# PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

# ZOOLOGICAL SOCIETY

OF LONDON.

1908, pp. 431–983.

(MAY—DECEMBER.)



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OF THE

# COUNCIL AND OFFICERS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.

1908.

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# LIST OF CONTENTS.

1908, pp. 431–983.

## May 12, 1908.

May 26, 1908.



June 16, 1908.

## December 15, 1908.

# ALPHABETICAL LIST

OF THE

# CONTRIBUTORS,

*With References to the several Articles contributed by each.*

(1908, pp. 431–983.)

---

# LIST OF PLATES.

1908, pp. 431–983.

---

# LIST OF TEXT-FIGURES.

## 1908, pp. 431–983.

---

Page

# LIST OF NEW GENERIC TERMS

PROPOSED IN THE PRESENT VOLUME (pp. 431–983).

# INDEX.

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# PROCEEDINGS

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# LIST OF CONTENTS.

## 1908, pp. 431–782.

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### May 12, 1908.



### May 26, 1908.



*Contents continued on page 3 of Wrapper*

# PROCEEDINGS

OF THE

# GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.

## (May to December, 1908.)

May 12, 1908.

F. Du Cane Godman, Esq., D.C.L., F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of April 1908:—

The number of registered additions to the Society's Menagerie during the month of April was 135. Of these 75 were acquired by presentation and 15 purchased, 43 were received on deposit, and 2 were born in the Gardens.

The number of departures during the same period, by death and removals, was 145.

Among the additions special attention may be directed to:—

A hybrid between a male Lion (*Felis leo*) and a female Jaguar-Leopard (*Felis onca* × *Felis pardus*), bred in the United States; deposited on April 14th.

A Vaal Rehbok (*Pelea capreolus*) from the Drakensberg Mountains, presented by Frederick Burgoyne, Esq., F.Z.S., on April 3rd.

Two Secretary Vultures (*Serpentarius reptilivorus*) from South Africa, purchased on April 21st.

Two Australian Cassowaries (*Casuarius australis*), presented by Sir William Ingram, Bt., on April 24th.

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Mr. W. Woodland, F.Z.S., exhibited preparations of a new gland he had found in certain teleostean fishes, and made the following remarks:—"This new gland is diffuse in form and is intermingled with the veins and arteries which subdivide to form the numerous parallel capillaries of the rete mirabile (text-fig. 79) found in connection with all teleost 'red bodies.' It is quite distinct from the gas-gland, and consists of rows of large columnar cells, situated in close connection with the venous blood-vessels, possessing large nuclei and nucleoli and packed with numerous large spherical granules derived from the red-corpuscle disintegration concerned in the generation of the oxygen found in the

Text-fig. 79.

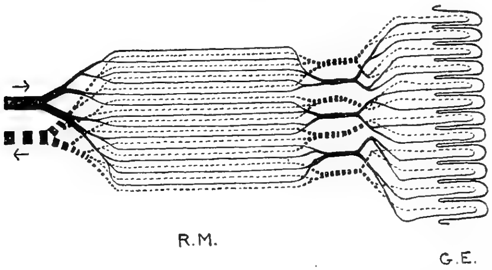
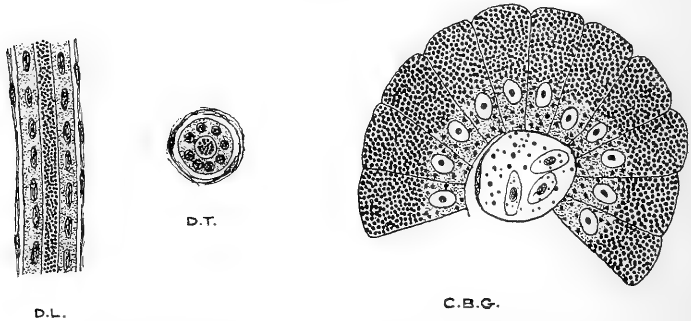



Diagram of the construction of the gas-gland rete mirabile ("red body"). R.M., rete mirabile; G.E., gas-gland epithelium. The new gland now described is situated round the veins at the proximal pole (pole remote from the glandular epithelium) of the rete mirabile.

Text-fig. 80.




C.B.G., cells of the new gland situated round and in contact with a vein; D.L., longitudinal section of a duct of the new gland containing spherical granules in its lumen derived from the gland-cells; D.T., a duct in transverse section.

swim-bladder. These granules, thus abstracted by the gland-cells from the blood, are carried away by special ducts appertaining to the gland (text-fig. 80). The discovery of this important gland in several genera—*Gobius*, *Syngnathus*, *Fierasfer*, *Box*, and others—confirms Jæger's view as to the mode of generation of the bladder oxygen. The rete mirabile of the gas-gland apparatus is to be explained as a mechanism for bringing the toxin secreted by the gas-gland cells (Jæger) into contact with the erythrocytes *before* these reach the region of the gas epithelium, so that when the blood does reach this region, the oxygen, liberated by the action of the toxin on the erythrocytes, has become freely mixed with the plasma and is therefore in a condition to be abstracted by the gas-gland cells."

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Mr. T. A. Coward, F.Z.S., exhibited a specimen of a Petrel, *Œstrelata neglecta* Schleg., the property of Mr. Arthur Newstead, of Cheshire, which had been picked up dead, yet in a quite fresh condition, at Tarporley in Cheshire, on April 1st, 1908. This bird is a native of the Southern Pacific, and has almost certainly never been recorded from the northern hemisphere, