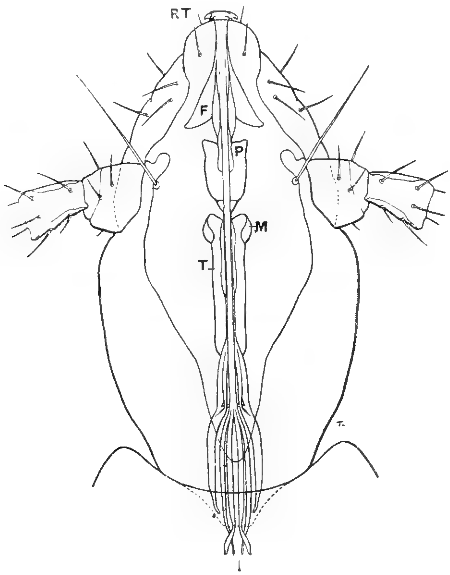
BP. Basal plate. *Par.* Parameron. *P.* Penis (*f*, finger, and *t*, thumb). *Ma.* Mesosome (anterior part). *Mp.* Mesosome (posterior part).

Comparison with the Male Copulatory Apparatus of Polyplax spinulosa (*Burmeister*). (Text-fig. 7.)—The remarkable copulatory apparatus of this common species of *Polyplax* from Rats has hitherto remained unnoticed save for a summary description by Piaget (**2**, p. 636), which is difficult to follow and is accompanied by an inaccurate figure (pl. lii. fig. 2 *a*).

The *basal plate* is longer than broad, with the lateral margins gracefully biconcave.

There are no separate *paramera*. Probably the deep band-like pieces (*Par*) represent modified paramera. At their anterior extremity there is a joint between them and the lower angles of the basal plate. At their posterior extremity they curve inwards and become fused with a remarkable penis consisting of two limbs like a finger and thumb—the longer "finger" (*f*) being ventral and the "thumb" (*t*) being dorsal. There is another chitinous piece (*Ma*) which consists of two limbs that arise from a single small median splint lying in the middle between the two lateral bars of the basal plate, dorsal to the basal plate and about half-way down its length. Each limb runs downwards and outwards so as to underlie the parts named paramera for as far as the penis. The strange form of the latter is probably correlated with some modification of the genitalia of the female.

Text-figure 8.



Polyplax oxyrrhynchus. Mouth-parts. × 252.

RT. Rostral teeth. *F.* Fulturæ. *P.* Pharynx. *M.* Mandible. *T.* Tendon.

In regard to the male copulatory apparatus *P. brachyrrhynchus* and *P. oxyrrhynchus* are much nearer to one another than they are to *P. spinulosa*.

An attempt at homologising these parts with those in the two new species is made in the legend to the figure.

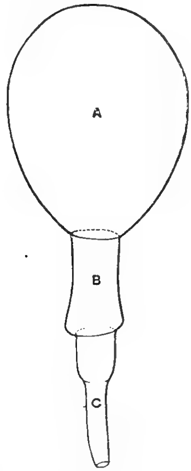
Mouth-parts. (Text-fig. 8.)—The figure shows the shape of the chitinised fore-part of the alimentary canal, *i. e.* pharynx (*larynx* of Enderlein) and fulturæ (**5**). No attempt is here made to describe the mouth-trophi, but attention is drawn to two structures lying together just behind the pharynx and above the needle-like trophi, strongly suggesting mandibles. In the figure they are labelled mandibles, and the chitinous band which runs backward from each is indicated as a tendon. Mandibles, of course, in blood-sucking Anoplura cannot be functional, but their presence as vestiges is to be expected if the Anoplura are in truth descended from the mandibulate Mallophaga. Enderlein (**4**) regards as mandibles certain pieces in the head of *Hæmatopinus suis*. Mjöberg (**3**) figures and describes mandibles in *Arctophthirus tricheci* Boh. The latter are extremely suggestive in form, and much resemble the mandibles here figured.

Spermatheca. (Text-fig. 9.)—Mjöberg (**3**, p. 254) finds a spermatheca present in *Linognathus angulatus* Piag. and in *Acanthopinus sciurinus* Mjöb., in both of which it consists of the same form, *i. e.*, "Aus einem fast kreisrundem Gebilde das beiden Übergang in den sehr schmalen Ausführungsgang mit einer gerundeten Chitinscheibe versehen ist, von deren Mitte der Ausführungsgang seinem Ursprung nimmt." Landois (**6**, p. 14) described the spermatheca of *Phthirus inguinalis* and remarked (**7**, p. 32) upon its absence in *Pediculus vestimenti*. Patton & Cragg (**5**, p. 560) single this out as a fact of some interest in view of the length of copulation in the louse and the large size of the seminal vesicles in the male. Landois explains the difference in *Phthirus* and *P. vestimenti* in this matter by reference to the habits of the two insects—*Phthirus* is sedentary and therefore rarely meets with its kind; the *Pediculus* is active, and coitus is, therefore, frequent.

Whatever be the explanation, the absence of the spermatheca in *P. vestimenti* is a confirmed fact, and it becomes a matter for further research to enquire from what other genera in both Anoplura and Mallophaga this receptacle may be absent. It probably occurs in a great many Mallophaga in which its chitinous "Scheibe" can frequently be seen at the end of the abdomen through the integument of specimens passed through caustic potash. Mjöberg figures it from *Nirmus lineolatus* N., and reports it as probably present in many Ischnocera. In the Amblycera he sought for it in vain. It may, however, exist unchitinised in these forms, though the club-shaped organ found in *Menopon titan* by Grosse, who regarded it as a spermatheca, is reported by Snodgrass (**8**) to be non-existent.

In the two species of *Polyplax* here described, a spermatheca is present, and its chitinous parts can be detected in specimens passed through potash. Text-fig. 9 shows the part in *P. oxyrrhynchus*. In general form it resembles the figure of the spermatheca of *Phthirus inguinalis*. Nothing comparable to the "Chitinscheibe" or disc of Mjöberg was observed; in some specimens, passed through caustic potash, the chitinous part of the duct B (the funnel) was telescoped backwards into the sac; it then presented the appearance of a dice-box in a glass bowl. The specimens were in too poor a state of preservation for histological examination, but both the sac and the upper part of the duct appear to be chitinised, while the lower part, which could not be traced, is of peculiarly elastic nature and capable of being pulled out a long distance.

Text-figure 9.



Polyplax oxyrrhynchus. Spermatheca.

A. Sac. *B.* "Funnel." *C.* Duct.

In the Siphonaptera the shape and size of the chitinous parts of the spermatheca vary a good deal, and are sometimes used for taxonomic purposes. It is improbable that they will serve this end in Anoplura and Mallophaga.

Notes on the Tracheal System.—The following description is taken from a preparation of an immature form in Stage III.:—

There is a pair of abdominal spiracles on each of segments 3 to 8 of the abdomen and a pair larger in size on the mesothorax. Text-fig. 5 (p. 253) shows the arrangement of the main branches in the abdomen. There is a posterior commissure in the abdomen and on each lateral diverticulum a posterior root. Anterior roots are absent except in segment 4, where one runs forwards and inwards as far as the first diverticulum. It will be remembered that a commissure is present in this segment in *P. brachyrrhynchus.*

There is, I believe, no longitudinal commissure in the thorax as in *Phthirus inguinalis* (**6**) and *Hæmatopinus taurotragi* (**9**). The two lateral trunks are continued, one on either side, through the head as far as the antennæ, where each splits into smaller branches. Small twigs are given off to the mouth-parts and antennæ, and across the base of the head there appears to be a commissure, although it is impossible to be sure that this does not consist of two separate branches. I find similarly an apparent commissure between the two lateral trunks, in exactly the same position, in the head of *Polyplax spinulosa*. *Polyplax spinulosa* further resembles *P. oxyrrhynchus* in the presence of a large anterior root on each lateral diverticulum in segment 4, which runs forward through the next segment.

Measurements of Polyplax oxyrrhynchus (*in millimetres*).

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Head	·25	·14 (behind antennæ)	·25	·15
Thorax	·16	·15	·18	·16
Abdomen	·92	·34 (across segment 6)	1·35	·46 (across segment 6)
Total	1·33		1·78	

	♂.		♀.	
	Length.	Breadth.	Length.	Breadth.
Legs: 1st pair ...	·14	·03	·16	·04
2nd " ...	·23	·06	·21	·08
3rd " ...	·20	·08	·20	·10

	♂.	♀.
Length of antenna	·15	·15

METAMORPHOSIS.—Very little mention of the post-embryonic changes of either Anoplura or Mallophaga is to be found in the rapidly growing literature of these two groups. In Warburton's (**10**) Report to the Local Government Board an account, in some detail, is given of the life-cycle of *Pediculus vestimenti*, while Dr. A. C. Oudemans (**11**) has described the nymphal stages of three species of Mallophaga—*Liotheum flavescens*, *Philopterus celebrachys*, and *P. macrocephalus*. Patton and Cragg (**5**) figure the three larval stages of *Pediculus vestimenti*; while in the standard work 'Les Pédiculines' (p. 6) Piaget (**2**) makes a few remarks about metamorphosis, amounting to little more than a profession of ignorance. (See, however, note in square brackets on p. 272.)

It seems very probable that, in the future, a careful study and description of the immature stages of both Anoplura and Mallophaga will prove largely the vehicle in which to arrive at a sound classification of these two orders.

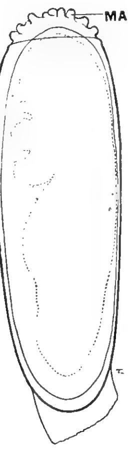
Several points of interest have emerged from a study of the immature stages of *Polyplax brachyrrhynchus* and *P. oxyrrhynchus*. In *Pediculus vestimenti* Warburton describes three stages:—

Stage I. on hatching.
,, II. after the first moult.
,, III. after the second moult.

Oudemans in *Philopterus macrocephalus* and *Liotheum flavescens* describes three stages.

In *Polyplax oxyrrhynchus* the immature forms are readily sorted out into three stages. In *P. brachyrrhynchus* only one stage was present. Little evidence can be given as to the number of moults. One would suggest two as in *Pediculus*, but from a study of a very instructive slide in which the larva in

Text-figure 10.



Polyplax sp. Egg. × 63·3. *MA.* Micropyle apparatus.

Stage I. of *P. oxyrrhynchus* is about to moult, and the new instar can be seen through the old skin, it seems evident that a larva changes its skin at least once with very little or no change in form or chætotaxy. On the other hand, in the last ecdysis the change from Stage III. to the imago is quite abrupt, as was proved by specimens in Stage III. about to moult with the imago beneath visible through the old skin. A comparison for example between text-figs. 14 and 1 shows the extent of the change.

In *P. brachyrrhynchus*, *P. oxyrrhynchus*, as well as in *P. spinulosa*, the chætotaxy of the head and thorax in the larval stages is almost identical with that of the adult. This probably holds for all the Anoplura. On the abdomen the larval chætotaxy differs from stage to stage, and it is a matter of particular interest to trace the sequence in which the hairs develop. Thus in the abdomen of *P. oxyrrhynchus* and *P. spinulosa* there is a tendency for the hairs to appear first at the end of the abdomen, and to develop subsequently in later stages further forward. For example, in Stage I., there are no hairs on the pleuræ except in the last segment, while the only hairs on the ventral surface appear first on the last segment.

The sexes of the larvæ are indistinguishable—at all events in external form. In the last stage the male copulatory apparatus is in some specimens visible in the imago beneath.

Text-fig. 10 is a representation of the egg, found in some numbers in the tube with both species; I am unable to say to which it belongs.

Polyplax oxyrrhynchus.

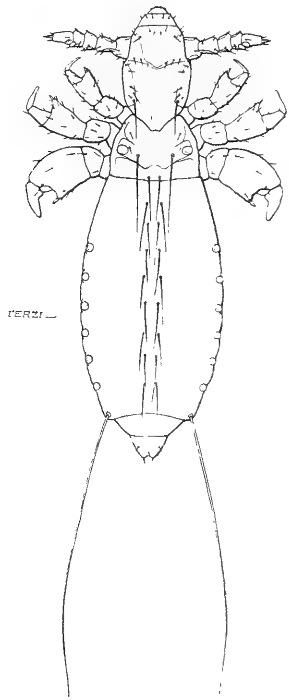
Stage I. (Text-fig. 11.)—The head is short and broad, and there are no sclerites on the abdomen. The sexes are indistinguishable, the abdomen in all specimens ending in a cone. The insect is very soft and delicate, and requires to be dehydrated very slowly in carefully graduated alcohols before clearing, if complete and instantaneous shrivelling is to be avoided. In parts, however, the cuticle is harder and more perfectly developed, *e. g.*, the mouth-parts (to enable the young larva to pierce and

Stage I.—*Measurements* (*millimetre scale*).

	Length.		Breadth.	
Specimen...	(1)	(2)	(1)	(2)
Head	·17	·20	·11	·14
Thorax	·10 (about)	·13	·16 (at the base)	·15
Abdomen	·56	·59	(Seg. 4) ·30	·33
Total...	·83	·92		
Antenna	·10 to	·12	·20 (Seg. 4) to	·25

suck), the legs and thorax (to enable it to cling to the host). The chætotaxy of the abdomen is as follows:—There are in the median area two hairs in the dorsum of each segment. On the sternum of the last segment there are also two hairs, medially placed. Rest of the ventral surface bare. Pleuræ without hairs, except on the last segment, where there is on each side a single long, curved hair, usually in a curl. The spiracles are large.

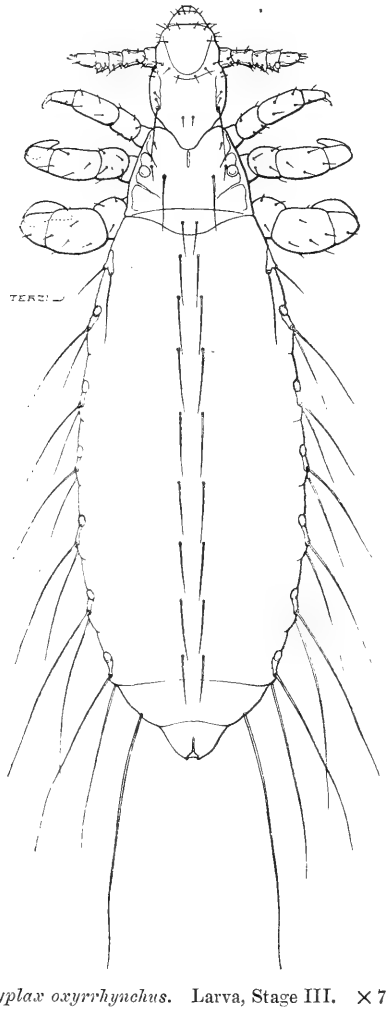
Text-figure 11.



Polyplax oxyrrhynchus. Larva, Stage I. × 65.

Stage II. (Text-fig. 13.)—In external form this stage resembles Stage I. It differs, however, in size (see measurements below) and in the development of minute pleurites on the abdomen. The head, too, is more produced in front of the antennæ, and its front margin is very rounded. The delicacy of structure is much less marked; the abdominal cuticle is thicker and covered with a great number of triangular denticles with sharp apices. On the abdomen the chætotaxy is more developed. Medially there are two hairs on both tergum and sternum of each segment. On each pleurite are two hairs; those on segments 7 and 8 are very long. On the terminal segment, which is without pleurites or spiracles, there is on each side a single elongate bristle.

Text-figure 12.



Polyplax oxyrrhynchus. Larva, Stage III. × 74·5.

The pleurites are small quadrilateral plates, attached along their anterior margin to the lower margin of the spiracle.

STAGE II.—*Measurements* (*millimetre scale*).

	Length.		Breadth.	
	Specimen... (1)	(2)	(1)	(2)
Head	·23	·19	·15	·14
Thorax	·17	·13	·18	·17
Abdomen	1·05	·88	(Segment 5) ·49	·37
	Total ... 1·45	1·20		
Antenna	·14	·13	(Segment 4) ·03	·03

Stage III. (Text-fig. 12.)—Except in the shape of the head, which is here longer and narrower in front of the antennæ, it has been difficult to discover any difference between Stage III. and Stage II.

STAGE III.—*Measurements* (*millimetre scale*).

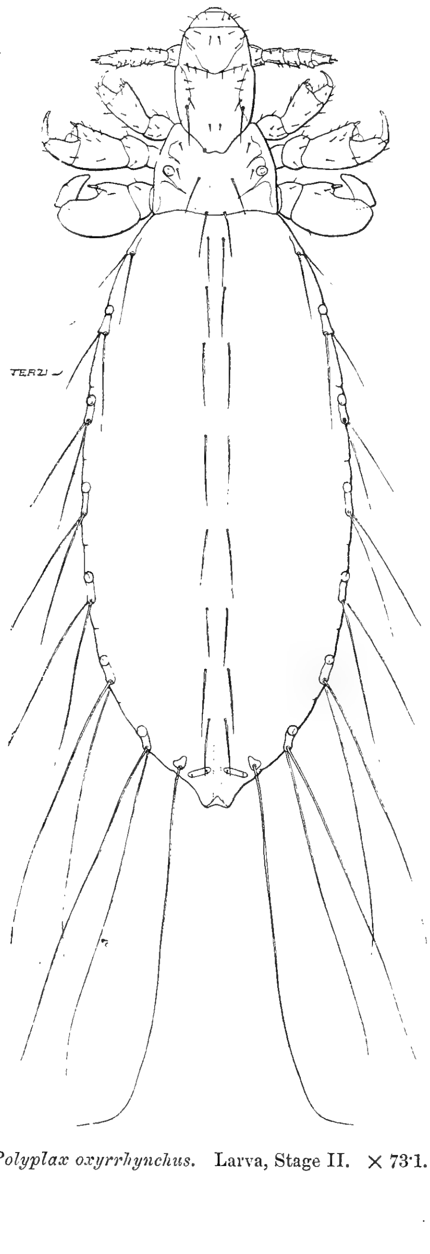
	Length.	Breadth.
Head	·21	·12
Thorax	·18	·18
Abdomen	·95	(Segment 4) ·38
Total...	1·34	
Antenna	·16	(Segment 4) ·03

POLYPLAX BRACHYRRHYNCHUS.

In this species only one stage was represented—Stage III. (text-fig. 14). The figure gives an accurate representation of the external form of the insect at this stage. It will be observed that on the abdomen are neither tergites nor sternites, while the pleurites also are either absent or very faint and indefinite.

The abdominal chætotaxy presents features of special interest. There are a couple of hairs in the middle area of each tergum and sternum, except the tergum of segment 8, which is bare. The pleuræ are bare, with the following exceptions :—Segment 3,

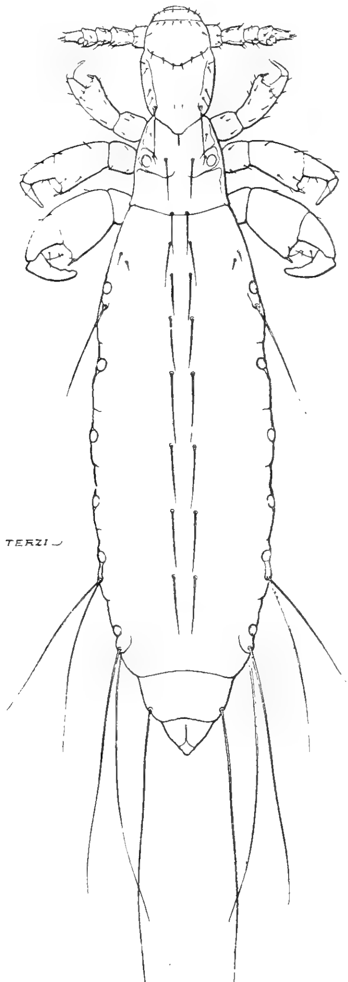
Text-figure 13.



Polyplax oxyrrhynchus. Larva, Stage II. × 73·1.

with one long bristle on each side; segments 7 and 8, each of which possesses two long bristles on each pleura; and segment 9, which possesses one long bristle on each side. The bearings of these facts are discussed on page 271.

Text-figure 14.



Polyplax brachyrrhynchus. Larva, Stage III. × 77·3.

Stage III.—*Measurements (millimetre scale).*

	Length.	Breadth.
Head	·19	·13
Thorax	·19	·15
Abdomen	·90	(Segment 4) ·29
	Total... 1·28	
Antenna	·15	(Segment 4) ·03

The Metamorphosis of Polyplax spinulosa (*Burm.*) *for Comparison.*

From a large amount of material from this common parasite of the Rats *Mus norvegicus* and *M. rattus*, presented to the British Museum, along with other species, by the Lister Institute, it has been a simple, if laborious, matter to sort out all the immature forms, which fell into three stages as in *P. oxyrrhynchus*.

Larva, Stage I. (Text-fig. 15.)—This is a tiny, delicate insect, with a rounded head, the postero-lateral angles being very slightly developed. On the dorsal surface of the head there is a suture between the two epicranial plates, which in front bifurcate and so divides the two epicranial plates from the single plate—frons—which roofs in the anterior part of the head. Sclerites on the abdomen absent.

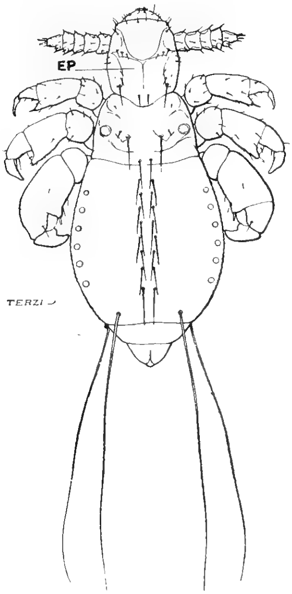
Chætotaxy of head and thorax as in the imago. On the abdomen two bristles in each tergum. Sterna bare except the last, which, as in *P. oxyrrhynchus*, has two bristles. Pleuræ bare, except that in the pleural region on each side of the last segment are two very elongate hairs—one dorsal and one ventral. Spiracles relatively large.

Stage I.—*Measurements (millimetre scale).*

	Breadth.	Length.
Head	·101	·102
Thorax	·112	·105
Abdomen	·203	·211
	Total...	·418
Antenna	·003	·001

Larva, Stage II.—Postero-lateral angles of the head more pronounced. Minute pleurites developed on the abdomen.

Text-figure 15.



Polyplax spinulosa. Larva, Stage I. × 112.
EP. Epicranium.

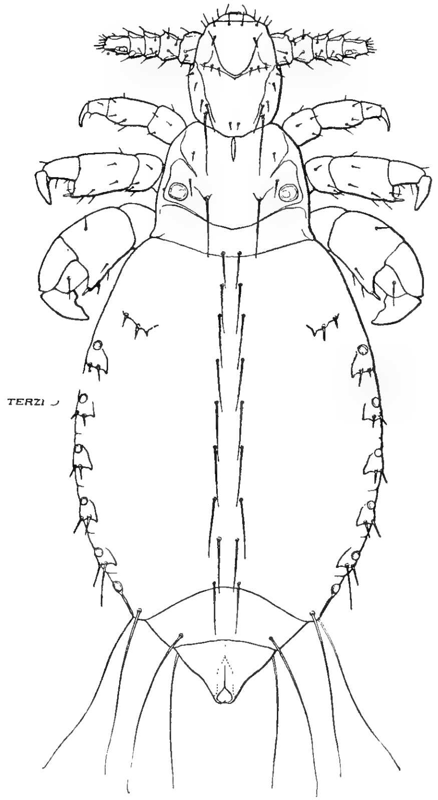
Chætotaxy of the abdomen :—Two minute hairs on the pleurites of the first seven segments. On segments 8 and 9 the pleurites bear two long bristles each. On terga and sterna of all segments two longish hairs on the middle area.

STAGE II.—*Measurements* (*millimetre scale*).

	Breadth.	Length.
Head	·12	·14
Thorax	·19	·14
Abdomen	·37 (Segment 4)	·55
	Total...	·83
Antenna	(Seg. 4) ·024	·12

Larva, Stage III. (Text-fig. 16.)—Head more angular, pleurites on the abdomen larger and more strongly chitinised. Chætotaxy as in Stage II., except that in the pleurites of segment 7 one hair is long and one short.

Text-figure 16.



Polyplax spinulosa. Larva, Stage III. × 102·2.

Reference to a figure or description of the imago makes clear that the final stage of the development differs from Stage III. in the possession of well-chitinised tergites and sternites on the abdomen carrying strong bristles in rows. The pleurites are also better developed than in the larvæ, and on those of segment 7 *both* hairs are elongate as in segment 8, while the two very elongate hairs on each of the pleuræ of the last segment in the larval stages are apparently replaced in the female imago by a group of short hairs on each side and in the male by one long hair.

STAGE III.—*Measurements (millimetre scale).*

	Breadth.	Length.
Head	·13	·15
Thorax	·20	·14
Abdomen	·40 (Segment 4)	·61
	Total...	·90
Antenna	(Seg. 4) ·03	·14

Summary.

An examination of the immature forms in these three species of *Polyplax* reveals that the metamorphosis in all three consists probably of at least three distinct stages, although there may be more than two moults. The differences between Stages II. and III. are slight. In the first stage the louse is very soft and delicate for the most part, although even thus early the mouth-parts, thorax, and legs are well chitinised. On the abdomen segmentation is absent except at the end, and sclerites are absent in all three stages, although in *P. oxyrrhynchus* and *P. spinulosa* minute pleurites appear in Stage II., and in Stage III. of *P. brachyrrhynchus* also there are present weak pleurites of indefinite outline. The spiracles are large. In the last stage the head and thorax closely resemble the adult.

In all three stages the chætotaxy of the head and thorax is almost identical with that of the imago.

The abdominal chætotaxy and the abdomen itself, however, undergo a very considerable metamorphosis at the last ecdysis into the imago.

The metamorphosis of all three shows that there is a tendency for the hairs to develop from behind forwards, inasmuch as the terminal pleuræ develop hairs while the rest are still bare, and in *P. oxyrrhynchus* and *P. spinulosa* the sterna are at first also bare except in the last segment.

Two hairs on each tergum and sternum is invariably the number if hairs are present at all.

Some of these early stages may represent stages in the phylogeny of the group, and in this connection it is suggestive to recall that the Anopluran genus *Linognathus* is characterized by the large size of its spiracles and the absence of abdominal plates, just as *Polyplax* is characterized byt he small size of the spiracles and the presence of the plates, so that in future it may be convenient to speak of the larva of *Polyplax* as the "Linognathus larva."

The larva of *P. brachyrrhynchus* described above recalls in particular such species as *Linognathus breviceps* Piaget, *L. gazella* Mjöberg, *L. limnotragi* Cummings, *L. africanus* Kell. & P., and

L. caviæ-capensis (Pallas), in which there is on each pleura of the 3rd abdominal segment an elongate bristle and on the pleuræ of the 7th and 8th two long bristles.

The chætotaxy of *L. caviæ-capensis* (see figs. 2 & 3, Bulletin of Entomological Research, iv. May 1913, pp. 38 & 39) bears a close resemblance to that of the *Polyplax* larvæ. Some later work further reveals the fact that a somewhat similar plan of abdominal chætotaxy exists also in the larvæ of at least two species of *Linognathus* in which the imaginal chætotaxy is more complex. This general plan of chætotaxy, therefore, is perhaps a primitive one in the Anoplura, and *Linognathus* is perhaps a more primitive genus than *Polyplax*, and perhaps the most primitive of all the Anopluran genera, an hypothesis which, however, cannot be supported by reference to the systematic position of the host-species, *Linognathus* occurring with *Hæmatopinus* on Ungulates such as the Antelope, *Capra* and *Ovis*, and also on the Dog.

It would be interesting to know whether Linognathoid types of a more primitive character than any Anoplura hitherto known remain to be discovered on the primitive Insectivora and other ancient mammalian groups. Hitherto, Anoplura have not been found on Monotremes and Marsupials. It should be remembered that *L. caviæ-capensis* is a parasite of the Cape Hyrax—a member of a very isolated group.

References.

(1) Waterston, J.—Annals of the South African Museum, x. pt. 9, p. 271.
(2) Piaget, E.—Les Pédiculines. Leide, 1880.
(3) Mjöberg, E.—Arkiv för Zoologi, vi. 1910, p. 166.
(4) Enderlein, G.—Zool. Anz. xxviii. 1905, p. 626.
(5) Patton, W. S., & Cragg, F. W.—A Textbook of Medical Entomology. London, Madras, and Calcutta (Christian Literature Society for India), 1913, p. 532.
(6) Landois. — Zeitschrift für wissenschaftliche Zoologie, 14te Bd., 1864, p. 14.
(7) Landois.—*Ibid.*, 15te Bd., 1865, p. 32.
(8) Snodgrass, R.—Occas. Papers California Acad. Sci. vi. 1899, p. 216.
(9) Cummings, B. F.—Bull. Ent. Res. vol. v. pt. 2, Sept. 1914, p. 157.
(10) Warburton, Cecil.—Report to the Local Government Board on Public Health and Medical Subjects. New Series, No. 27, 1910.
(11) Oudemans, A. C.—Ber. Nederl. Ent. Ver., Deel iii. No. 67, Sept. 1912, p. 278.

[Note.—I find I have overlooked the following paper by H. Fahrenholz: "Beiträge zur Kenntnis der Anopluren," Hannover Jahresber. zool. Ver. 2–4 (1910–12), 1912. The author describes the larvæ of *Pediculus capitis* and of one or two species of *Polyplax*, including *P. spinulosa*. He is mistaken in supposing there are hairs on all the sterna of what we are agreed in calling Stage I. of *P. spinulosa*. See also:—"Neue Läuse," Hannover Jahresber. zool. Ver. (1909), 1910, and the figures of various larval Mallophaga scattered through Kellogg's papers.]

22. Some Notes on the Niata Breed of Cattle (*Bos taurus*). By Ernest Gibson, F.Z.S.

[Received March 12, 1915: Read April 13, 1915.]

(Text-figures 1 & 2.)

Variation.

When Charles Darwin * published in 'The Voyage of H.M.S. Beagle,' more than 80 years ago, his account of this curious race, he attributed its then rarity and probable extinction to the abnormal formation of the lips, which rendered browsing difficult in times of drought, *i. e.* when the pasture became very short. Be that as it may, its career would seem to be now nearly ended. Dr. W. J. Holland, in his very interesting book 'To the River Plate and Back,' p. 117 (1912–13), sums up its epitome as follows:—"Dr. Bruch, the learned Curator of Zoology at the Museum of La Plata, informs me that the race is either verging upon extinction, or has already become totally extinct. Although it is still reported to survive in the Province of Catamarca, Dr. Bruch told me that a German naturalist, who recently visited Argentina for the express purpose of studying these creatures, and travelled widely in quest of them, was unable to see or secure a single specimen" †. I have an impression of reading very recently in a director's report of his visit to one of the Estancias belonging to his Company in North Patagonia, that he saw quite a number of Niata cattle; but it is to be feared that what he saw and what his Company is the proud possessor of, were only some shockingly bad Creole animals of the old type.

In the 'La Nacion' newspaper of 14th May, 1890, or nearly a quarter of a century ago, Señor Ramon Lista (Argentine explorer and naturalist) published an open letter, directed to Dr. Francisco P. Moreno, of which the following is a translation:—

"*An Interesting Animal.*—The actual great Agricultural Show (Palermo, Buenos Aires) presents much that is admirable in respect of its livestock; but with all frankness, I must confess that what has most aroused my curiosity as a naturalist is a little snub-nosed cow, which might well be denominated Cow-dog from its resemblance to a Bull-dog, of which it has the same defiant and sneering expression, produced by the permanent retraction of the upper lip, leaving the teeth exposed in a manner similar to that breed of dogs.

* This breed was further discussed by Darwin ('Variation of Animals and Plants under Domestication,' i. pp. 109–111, ed. 1905) and by Romanes ('Darwin and after Darwin,' ii. p. 192), who published a figure of the skull described by Owen.

† The skull figured by Dr. Holland is nearly intermediate in length of jaw between the skull of ordinary cattle and that of the Niata breed figured by Romanes.

"It is the property of Mr. Ernest Gibson, of Ajó *, who intends sending it to the Zoological Society of London, in whose natural history museum † exists a skeleton of the same animal, studied and described by the celebrated naturalist Professor Owen.

"The Ajó cow is almost a dwarf. The head is small and the lower jaw very projecting. In its other characteristics it presents nothing notable beyond a continual restlessness, well in keeping with its wild disposition, and marked contrast with the placidity of the large and beautiful European breeds surrounding it.

"The Cow-dog is perhaps at this date an example of atavism, unique in this country, of a breed produced naturally in the Pampas of Buenos Aires, and very recently extirpated by the foremost Argentine stockbreeders, who were naturally afraid of the increase in their herds of a race of so little utility and unadapted for the struggle for existence, inasmuch as it was the first to succumb in the great droughts when the abnormal conformation of the jaw-bones handicapped it in grazing on the scanty and shortened pasture.

"In the time of the tyrant Rosas it was believed that the Niatas constituted an indigenous race which had nothing to do with the cattle imported from Paraguay by the brothers Goëss in 1558.

"Later on it has been said that they originated from an African breed, introduced on both sides of the River Plate. This latter supposition has been based upon the existence in Equatorial Africa of bovine animals which resemble, though remotely, the Niata type of the Pampas. But up to date, so far as is known, no one has been able to produce any proof in reference to the importation to the Argentine or Uruguay of bulls or cows from that country.

"In my opinion, the Niata type is nothing more than a variety of the primitive bovine type, introduced into the country by the Goëss brothers, and later on propagated in the Pampean zone comprehended between the Sierra ranges of Tandil and Ventana.

"On this hypothesis, the question arises as to the manner in which this strange breed should have evolved itself in a strain so notably distinct from the ordinary Creole class.

"First of all, whoever has read the 'Journal of Researches into the Natural History and Geology' (admirable investigations of the illustrious Darwin) will recall what he states regarding the transitory appearance in France of the Niata type of the Plate, which has since been confirmed from other parts of Europe; but it has been described as hornless and of a less accentuated prognathism.

* The district of Ajó, pronounced "Ah-hó," lies at the mouth of the estuary of the River Plate, near Cape San Antonio.

† [The skeleton is in the Museum of the R. Coll. Surgeons.—EDITOR P. Z. S.]

"These data, which nevertheless should be taken with some reserve, lead one to imagine the existence of a possible primitive European Niata type, the progenitor of that of America; but perhaps the said instances were in reality only casual monstrosities, and in nowise to be confounded with permanent variations of races."

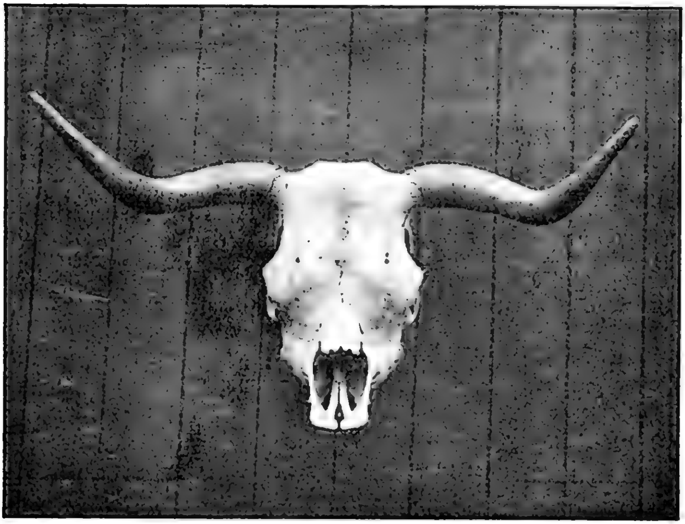
The head of the individual cow alluded to at the beginning of the foregoing article is figured in the accompanying photograph (text-fig. 1), the skull (text-fig. 2) being that of its mother.

Text-figure 1.

Head of living example of Niata cow.

Some time in 1889 I was informed of their existence in the possession of a neighbour (a widow occupying a small piece of land in the township of Ajó), and after a little difficulty succeeded in buying them; but my agent could learn nothing of their origin. The family-group consisted of three generations—a very old cow, her daughter, and the calf of the latter; the last presented only the usual characteristics of the prevalent Creole breed, and consequently was promptly converted into veal! Its mother went to the Rural Exhibition in Buenos Ayres the following year, as chronicled by Don Ramon Lista, in company with some fine stock; and when the Show was closed I transferred it (at Dr. Moreno's request) to the Zoological Park. How long it lived there subsequently I cannot tell; but I should not be surprized to learn that the skull figured in Dr. Holland's book as existent in the La Plata Museum belongs to the animal in question. The old cow was of a totally different disposition from her daughter, being perfectly tame and placid. She was kept in a little lucerne-paddock at the back of my Estancia business office, and would frequently approach close to, and gaze through, the windows. But I confess that I never glanced up on feeling the shadow cast on my desk, and met the aspect of her extraordinary visage in such close proximity, without experiencing a distinct thrill and shock of almost terror. She died also in due time of sheer old age whilst I was in England, and unfortunately the lower jaw was not retained for me along with the skull.

Text-figure 2.



Skull of old Niata cow.

During some forty years residence in the River Plate (mostly in the country districts), it has not been my good fortune to gather any further information regarding the Niata type. Even before the present improvement on the original Creole race had made any way, and when many many thousand head of cattle had passed under my notice, I never saw a single example on either margin of the River Plate. Since 1890 until recently (1914) this skull and photograph hung on the walls of my Estancia office in Ajó, and were frequently commented upon by visitors; but though some few of these had heard of the breed, their personal knowledge reached no further. The one exception, an English friend, told me that as a boy in Uruguay (Department of San José), about the year 1870, he well remembers a little herd of seven or eight Niata cows with their accompanying bull. They belonged to a Uruguayan neighbour, were exceedingly tame and (in those days of no fences) were always trespassing, it being his privilege and delight to chase them back into their own territory. The prevalent colour seems to have been dun, with black legs (resembling the Jersey ?). An impressive characteristic was the bulldog-like habit of "sniffing" whenever the muzzle was raised from the ground (a habit I also had particularly noted). In 1880 there came one or two solitary cows, accompanying bought troops of ordinary cattle; these had probably been thrown in by the seller for the drover's consumption. Subsequently my informant lived thirty years in the Argentine (on a central Buenos Ayrean estancia), but never again met the quaint friends of his youth.

[Note.—The skull of the old Niata cow shown in text-fig. 2 has been presented to the British Museum (Nat. Hist.) by Mr. Gibson.—Editor, P. Z. S.]

23. White Collar Mendelising in Hybrid Pheasants.

By Rose Haig Thomas, F.L.S., F.Z.S.

[Received March 22, 1915: Read April 27, 1915.]

(Text-figure 1.)

Index.

Two or three years ago it occurred to me that an examination made of the relative numbers of dark-necked and ringed male pheasants shot in our coverts would provide some interesting material wherein to trace the working of Mendel's law. The dark-necked pheasant *Phasianus colchicus* had been the only inhabitant of Britain's forests and woods for centuries; the pheasant is mentioned in Saxon times in a "bill of fare drawn up by Harold for the Canons' households ...... A.D. 1059, and preserved in a manuscript of the date of circa 1177": (see Dawkins, 'Ibis,' 1869, p. 358). The first introduction of *Phasianus torquatus*, the so-called "ringed pheasant," to our woods was towards the latter end of the eighteenth century. This species has a white collar, broken or interrupted on the throat.

For two seasons a simple reckoning was made of the males shot, and the data collected are remarkable evidence of the continual Mendelising occurring in the collar of the hybrid pheasants of our coverts, absence being the recessive.

The grading was arranged as follows:—

Collar absent.	Dark-necked *Phasianus colchicus* type.
Few tips.	From two or three to a dozen feathers with very narrow white margin, found beneath ear-coverts.
Half collar.	Collar arrested beneath the ear-coverts.
Three-quarters collar.	*Phasianus torquatus* type, collar broken at throat.
Complete ring.	Hybrid mutation collar making a complete circle round the throat.

The dark-necked male pheasant *P. colchicus* has the whole neck green lustre.

The hybrid (*P. colchicus* × *P. torquatus*) male pheasant has the green lustre on neck above the collar, but a rich bronzed copper beneath the collar. The "complete ring" differs in individuals—it is sometimes broad, sometimes slender, sometimes medium.

Shooting Season 1912–1913.

Number of males examined—294.

Collar absent.	Few tips.	Half collar.	Three-quarters collar.	Complete ring.
26	47	10	175	36

Shooting Season 1913–1914.

(Christmas shoot omitted.)

Number of males examined—244.

Collar absent.	Few tips.	Half collar.	Three-quarters collar.	Complete ring.
15	47	52	118	12

Total number of male pheasants examined—538.

Collar absent.	Few tips.	Half collar.	Three-quarters collar.	Complete ring.
41	94	62	293	48

making 449 variations of broken collar and the numbers for the recessive "collar absent" (dark-necked pheasant) and those for the "complete ring" nearly equal, suggesting that the latter may be a "mutation recessive."

Further evidence of the Mendelising of the white collar, collar dominant, dark neck recessive, was found in a cross made in captivity in my pheasantry between *P. versicolor*, collar absent, and *P. formosanus*, collar present, where, though the numbers are necessarily small, the same graded forms occur. The reciprocal cross made in 1914 gave the same result.

Desiring to ascertain whether a complete ringed pheasant had ever been shot in a wild state, I sought information from several persons, all of whom have been most kind in replying to my inquiries.

Mr. W. R. Ogilvie-Grant, Assistant Keeper of Zoology in the Natural History Museum, states that all the *Phasianus torquatus* group have the white collar interrupted at the throat, but that males from Northern China—*Phasianus kiangsuensis* and *Phasianus pallasi*—have the collar interrupted on the nape and widest on the throat. I am not aware that any *P. torquatus* of this form has ever been introduced into Britain.

Mr. J. H. Miller (of the Miller-Carruthers Expedition to Central Asia) stated that he could not be absolutely certain, but was under the impression that he had never seen a complete ring on any of the male pheasants he shot of the variety of the *torquatus* group named *P. mongolicus* (a pheasant frequently introduced into English coverts). Mr. Miller generously presented me with a beautiful specimen which he had shot in the

Tekkes Valley, Ili, alt. 3000 ft. This bird has the white three-quarters collar broken at the throat, and also the major, median, and minor wing-coverts of isabelline-white. This isabelline-white wing-patch has not been observed on any of the male common wood-pheasants examined from 1912 to 1914, but it is quite possible that its occurrence amongst our hybrids may have been noticed by others.

The major, median, and minor wing-coverts in *P. formosanus*—a variety of *torquatus* also often introduced into our coverts—are pale grey, and this colour was frequently found amongst the hybrid males examined.

Mr. Douglas Carruthers, who is now bringing out a work on the fauna of North-west Mongolia and the Dzungaria, replied to my inquiry as follows:—"I do not recollect ever collecting a wild pheasant with a complete ring, nor do I believe that there are any. Badly made up skins can often give the idea of a ring joining up the front, for the white feathers can be pulled round so as to meet. The rings *varied* in breadth and whiteness, but none formed the complete circle."

It thus seemed fairly established, from the specimens in the Natural History Museum and the observations of these two experienced travellers, that a pheasant with a complete ring in the wild state had not been recorded.

Mr. Fenwick-Owen, however, supplied me with an interesting series of observations on a new variety of pheasant he shot in 1912 in the Chone district of the province of Kansu, on the Peling Mountains. This pheasant was classified as a new form of the *P. torquatus* group by Mr. Ogilvie-Grant and named *Phasianus stranchi chonensis.*

Mr. Fenwick-Owen also shot *P. elegans*, a dark-necked (collar absent) pheasant in the Chone district; and in the neighbouring province of Sechuan, Prejevalsky, a Russian, first found a three-quarters ring-necked pheasant named *P. sechuanensis.* The habitats of *P. elegans* and *P. sechuanensis* overlap.

In a letter to Fenwick-Owen dated November 18th, 1912, Ogilvie-Grant remarks on certain resemblances in *P. stranchi chonensis* to both *P. sechuanensis* and *P. elegans.*

In Mr. Fenwick-Owen's words:—"In *P. stranchi chonensis* the ring varies from the faintest suspicion of a ring to the complete full ring. Occasionally there is no sign of a ring at all."

These remarks suggest that a hybrid segregation similar to that found in our own coverts is taking place in a wild state—that, in fact, his new pheasant may be the result of a cross between the "dark-necked," collar absent, *P. elegans* and the "ring-necked," collar present, *P. sechuanensis*, whose habitats overlap.

The following short descriptions of characters found in *P. elegans* resembling *P. colchicus*, and of characters found in *P. sechuanensis* resembling *P. formosanus*, the form of *torquatus* peculiar to the island of Formosa, made from a brief inspection of these species at the Natural History Museum with the males and females of all four laid side by side, afford some ground for the hypothesis.

Male. *P. elegans*, dark neck, collar absent, coloration much resembles male *P. colchicus*.

Female. *P. elegans*, *dark bird*, breast *patterned* like female *P. colchicus*.

Male. *P. sechuanensis*.

- Crest identical with male *P. formosanus*.
- Wing *secondaries* pattern identical with male *P. formosanus*.
- Collar three-quarters interrupted at throat, widest at the ends like male Formosan, but the ends are square instead of a vandyke-point like the male *P. formosanus*.
- Flank-feathers differ, being a bronze-copper instead of pale cream as those of the male *P. formosanus*.

Female. *P. sechuanensis*.

- *Light bird*, breast *unpatterned*; strongly resembles *P. formosanus* female.
- Tail—lateral rectrices—identical with female *P. formosanus*.
- Wing—secondaries—identical with female *P. formosanus*.

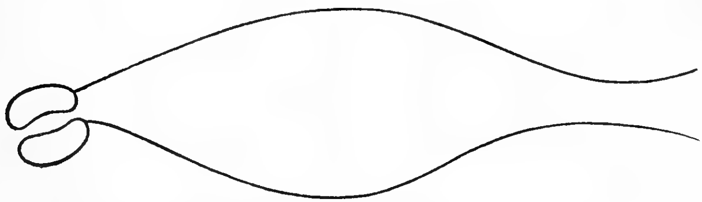
From the above comparison it might be inferred that a hybrid from a cross between *P. elegans* and *P. sechuanensis* would give the same collar segregation as the hybrid between *P. colchicus* and *P. torquatus* in our woods. Fenwick-Owen's observations on the collar variations in his new pheasant *P. stranchi chonensis* would appear to be at least very suggestive of the hybrid origin of the bird.

Mosaic of male and female Secondary Sexual Characters in Common Pheasant.

I would now draw attention to a remarkable specimen of the common male pheasant (of which a detailed description will be found at the end of this paper) with a curious mosaic of male and female plumage in transverse section. Colour and pattern are coupled in every case, and where the male and female plumage also differ in structure (the male degenerate, the female normal, as on the posterior back feathers and the tail-coverts) we find all three factors correlated. The bird was a young male bred in May 1913, so there is no question of age having produced the phenomenon. A male *P. formosanus* had been used for three years previously in the breeding-season in the pheasant pen. From experiments in my own pheasantry I infer that this extraordinary bird was a hybrid, which, had it not unfortunately been shot, would have proved sterile, although the testes, on dissection, were normal in size and healthy in appearance, and no trace of an ovary could be discovered. The dissection was witnessed and examined by two people. During some twelve or thirteen pheasant rearing-seasons within my own experience, from one to two so-called "mules" appear in every thousand birds reared. An old keeper in our employ makes the same statement from a life experience. These "mules," on dissection, have generally been females. The bird exhibited is only the second male mule I have ever met with.

In the 'Journal of Genetics,' vol. iii. p. 205, Mr. C. J. Bond describes and illustrates an example of hemilateral development of secondary sexual male character in a hermaphrodite *P. formosanus*. He is inclined to attribute the peculiar divisions of male and female pattern to male hormonic activity in an atrophied female sex-gland, patches of male element in active growth in a degenerating ovary; but in the example before us the mosaic of male and female colour and pattern is *transversely* segmental, also dissection only revealed a male organ of healthy normal appearance. A paragraph in a daily newspaper, July 1914, refers to some abnormal pheasant skins on exhibition at the Royal College of Surgeons, in which one specimen is noted of a male having some feathers of female type.

Text-figure 1



Sexual organ of mosaic male common Pheasant, seven months old. Length 4 inches, without reckoning the curve: testes 7/16 inch.

Male Common Pheasant.

A mosaic of male and female plumage.

Shot 17th January, 1914.—Moyles Court.

First skinned, then dissected*. The plumage was compared with a dark-necked common male and a common female *P. colchicus*, also shot in the woods. It was observed that pattern, colour, and structure are linked.

* Ernest Adlem, the keeper, witnessed the dissection, and a drawing to scale was made of the male organ, a rule with sixteenth divisions being used for measurement. No trace of a female organ was seen.

Crest: Common male pheasant, feathers paler, amongst them some feathers, mosaics of male and female.

Neck: (Collar, form of male *P. formosanus*, Formosa variety of *P. torquatus*.)

Interscapulars: Common male pheasant, but *duller* in colour.

Scapulars: Some common female pheasant: some mosaics of male and female.

Back: Mosaics of common male and female.

Tail-coverts: Pattern, colour, and structure, mosaics of common male and female.

Tail: Centrals and Laterals. All mosaics in transverse sections of common male and female colour and pattern.

One extra quill-feather on each side, a small straight quill, making 20 instead of 18 feathers.

Throat: Common male.

Breast: A few common female, unpatterned fawn.
Many common male, colour less brilliant.
Some mosaics of both male and female.

Flank: Common male; some common female; some mosaics of both.

Thigh-tuft: Common male.

Wing: Primaries; common female.
Secondaries; common female.

Wing-coverts: Major; common male.
Median; mosaics, colour and pattern, of male and female.
Minor; some common female.
some mosaics, colour and pattern, of common male and female.

EXHIBITIONS AND NOTICES.

March 23, 1915.

R. H. Burne, Esq., M.A., Vice-President, in the Chair.

Colour-Variation in Partridges.

Mr. W. R. Ogilvie-Grant, F.Z.S., exhibited a series of specimens of Partridges, including a number from the Tring Museum, kindly lent by the Hon. Walter Rothschild, D.Sc., F.R.S., F.Z.S., and drew attention to two notable colour-variations of the Red-legged Partridge (*Caccabis rufa*). He remarked:—

"As most people are aware this species is not indigenous to Great Britain, having been introduced about 1770, and since spread over a large part of England, being especially numerous from Lincoln to Essex and in the Home Counties. The remarkable variation which I now exhibit has the head, eyebrow-stripes, cheeks, and throat black, and the rest of the plumage dull vinaceous-red with a patch of white feathers in the middle of the belly, forming an irregular horse-shoe-mark. The first example was killed at Braintree, Essex, on October 20th, 1908, by Mr. A. W. Ruggles-Brise, and presented by him to the Natural History Museum. On October 20th, 1914, an almost precisely similar specimen was killed at Higham, Kent, by Mr. H. M. Cobb, sent by him to the 'Field' office, and subsequently presented by Dr. H. Hammond Smith to the Museum. Higham is about 30 miles, as the crow flies, from Braintree, and it seems a remarkable coincidence that a second specimen of this quite unique variation of the Red-leg should have been killed exactly six years after the first, and in nearly the same locality."

Other variations of this species were also shown, but it was pointed out that colour-variations were very rare, although partial albinism sometimes occurred. The remarkable variation above mentioned had been described and figured in 'British Game-Birds and Wildfowl' (pl. xxi. fig. 2, 1912).

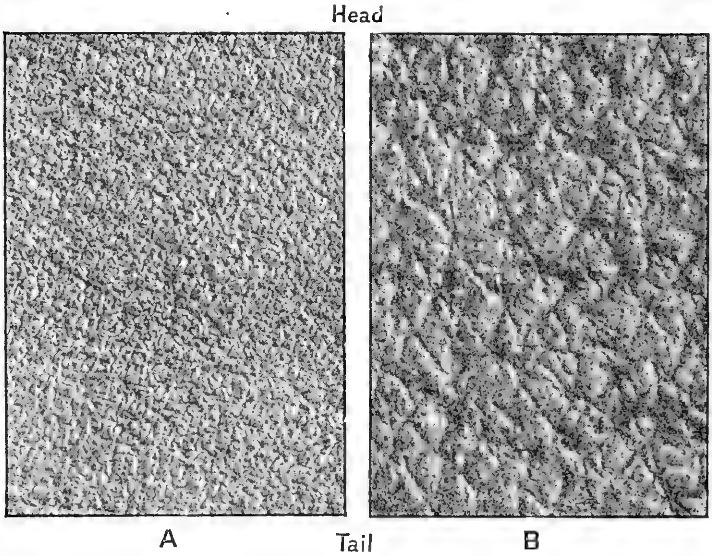
Mr. Ogilvie-Grant also exhibited a series of colour-variations of the Common Partridge (*Perdix perdix*), amongst which was the well-known chestnut form, *P. montana* Brisson. This form appeared to be comparable to the rufous variety of the Red-leg, but in this instance the variation was comparatively common, having been first described in 1760 from the mountains of Lorraine, and subsequently obtained in almost every county in England and some parts of Scotland.

Lastly, specimens of the Bearded Partridge (*P. daurica*), from Manchuria, were exhibited. This species was being sold in large numbers in the London markets, and the exhibitor had recently purchased a beautiful pale grey variety, which, however, had the black horse-shoe-patch normal.

"Pigskin" and Capybara Skin.

Sir EDMUND G. LODER, Bt., F.Z.S., exhibited the tanned skins of a Pig (text-fig. 2), and of a Capybara (text-fig. 1), and made the following remarks:—

Text-figure 1.



A portion of the skin of a Capybara: (A) natural size; (B) enlarged four times.

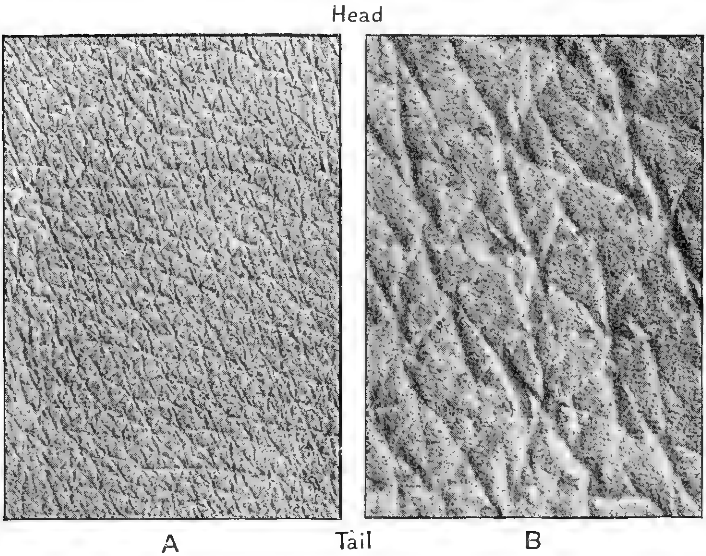
"In most parts of England and of America pigs are not skinned: they are scalded and scraped. It was therefore not clear where the pigskins used in trade came from.

One of my Capybaras having died, the skin was sent to the tanners and, on its return, it was suggested that this was perhaps what was used as "pigskin."

This idea was favoured by the knowledge that in South America saddles are commonly covered with Capybara skin, but after I had exhibited this Capybara skin at one of our meetings, a correspondent wrote to the 'Field' newspaper saying that in his part of Scotland it was the custom to skin pigs, the flesh being pickled for the Navy. I then procured a tanned pigskin from Scotland, which is the skin now exhibited with that of the Capybara for comparison."

Sir Edmund Loder, at the request of the Committee of Publication, has since had the skins photographed. The result is shown in text-figs. 1 and 2, which should be viewed so that the light falls on them from the right.

Text-figure 2.



A portion of the skin of a Pig: (**A**) natural size; (**B**) enlarged four times.

Notes from the Caird Insect House.

Prof. H. Maxwell Lefroy, M.A., F.Z.S., Curator of Insects, exhibited specimens of Insects that had been bred in the Caird Insect House and read the following notes, which had been extracted, with the assistance of Mr. C. J. C. Pool, from the records made:—

The Caird Insect House was opened in October, 1913, for the exhibition of living insects and other invertebrates. Owing to the difficulties of keeping living insects under artificial conditions, and to the death of the head keeper, Quantrill, we have not attempted to do more than maintain a large variety of species in good condition. The following few notes of interesting species that have been exhibited will illustrate some of the difficulties we have had to deal with, and some of our successes.

Phasmidæ.

Stick Insects.

Carausias morosus has been in the house continuously, and now occupies a whole bay. All are females, and no male has been seen. Part of the stock was reared in the open in July–August, and they do well under such conditions.

In the cages the green and brown insects place themselves irrespective of the colour of their background; in the open on large bushes the green insects invariably sit among the foliage or on the green shoots, the browns choosing the stem, low down near the ground. There are, as a rule, many more greens than browns, just as there is on a plant a much larger proportion of green area than brown.

Carausias will eat a variety of plants—roses, beans, privet, euonymus, lilac, ivy, hawthorn, rubber fig, *Coleus*, *Spiræa*, and *Aralia* being some of those on which they have thriven.

Owing to the shortage of mealworms, these stick insects have been used for feeding some birds and small mammals: the Curator of Birds is anxious to breed them on a large scale for his birds, the Curator of Reptiles wants them for his lizards, and the Superintendent covets them for some of the more delicate mammals. They are very prolific, laying some hundreds of eggs; but the life-history is long and they remain several months in the egg stage. Whether it will be feasible to breed them on a large scale remains to be seen; there is no difficulty, but they require fresh food and a certain amount of attention.

We may contrast the prospects of breeding mealworms and stick insects as follows:—

Mealworm:—Egg 16–21 days.
Larva 5–6 months.
Pupa 14 days.
Beetle lives 2–3 months, begins to lay in 10 days, and lays 50–100 eggs—say 60.

In 5 years a stock of 100 might have increased by 6 broods to 600 million individuals, assuming half of each lot were used as food when larvæ (*i. e.* 27 million) and half were females.

Every mealworm used as food has not bred, so there is a loss, and it requires two beetles, a male and a female, to produce 100 eggs; these two can only be used for feeding as beetles.

The mealworms require little attention—a very little meal as food, a few dead mice, sparrows, and other small game as luxuries, and quite simple boxes as cages.

Stick Insect:—Egg takes 2–3 months.
Nymph takes 5 months.
Adult takes 9 months, begins to lay in a few weeks, and lays 300–500 eggs.

In 5 years from 100 one might have 5 broods, the last amounting to about 10 billion, all of which could be used for food and none of which would have been kept as adults after they had laid 100 eggs; for 100 eggs only one female is required, as there are no males.

They require fresh food, more attention, more space; they are much larger, and are greedily eaten by many of the animals and birds. On the whole, it looks as if at our Gardens, with lots of privet, it might be profitable to breed *Carausias.*

Leaf Insects.

Mr. E. G. B. Meade-Waldo has given us stocks of *Pulchriphyllium crurifolium*, and they appeal very much to the public. We have not been very successful with them, and large numbers of our brood vanished. We lost many young probably from a spider, *Psalmopœus cambridgii*, which "disappeared," hiding itself behind the cork fittings in the case and apparently coming out at night to feed on the young ones; the spider was found well and flourishing when the cork was taken down. Cockroaches (*Periplaneta americana*) also eat the living insects.

We obtained seed of guava from Bombay and plants were grown, but the insects do better on the oak their parents in England have fed on.

Many full-grown females have died as a result of injuries sustained by being nibbled by their fellows; not a single specimen has completely escaped this unfortunate mishap.

We are in possession of a number of ova, from which we expect a good stock for the coming season.

Mantidæ.

Sphodromantis guttata.

Of wide African distribution, and also found in Persia.

An egg-mass from East Africa, hatched on July 6th, 1914; the young were fed on Aphides, small caterpillars, the larvæ of *Cis*, and other small insects. One was loose in the bay containing caterpillars of *Attacus cynthia*, and throve amazingly. It was eventually placed in solitary confinement. Two have survived up to the present, and one completed its development on March 20th; for the last three months they have been fed on stick insects and moths. It is an unusual thing to bring a Mantis through all its moults in captivity; the second appears likely to complete its development very soon.

These insects are bark-coloured, and rest motionless by day, feeding at night; probably in the wild state they do the same, differing from the commoner green variety, which sit among green foliage awaiting their prey during the daytime. These insects were green until half-grown, so doubtless in a wild state some change of appearance becomes necessary through a change of season and the colour of the foliage. Unfortunately, both our specimens are females. Before the penultimate moult one had lost part of its antenna, after the moult this was found to be complete; a tarsus lost before the final moult was not regenerated, and the perfect insect is without it.

Coleoptera.

Dermestes frischi.

This very rare beetle was exhibited in all stages of development. The specimens came from Millwall Docks, where the larvæ were feeding in hard fungi on decaying aspen logs. The Port of London Authority very kindly granted permission for the logs to be removed to the Insect House, where they are now under observation. The fungus was inhabited by two other beetles, both of which are common British species—*Cis boleti* Scop. and *Cis villosulus* Marsh.; we have bred these for feeding the Mantides referred to above. Several pupæ of *D. frischi* were found no less than four inches from the surface of the logs. The larval borings resembled those of the oak timber pest *Xestobium tessellatum* F. It is interesting to note this remarkable departure from the ordinary habits of *Dermestes*. These beetles are usually found in dead animals and birds or in raw hides and natural history specimens.

Xestobium tessellatum.

We have been fortunate in getting material in an oak-tree of this beetle, which is doing so much damage in the roof of Westminster Hall. The live larvæ and beetles obtained from this tree have been of great use in testing methods of dealing with the beetle in Westminster Hall, as very little other live material has been available.

Dorcatoma punctulata.

The only known British specimens of this pretty little beetle were discovered at Enfield, Middlesex (Entom. Monthly Mag., July 1914, p. 167).

Two other British species, *D. chrysomelina* and *D. flavicornis*, are found in oak timber in the New Forest and other localities.

D. punctulata closely resembles *Chrysomelina*, but its habits appear to be different. The insects have been exhibited in all stages, inhabiting a hard dry fungus from the trunk of an old ash-tree at Forty Hill, Enfield. The beetle emerges in June and July: there are a number of larvæ in the fungus which should produce beetles shortly.

Eryx fairmairei.

The only known British locality for this beetle is Sherwood Forest, Notts. The larva, which closely resembles a mealworm, is very destructive to the bark of old growing oak-trees. A number of the larvæ were collected in July 1913, and beetles bred from them have been shown. The beetle, which resembles the other British species *Eryx ater* F. (and with which it was confused in some of the old collections), appears to have received little or no study as to its habits. It is therefore as well to draw attention to the different conditions under which the larvæ of the two species were found.

Eryx ater is common in the New Forest and other well-wooded districts, but has not been taken at Sherwood. It was formerly very rare in collections, as owing to its nocturnal habits it usually escaped the notice of collectors; but it was taken a t sugar by lepidopterists. The larva, which appears to be indistinguishable from that of *E. fairmairei*, is common in hollow trees, where it is usually found associated with a Lamellicorn beetle, *Dorcus parallelopipedus* L., in ash or beech, or with *Sinodendron cylindricum* in apple. The burrows of these two beetles appear to form ideal conditions for the *Eryx* to establish itself. It never attacks the Lamellicorn larvæ, and is entirely a wood-feeder. It has been found in more than twenty trees in the Enfield district, but always in the hollows and never in the bark.

At Sherwood Forest, with *E. fairmairei*, the conditions are always completely reversed. A hollow oak-tree there contained some larvæ which appeared to be *Eryx*, but which afterwards produced specimens of an allied species, *Cistela ceramboides* L.

The bark of this tree was infested with groups of *Eryx* larvæ, the eggs having been deposited in crevices in various parts of the trunk.

The larva feeds upon the growing bark, and the work of destruction is more complete than that produced by the elm-bark pest *Scolytus destructor*. There are many fine old trees at Sherwood upon which the bark was held together merely by the strength of its outer layers, the whole of the inner layer having been devoured by the *Eryx* larvæ. Only a little effort was needed to bring the whole mass to the ground, when amidst a cloud of dust and spiders one might hope to find a few of the beetles, but more often the larvæ of several generations together.

Aulonium trisulcum.

The following extract from Fowler and Donisthorpe's 'British Coleoptera' is of interest in connection with the specimens now exhibited :—" Enfield. Under elm-bark in the burrows of *Scolytus multistriatus*. Subsequently, Mr. Pool took it both at Edmonton and Winchmore Hill. This very interesting addition to our list (Ent. Record, xvi. 1904, p. 310) was made by Mr. C. J. C. Pool in July 1904. The insect is found rarely under elm-bark in Central and Southern Europe in the burrows of *S. destructor* and *S. multistriatus*. The larva of this species is briefly described by Westwood. It is long, subdepressed, and slightly curved, with three pairs of thoracic legs and a pair of short, recurved, horny points upon the terminal segment of the body. The pupa is very much elongated, with two short obtuse points at the extremity."

The elm post from which the original British specimens were taken at Enfield was made from a portion of a very large prostrate bough close at hand. The bark was infested with the Scolytids and a colony of about thirty of the *Aulonium* in various stages.

Many elm-trees are standing in the Zoological Gardens from which boughs have been removed, for use as perches in various out-door cages for birds and mammals.

This habit of using fresh material has the effect of producing exactly the right conditions for the Scolytid pests to flourish.

We have collected some infested branches, and in the burrows of the *Scolytus* the *Aulonium* (larvæ and remains of beetles) has been rediscovered.

This interesting discovery will add something to our knowledge of the habits and distribution of this rare beetle.

Material is now exhibited in the Insect House, from which the beetles will be emerging from May to July.

Anthia sexguttata. (Six-spotted Ground-Beetle.)

We received five specimens from India in July 1914, one of which is still alive (March 17th, 1915). It burrowed down into the sand on August 10th, and reappeared on October 1st. They have this burrowing habit in India, but this specimen alone of the five exhibited it. All the others died before the middle of October. *Anthia* is fed on sugar and live insects.

Geotrupes sylvaticus. (Forest-Geotrupid.)

In September, 1914, we obtained this species from the New Forest. Unlike their brethren, which feed on cattle-dung, these beetles eat fungus and decayed vegetable matter. This colony is laying eggs in a mixture of decaying leaves and banana-skins, and promises to become a permanent addition.

Enceladus gigas. (Giant Ground-Beetle.)

A specimen arrived alive and in robust health from Trinidad; it had devoured all the many insects with which it had been sent, and alone survived. It has flourished with us; it escaped once, and was recaptured in the Small Mammal House.

Hæmonia appendiculata.

This rare beetle has been represented by four specimens living in a small tank since October 13th, 1914, when they were received from Oxford. It is probable that they will breed here.

Sphodrus leucophthalmus.

This rare Carabid beetle has been collected at Woolwich, and is now exhibited with two allied species, *Læmostenus complanatus* and *Pristonychus terricola*. All are doing well upon a diet of sugar and water.

April 13, 1915.

E. T. Newton, Esq., F.R.S.,
in the Chair.

The Secretary read the following report on the Additions made to the Society's Menagerie during the month of March 1915 :—

The number of registered additions to the Society's Menagerie during the month of March was 49. Of these 26 were acquired by presentation, 15 were received on deposit, 3 in exchange, and 5 were born in the Gardens.

The number of departures during the same period, by death and removals, was 127.

Amongst the additions special attention may be directed to :—

1 Philippi's Tucutucu (*Ctenomys mendocinus*), new to the Collection, from Cordova, Argentina, presented by Wilfred A. Smithers, C.M.Z.S., on March 2nd.

4 Black-backed Jackals (*Canis mesomelas*), born in the Menagerie on March 26th.

Dr. A. Smith Woodward, F.R.S., F.Z.S., exhibited an anterior horn of a Woolly Rhinoceros (*Rhinoceros antiquitatis*), obtained for the British Museum, from frozen earth in Northern Siberia, by Mr. Bassett Digby. The horn must have measured originally nearly a metre along the curve of the anterior border. It has been cut and trimmed in places by the finders, but is sufficiently well preserved to show its laterally compressed shape and sharp posterior border.

Mr. D. Seth-Smith, F.Z.S., Curator of Birds, exhibited a series of lantern-slides, from photographs taken in the Gardens, showing the nuptial display of the male Great Bustard (*Otis tarda*).

Mr. E. Heron-Allen, F.L.S., F.Z.S., exhibited, and invited suggestions relative to, a lantern-slide representing a specimen of *Miliolina circularis* (d'Orb.), the final chamber of which, being dissected off, revealed a fully-grown second individual inside. It was suggested that it represented a case of arrested twinning. The exhibitor was convinced that it had nothing to do with the phenomenon of viviparous reproduction recently exhibited by him.

April 27, 1915.

Prof. E. A. Minchin, M.A., F.R.S., Vice-President
in the Chair.

The Secretary exhibited lantern-slides of young Grey Seals (*Halichœrus grypus*) prepared from photographs taken by Mr. H. M. Banbury, F.Z.S., off the West Coast of Scotland. The seals were about five feet in length on the 24th of October, 1914.

Mr. H. J. Elwes, F.R.S., F.Z.S., read the following extract from a letter that he had received from Mr. J. R. P. Gent, Forest Officer of the Darjeeling Division, on the possible existence of a large Ape, unknown to science, in Sikkim :—

"I have discovered the existence of another animal but cannot make out what it is, a big monkey or ape perhaps—if there were any apes in India. It is a beast of very high elevations and only gets down to Phalut in the cold weather. It is covered with longish hair, face also hairy, the ordinary yellowish-brown colour of the Bengal monkey. Stands about 4 feet high and goes about on the ground chiefly, though I think it can also climb.

"The peculiar feature is that its tracks are about eighteen inches or two feet long and the toes point in the opposite direction to that in which the animal is moving. The breadth of the track is about 6 inches. I take it he walks on his knees and shins instead of on the sole of his foot. He is known as the jungli admi or sogpa. One was worrying a lot of coolies working in the forest below Phalut in December, they were very frightened and would not go into work. I set off as soon as I could to try and bag the beast, but before I arrived the Forester had been letting off a gun and frightened it away, so I saw nothing. An old choukidar of Phalut told me he had frequently seen them in the snow there, and confirmed the description of the tracks.

"It is a thing that practically no Englishman has ever heard of, but all the natives in the higher villages know about it. All I can say is it is *not the Nepal Langur*, but I've impressed on people up there that I want information next time one is about."

Prof. William Bateson, F.R.S., F.Z.S., exhibited a number of drawings illustrating the heredity of "hen-feathering" in Cocks.

Foraminifera of the Kerimba Archipelago.

Messrs. E. Heron-Allen, F.L.S., F.Z.S., and Arthur Earland, F.R.M.S., read the second portion of their memoir on the "Foraminifera of the Kerimba Archipelago, Portuguese East Africa."

As noted on a previous occasion, the similarity existing between the general facies of the gatherings and those which form the subject of the late Mr. F. W. Millett's Monograph on the Foraminifera of the Malay Archipelago * and the reason for that similarity still defy explanation. The zoological interest of the district lies in the fact that since d'Orbigny published the result of his examination of sands from Madagascar in 1826 †, the district never received attention from protozoologists until Brady reported the result of his examination of some shore sands from Tamatave, Madagascar, sent to him by Mr. Kitching, in which he rediscovered the comparatively rare and beautiful form *Pavonina flabelliformis* ‡. D'Orbigny gave an unsatisfactory description and figure of this species in 1826 §, and an equally unsatisfactory "Modèle" which was discussed by Messrs. Parker and Jones in their "Nomenclature of the Foraminifera" ||, who thought it "possibly a symmetrical *Peneroplis* but more probably a semidiscoidal modification of *Orbitolites*." We have searched the d'Orbigny collections both in Paris and La Rochelle in vain for any type-specimens. It was reserved for Brady to rediscover the species in many tropical localities and it is one of the most frequent of the striking Kerimba types.

The romance attaching to it is, however, insignificant compared with that which surrounds an organism to which d'Orbigny gave the *nomen nudum*, *Rotalia dubia* ¶. Unlike the case of *Pavonina flabelliformis*, of which there is a finished *Planche inédite* in Paris but no type-specimens, of *Rotalia dubia* there is a water-worn type-specimen in Paris but no finished *Planche inédite*. D'Orbigny's original sketch of the organism, however, is there, and Fornasini of Bologna has published a tracing of it,** sent to him by Berthelin †† with a statement that he doubted whether it was a foraminifer at all, and not an ostracod, and this appearance is certainly borne out on a superficial view of the type-

* F. W. Millett, 1898, etc., J. R. Micr. Soc. 1898–1904.

† A. d'Orbigny, Tableau Méthodique des Céphalopodes, Ann. Sci. Nat. 1826, vol. vii.

‡ This is his account in the "Challenger Report," 1884 (p. 375). In his Preliminary Report, however, on the Reticularian Rhizopods of the Challenger Expedition (Q. Journ. Micr. Sci. n.s. vol. xix. p. 282), he states that he found it in shallow-water sand dredged by Dr. E. Perceval Wright in the Seychelle Islands and refers to Ann. & Mag. Nat. Hist. 1877, ser. 4, vol. xix. p. 105 (*error for* p. 41).

§ *Loc. cit.* p. 260, pl. x. figs. 10, 11, Modèle no. 56.

|| Ann. & Mag. Nat. Hist. 1863, ser. 3, vol. xii. p. 440.

¶ d'Orbigny, Tableau Méthodique des Céphalopodes, 1826, p. 274, no. 34.

** See Fornasini, "Specie Orbignyane," Mem. Acc. Sci. Ist. Bologna, 1908, ser. 6, vol. v. p. 46, pl. i. fig. 14.

†† See Fornasini, Rend. Sess. Acc. Sci. Ist. Bologna, 1897–8, vol. ii. p. 11.

specimen and the sketch. It has been reserved for us after the lapse of 90 years to rediscover this organism in the Kerimba sands, and though there can be no doubt about its rhizopodal nature, its affinities and structure are so obscure that in the absence of further specimens we are unable at the present time to do more than record it under d'Orbigny's original name. It will almost certainly require the establishment of a new genus.

The leading zoological feature of the gatherings is perhaps the great abundance and variety of the Miliolidæ, of which we publish notes upon 122 species, no less than 77 belonging to the genus *Miliolina*, of which six are new to science. Interesting specimens of Millett's species *Miliolina durrandii* have been found containing ingested smaller Miliolids and other organisms, comparable with the occurrence of a specimen of a rare variety *Cassidulina bradyi* var. *elongata* Sidebottom, which we found by accidentally crushing a shell of *Cymbalopora bulloides* d'Orbigny. The immense abundance of the genus *Peneroplis* and the generosity of the Council of the Society with regard to space have enabled us to publish with all necessary text-figures a revision of the lituiform species of this genus. The conclusion we have arrived at, after considering every record from Linnæus's *Nautilus lituus* and his very confusing earlier authorities, is that the short stout spirilline forms must be included under *P. arietinus* Batsch, the long narrow forms must be *P. cylindraceus* Lamarck, and the specific name *lituus* must lapse altogether, its place being taken by Chapman's genus and species *Monalysiduum polita* *.

In connection with the new genus *Iridia*, discussed at length in Part I. of this Paper, a new point has arisen since the publication of that part. As regards the abnormal specimens ascribed to the genus and figured in pl. xxxvi. (fig. 10), in which the arenaceous investment is limited to an encircling wall, the two faces of the shell being formed by transparent chitinous pellicles, a figure given in 1905 by Dr. Rhumbler of a new genus and species named by him *Vanhoeffenella gaussii* † appears to be identical with them. Rhumbler's specimens were from a depth of 400 metres in the Antarctic, and he states that the pellicle is so transparent as to be visible only with special illumination. He suggests that the object of the pellicles is to serve as windows by which the animal may obtain some benefit from the last rays of sunlight penetrating to this depth ‡.

In the Kerimba specimens the pellicle is a stout chitinous membrane distinctly visible with ordinary illumination, both dry and in balsam, and in no way differing from the chitinous lining which is present in all stages in *Iridia*. It does not appear from Rhumbler's paper that he was acquainted with any other form

* F. Chapman, 1899, Funafuti Foraminifera, Journ. Linn. Soc., Zool. vol. xxviii. p. 4, pl. i. fig. 5.

† Verh. d. Deutsch. Zool. Ges. 1905, p. 105.

‡ *Cf.* his description and text-figure 57 on page 216, in his "Foraminiferen der Plankton-Expedition," pt. i. 1909.

of the organism, whether free or attached, and in the absence of information on this point and the impossibility at the present time of communicating with Dr. Rhumbler or of examining his specimens, the question of the identity of the two forms must remain temporarily unsolved. If it turns out that *Vanhoeffenella gaussii* is identical with the abnormal form of *Iridia* represented by our figure 10, it will become a question for experts in the rules of nomenclature whether or not his name should have precedence, but we do not feel inclined to accept his views on the window theory to account for the existence of the membrane. The glare of tropical sunlight in the shallow waters of the Kerimba reefs would certainly not be an advantage to the organism, and we prefer the theory we have expressed, that these are abnormal forms which have grown between two large sand-grains and have subsequently become detached. Of course any astrorhizid growing under such conditions would have a tendency to form a structure similar to *Vanhoeffenella*, and unless Dr. Rhumbler found other specimens attached or free similar to the adult Iridiæ which we have figured, the identity of the two organisms remains unproved and our genus *Iridia* holds good.

The Kerimba material has supplied us with a very fine series of those double shells of *Discorbina* which one of the authors has recently exhibited in support of his conviction that the so-called phenomenon of plastogamy is in truth a process of budding. We have prepared a series of such pairs from the earliest primordial emerged chamber to the young but adult and almost independent shell.

The other important observations arising out of the material are afforded by the study we have been able to make of the vast quantities present of the various species of the genus *Cymbalopora*. We have been able to make a series of sections and dissections showing most clearly and in all its stages of development the peculiar dual nature of the large terminal balloon-chamber of *Cymbalopora bulloides* d'Orbigny. It was Earland who first (in 1902), called attention to this feature*, which had curiously enough escaped in turn the observation of d'Orbigny, Brady, Möbius, and Sir John Murray, all of whom paid special attention to the species. The detailed results of our observations are in course of being published † and are too elaborate and far reaching to go into at length on this occasion. We have found many specimens the float-chamber of which has been found on dissection to be filled with desiccated remains of Xanthellæ such as were noted by Sir John Murray in his 'Challenger' Note Books. And we have separated as a new species, a smaller and more compact form of *Cymbalopora*, in which the inner float and outer balloon chambers are so closely connected as to be practically

* A. Earland on "*Cymbalopora bulloides* d'Orbigny and its Internal Structure," Journ. Quek. Micr. Club, ser. 2, vol. viii. 1902, p. 309.

† Heron-Allen, in Phil. Trans. Roy. Soc. London, 1915. (*In the press.*)

homogeneous, the surface of whose balloon is characterized by a wrinkled dendritic pattern, and the rotalian portion of which is uniformly acervuline instead of rotaline as in the type-form *C. bulloides*.

The most remarkable phenomenon, however, which has presented itself in the gatherings is that exhibited by certain specimens of *Cymbalopora tabellæformis* Brady, which have been found in a condition which, so far as our researches go, has never been observed before in connection with any other rhizopod. Certain comparatively large fragments of molluscan shells coated or not, as the case may be, with nullipore corals, we found to be dotted with little pits, some filled and others empty and showing canals radiating from them in all directions. The occupied pits were discovered on examination to be filled each with one specimen of *Cymbalopora tabellæformis* which had encrypted itself at an early age and had by some obscure means not only enlarged its crypt to accommodate the growth of its shell, but had excavated tunnels, often exceeding in length many times its diameter, in all directions in the solid substance of the host-shell for the accommodation of its pseudopodia. It can only be assumed that the solvent and assimilative powers of the protoplasm which enable the animal to secrete the carbonate of lime of which its shell is composed, enable it to dissolve the solid calcareous substance of the host-shell in the manner which is seen in the specimens. The suggestion that the boring of the tunnels and enlargement of the crypt may be effected by the carbonic acid generated by the action of the chlorophyll of the minute symbiotic algæ which are almost invariably found in the protoplasm of this foraminifer, is an interesting and a suggestive one, but it is doubtful whether we have need of this hypothesis to explain the phenomena.

In conclusion we may say that the outcome of our labours upon this material amounts to over 470 species and varieties, of which 32 are new to science.

This memoir will be published in the "Transactions" in due course.

No. 142.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

March 23rd, 1915.

R. H. Burne, Esq., M.A., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Sir Edmund G. Loder, Bt., F.Z.S., exhibited a tanned Pig-skin and, for comparison, the skin of a Capybara.

Mr. W. R. Ogilvie-Grant, F.Z.S., exhibited a series of specimens of Partridges, and drew attention to two extremely remarkable colour-variations of the Red-legged Partridge (*Caccabis rufa*). As most people are aware this species is not indigenous to this country, having been introduced about 1770, and since spread over a large part of England, being especially numerous from Lincoln to Essex and in the Home Counties. This remarkable variation has the head, eyebrow-stripes, cheeks, and throat black, and the rest of the plumage dull vinaceous-red with a patch of white feathers in the middle of the belly, forming an irregular horseshoe mark. The bird was killed at Braintree, Essex, on October 20th, 1908, by Mr. A. W. Ruggles-Brise, and presented by him to the Natural History Museum. On October 20th, 1914, an almost precisely similar specimen was killed at Higham, Kent, by Mr. H. M. Cobb, sent by him to the 'Field' office, and subsequently presented by Dr. H. Hammond Smith to the Museum. Higham is about 30 miles, as the crow flies, from Braintree, and it seems a remarkable coincidence that a second specimen of this quite unique variation of the Red-leg should have been killed exactly six years after the first, and in nearly the same locality.

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Other variations of this species were also shown, but it was pointed out that colour-variations were very rare, although partial albinism sometimes occurred. The remarkable variation above mentioned had been described and figured in 'British Game-Birds and Wildfowl' (pl. xxi. fig. 2, 1912).

Mr. Ogilvie-Grant also exhibited a series of colour-variations of the Common Partridge (*Perdix perdix*), amongst which was the well-known chestnut form, *P. montana* Brisson. This form appeared to be comparable to the rufous variety of the Red-leg, but in this instance the variation was comparatively common, having been first described in 1760 from the mountains of Lorraine, and subsequently obtained in almost every county in England and some parts of Scotland.

Lastly, specimens of the Bearded Partridge (*P. daurica*), from Manchuria, were exhibited. This species is now being sold in large numbers in the London markets, and the exhibitor had recently purchased a beautiful pale grey variety, which, however, had the black horseshoe patch normal.

Prof. H. Maxwell Lefroy, M.A., F.Z.S., Curator of Insects, exhibited a specimen of *Sphodromantis guttata*, which had been bred from the egg in the Caird Insect House and had attained maturity during March. He discussed the advantage of breeding stick insects to supply a substitute for meal-worms, and read notes on insects that had been bred in the insect house.

Mr. R. Lydekker, F.R.S., F.Z.S., presented a paper entitled "The True Coracoid," in which he stated that the element in birds and post-Triassic reptiles universally known as the coracoid is the homologue of the human coracoid process, and its equivalent the true coracoid of the monotremes and mammal-like reptiles.

Dr. F. E. Beddard, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper dealing with certain points in the anatomy of the Cestode genera *Amabilia* and *Dasyurotænia*.

Mr. Bruce F. Cummings read a paper "On new Species of *Polyplax* (Anoplura) from Egypt." This paper contained a systematic description of two new species of louse based on a large supply of material in spirit collected on *Acomys cahirinus* Des., and forwarded by the Department of Public Health in Egypt to the Lister Institute, by whom they were subsequently presented to the British Museum.

Both the new species were fortunately collected in large numbers in all stages of development, and an account of the larvæ consequently has been prepared. Unfortunately the specimens were in a poor state of preservation, so that a study of the soft parts was not possible.

Mr. J. T. Cunningham, M.A., F.Z.S., read a paper on the resemblance in form and markings of the plates of paraffin-wax originally obtained by Prof. Kappers, of Amsterdam, to the shells of Molluscs. Examples of these structures had been exhibited at a previous meeting by Mr. R. H. Burne, V.P.Z.S. Mr. Cunningham found that the forms were produced by pouring molten paraffin-wax on to the surface of cold water, and he had no doubt that Prof. Kappers's specimens were produced in the same way by the molten wax running over on to a vessel filled with water. The surface-layer of the wax was cooled by contact with the water, then the flowing wax was piled up on the cooled film till the surface-tension gave way and the wax flowed over, and being cooled in its turn formed an additional zone of wax beyond the original edge, and so on in succession. Thus the parallel lines of increment seen on the underside of the wax plate were produced, just as the parallel lines on Mollusc shells are produced by periodical increments of growth. The author concluded that the form and markings were not in either case in any way due to effects of crystallization as Prof. Kappers supposed. By causing the water to rotate spiral forms were produced, and either right- or left-handed spirals could be produced at will according as the water was stirred to the right or left. The author concluded with a demonstration, pouring molten wax on to a dish of water and showing the shell-like appearance of the cooled plate of wax.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 13th, 1915, at half-past Five o'clock p.m., when the following communications will be made :—

G. A. Boulenger, F.R.S., F.Z.S.

A List of the Snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola.

R. Broom, M.D., D.Sc., C.M.Z.S.

1. On some new Carnivorous Therapsids in the Collection of the British Museum.

2. On the Organ of Jacobson and its Relations in the "Insectivora."

G. E. Nicholls, D.Sc., F.L.S.

A Note on the Urostyle (*Os Coccygeum*) of the Anurous Amphibia.

Ernest Gibson, F.Z.S.

Some Notes on the Ñato Breed of Cattle (*Bos taurus*).

The following papers have been received :—

E. Heron-Allen, F.L.S., F.R.M.S., F.Z.S., and Arthur Earland, F.R.M.S.

The Foraminifera of the Kerimba Archipelago (Portuguese East Africa).—Part II.

Mrs. Rose Haig Thomas, F.Z.S.

White Collar Mendelising in Hybrid Pheasants.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
March 30*th*, 1915.

No. 143.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

April 13th, 1915.

E. T. Newton, Esq., F.R.S., in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The Secretary read a Report on the Additions made to the Society's Menagerie during the month of March 1915.

Sir Edmund G. Loder, Bt., F.Z.S., exhibited lantern-slides of tanned skins of a Pig and a Capybara.

Dr. A. Smith Woodward, F.R.S., F.Z.S., exhibited an anterior horn of a Woolly Rhinoceros (*Rhinoceros antiquitatis*), obtained for the British Museum, from frozen earth in Northern Siberia, by Mr. Bassett Digby. The horn must have measured originally nearly a metre along the curve of the anterior border. It has been cut and trimmed in places by the finders, but is sufficiently well preserved to show its laterally compressed shape and sharp posterior border.

Mr. D. Seth-Smith, F.Z.S., Curator of Birds, exhibited a series of lantern-slides, from photographs taken in the Gardens, showing the nuptial display of the male Great Bustard (*Otis tarda*).

Mr. E. Heron-Allen, F.L.S., F.Z.S., exhibited examples of the Foraminiferan *Milliolina* in viviparous reproduction.

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. Ernest Gibson, F.Z.S., read a paper on the Ñato Cattle of the Argentine, and exhibited the skull and a photograph of some specimens formerly in his possession which he believed to be the last of the breed.

Dr. G. E. Nicholls, F.L.S., contributed a paper on the Urostyle (*Os Coccygeum*) of the nurous Amphibia.

Mr. G. A. Boulenger, F.R.S., F.Z.S., gave an account of his paper "On the Snakes of the Belgian and Portuguese Congo, Northern Rhodesia, and Angola." It contained a list of all the species known to inhabit this region, with keys to the identification of the genera and species, and the descriptions of two new forms from Angola and Katanga.

Dr. Robert Broom, D.Sc., C.M.Z.S., read a paper on some new. Carnivorous Therapsids in the Collection of the British Museum. Most of the specimens described have been for many years in the Collection, but owing to their small size and imperfect condition they have not hitherto been recognised as new. Five species, belonging to four new genera, are Therocephalians. Two species, one of which belongs to a new genus, are Gorgonopsians, and one of a new species of a previously known Cynodont genus.

Dr. Broom also read a paper dealing with the organ of Jacobson and its relations in the "Insectivora" *Tupaia* and *Gymnura*. *Gymnura* is shown to have the same type as is found in *Erinaceus*, *Sorex*, and *Talpa*, and most higher Eutherians such as *Felis*, *Lemur*, *iniopteris*, *Ovis*, *Bos*, *Equus*, *Procavia*. *Tupaia* is, on the other hand, has, like the allied *Macroscelides*, the primitive Marsupial type. Peters and Haeckel in 1864 and 1866 had suggested separating *Tupaia* and *Macroscelides* as a suborder of the Insectivora, but the condition of the nasal cartilages shows that the Menotyphla should form a distinct Order, not even closely allied to the typical Insectivora.

The next Meeting of the Society for Scientific Business will be held on Tuesday, April 27th, 1915, at half-past Five o'clock p.m., when the following communications will be made:—

Exhibitions and Notices.

Mrs. Rose Haig Thomas, F.Z.S.

White Collar Mendelising in Hybrid Pheasants.

E. G. Boulenger, F.Z.S.

On Two new Tree-Frogs from Sierra Leone, recently living in the Society's Gardens.

E. Heron-Allen, F.L.S., F.R.M.S., F.Z.S., and Arthur Earland, F.R.M.S.

The Foraminifera of the Kerimba Archipelago (Portuguese East Africa).—Part II.

The following paper has been received:—

Mrs. Helen L. M. Pixell-Goodrich, B.Sc.

Minchinia: A Haplosporidian.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
April 20*th*, 1915.

No. 144.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

April 27th, 1915.

Prof. E. A. MINCHIN, M.A., F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY exhibited lantern-slides of young Grey Seals (*Halichœrus grypus*) prepared from photographs taken by Mr. H. M. Banbury, F.Z.S., off the West Coast of Scotland. The Seals were about five feet in length on the 24th of October, 1914.

Mr. H. J. ELWES, F.R.S., F.Z.S., read a letter from Mr. J. Gent, Forest Officer of the Darjeeling Division, on the possible existence of a large Ape, unknown to science, in Sikkim.

Prof. WILLIAM BATESON, F.R.S., F.Z.S., exhibited a number of drawings illustrating the heredity of "hen-feathering" in Cocks.

Mrs. R. HAIG THOMAS, F.L.S., F.Z.S., read a paper on "White-collar Mendelising in Hybrid Pheasants," based on an examination of the relative numbers of dark-necked and ringed male Pheasants shot during two seasons. The data collected were interpreted as providing evidence of the continual Mendelising which occurred in the collar of hybrid birds.

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, read a paper containing the description of two new species of Tree-Frogs from Sierra Leone which had been presented to the Society by Mr. Guy Aylmer, F.Z.S.

Messrs. E. HERON-ALLEN, F.L.S., F.Z.S., and ARTHUR EARLAND, F.R.M.S., read the second portion of their memoir on the "Foraminifera of the Kerimba Archipelago, Portuguese East Africa." The contents of this part were chiefly systematic, over 470 species and varieties being dealt with, of which 32 are new to science.

This memoir will be published in the 'Transactions' in due course.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 11th, 1915, at half-past FIVE o'clock P.M. when the following communications will be made:—

EXHIBITIONS AND NOTICES.

Prof. H. MAXWELL LEFROY, M.A., F.Z.S.

The House-Fly Campaign.

PAPERS.

Mrs. HELEN L. M. PIXELL-GOODRICH, B.Sc.

Minchinia: a Haplosporidian.

Miss ELIZABETH A. FRASER, B.Sc., F.Z.S.

The Head-cavities and Development of the Eye-muscles in *Trichosurus vulpecula*, with Notes on some other Marsupials.

Dr. R. BROOM, M.D., C.M.Z.S.

(1) On the Organ of Jacobson and its Relations in the "Insectivora."—Part II. *Talpa*, *Centetes*, and *Chrysochloris*.

(2) On the Anomodont Genera, *Pristerodon* and *Tropidostoma*.

The following paper has been received:—

STANLEY HIRST, F.Z.S.

On a Blood-sucking Gamasid Mite parasitic on Couper's Snake.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

ZOOLOGICAL SOCIETY OF LONDON,
REGENT'S PARK, LONDON, N.W.
May 4th, 1915.

No. 145.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

May 11th, 1915.

Dr. A. Smith Woodward, F.R.S., Vice President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

The Secretary read a Report on the Additions made to the Society's Menagerie during the month of April 1915.

The House-Fly Campaign.

Prof. H. Maxwell Lefroy, M.A., F.Z.S., Curator of Insects, gave an account of the House-Fly Exhibition to be held in the Society's Gardens, and exhibited specimens of various kinds of fly-traps which would be on view to the public. The habits of the common house-flies and blow-flies would also be shown, as well as samples of the chemicals and appliances useful in dealing with fly-outbreaks.

For the benefit of health officers, the publications dealing with flies had been collected, and would be available for consultation by those interested.

Attention was drawn to the fact that not much practical information was available, and the need of immediate research was emphasised. Definite problems were indicated, whose selection would greatly help any campaign against house-flies or blow-flies.

A special illustrated pamphlet dealing with the life-history of

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

flies, diseases carried by them, methods of destruction, etc., was in course of preparation, and would be placed on sale at the price of twopence per copy at an early date.

Miss E. A. Fraser, B.Sc., F.Z.S., presented a paper on the head-cavities and development of the eye-muscles in *Trichosurus vulpecula*, with notes on some other Marsupials. The usual eye-muscles, including a well-developed m. retractor bulbi, are present in the Marsupialia. A large premandibular head-cavity, representing the first somite of the head, is found in all the Diprotodontia, and appears to be either absent or of very small size in the Polyprotodontia. The walls of the cavity proliferate and give rise to the mm. recti superior, inferior, and internus and the m. obliquus inferior. The second and third somites of the head are solid. In the earliest stages they are united together and are rather difficult to distinguish from the surrounding mesenchyme, the second being at the same time connected ventrally with the maxillo-mandibular mesenchyme. The m. obliquus superior develops as an upgrowth from the second somite. The anterior portion of the third somite becomes the m. rectus externus, whilst the posterior portion gives rise to the m. retractor bulbi.

Dr. R. Broom, M.D., C.M.Z.S., gave an account of the following two papers:—

(1) On the Organ of Jacobson and its Relations in the "Insectivora."—Part. II. *Talpa*, *Centetes*, and *Chrysochloris*.

In Part I. it was shown that *Tupaia* and *Macroscelides* and their allies must be separated from the typical Insectivores, such as *Erinaceus* and *Gymnura*, to form a very distinct and not nearly related order—the Menotyphla. In Part II. it is shown that *Chrysochloris* has no near relationship with either the Insectivora or the Menotyphla, and must be made the type of a distinct order, the Chrysochloridea. *Centetes*, which has hitherto been regarded as allied to *Chrysochloris*, is more nearly related to *Erinaceus*, though it differs from it in many points and may later have to be separated from it. *Talpa* shows many affinities with *Erinaceus* and a number of differences, the value of which is at present not apparent.

(2) On the Anomodont Genera, *Pristerodon* and *Tropidostoma*.

Pristerodon, described by Huxley in 1868, is a very near ally of *Dicynodon*, differing mainly in having a series of molars which are smooth in front and have a series of denticulations behind. The males are tusked, the females without tusks. *Oudenodon raniceps* of Owen is a species of *Pristerodon*; while *Opisthoctenodon agilis* Broom and probably also *Opisthoctenodon brachyops* Broom are other species of *Pristerodon*.

In 1889 Seeley described two occiputs under the names *Dicyno-*

don microtrema and *Dicynodon* (*Tropidostoma*) *dunni*. As pointed out by Lydekker, these belong to the one species, *D. microtrema*, and other specimens in the British Museum show that it differs from *Dicynodon* in the structure of the parietal region and in having molars very similar to those of *Pristerodon*, but fewer in number. This species is therefore placed in a distinct genus, for which the name *Tropidostoma* must be accepted.

Mrs. H. L. M. Pixell-Goodrich, B.Sc., contributed a paper entitled "*Minchinia*: a Haplosporidian," dealing with the life-history of *Minchinia chitonis* (Lankester), a protozoan parasite of the Mollusc *Chiton*. Hitherto this parasite has been considered to belong to the Coccidia, but convincing evidence is here brought forward to show that it is a Haplosporidian. An account is given of the multiplication in the host by plasmotomy and sporogony, and a detailed description of the development of the very characteristic spores.

The next Meeting of the Society for Scientific Business will be held on Tuesday, May 25th, 1915, at half-past Five o'clock P.M., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

R. I. Pocock, F.R.S., F.L.S., F.Z.S.

(*a*) Exhibition of pieces of Wild Boar skin.

(*b*) Exhibition showing evolution of Porcupines' quills.

PAPERS.

Stanley Hirst, F.Z.S.

On a Blood-sucking Gamasid Mite parasitic on Couper's Snake.

G. A. Boulenger, F.R.S., F.Z.S.

A List of the Snakes of Madagascar, Comoro, Mascarenes, and Seychelles.

P. Chalmers Mitchell, M.A., D.Sc., F.R.S., F.Z.S.

Anatomical Notes on the Gruiform Birds *Aramus giganteus* Bonap. and *Rhinochetus kagu*.

The following paper has been received :—

R. I. Pocock, F.R.S., F.L.S., F.Z.S.

On the Feet and Glands and other External Characters of the Paradoxurine Genera *Paradoxurus*, *Arctictis*, *Arctogalidia*, and *Nandinia*.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,
Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
May 18*th*, 1915.

No. 146.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

May 25th, 1915.

Prof. E. W. MacBride, D.Sc., F.R.S., Vice-President, in the Chair.

The Minutes of the last Scientific Meeting were confirmed.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited two pieces of skin cut from the shoulder of a wild boar and a wild sow (*Sus scrofa*) to show the difference in thickness between the two, the skin of that area in the boar being about four times as thick as in the sow.

Mr. Pocock also exhibited some skins of Asiatic and African Porcupines, and pointed out the gradation that could be traced from the Bornean *Trichus* through *Atherura* to *Hystrix* in the shortening of the tail, the evolution of the rattle, the growth of the crest on the head, and the elaboration of the spine-armature. He also showed a piece of the skin of a Javan Porcupine with some of the quills cut short to illustrate their definite arrangement in short, regular transverse rows.

Mr. Stanley Hirst, F.Z.S., presented a note on a minute blood-sucking mite belonging to the family Gamasidæ, found on Couper's Snake in the Society's Gardens, which he described as a new species of the genus *Ichoronyssus*. The adult female presents a remarkably close resemblance to the protonymph stage of other species of that genus, and therefore this species must be regarded as a primitive form.

---

* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications ; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. H. R. Hogg, M.A., F.Z.S., gave an account of his paper on the Spiders of the family Salticidæ, collected in Dutch New Guinea by the British Ornithologists' Union and Wollaston Expeditions. One new genus and eleven new species were described.

Mr. G. A. Boulenger, F.R.S., F.Z.S., read a paper on the Snakes of Madagascar, Comoro, Mascarenes, and Seychelles. The fauna of these islands is remarkable for the absence of snakes dangerously poisonous to man, with the exception of two Sea-snakes known from the western part of the Indian Ocean. The paper contained a complete list of the species known to inhabit these islands, with keys to the identification of the genera and species.

Dr. F. E. Beddard, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper dealing with Avian Cestodes, entitled "On *Tœnia tauricollis* of Chapman and on the genus *Chapmannia*."

Dr. P. Chalmers Mitchell, F.R.S., F.Z.S., Secretary to the Society, read a communication on the Anatomy of the Gruiform birds, *Aramus giganteus* Bonap., and *Rhinochetus kagu*, in which he showed that *A. giganteus* resembled *A. scolopaceus* very closely in the details of its muscular and bony anatomy, and that the genus *Aramus*, in these respects, was very close to the true Cranes.

The next Meeting of the Society for Scientific Business (closing the Session 1914–15) will be held on Tuesday, June 8th, 1915, at half-past Five o'clock p.m., when the following communications will be made:—

EXHIBITIONS AND NOTICES.

George Jennison.

Notes on a nest-making Chimpanzee.

PAPERS.

R. I. Pocock, F.R.S., F.L.S., F.Z.S.

On the Feet and Glands and other External Characters of the Paradoxurine Genera *Paradoxurus*, *Arctictis*, *Arctogalidia*, and *Nandinia*.

Dr. A. Smith Woodward, F.R.S., F.Z.S.

On the Skull of an Extinct Carnivore related to *Æluropus*, from a cavern in the Ruby Mines, Mogok, Burma.

Miss K. M. Parker, B.Sc.

The Early Development of the Heart and Anterior Vessels in Marsupials, with special reference to *Perameles*.

Dr. R. Broom, D.Sc., C.M.Z.S.

On the Triassic Stegocephalians, *Brachyops*, *Bothriceps*, and *Lydekkerina*, gen. nov.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

Secretary.

Zoological Society of London,
Regent's Park, London, N.W.
June 1*st*, 1915.

PAPERS.

LIST OF PLATES.

1915, Part II. (pp. 157–298).

NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1915, p. . . . The Distribution is as follows:—

Part	I.	issued in	March.
„	II.	„	June.
„	III.	„	September.
„	IV.	„	December.

'Proceedings,' 1915, Part I. (pp. 1–156), were published on March 26th, 1915.

The Abstracts of the 'Proceedings,' Nos. 142–146, are contained in this Part.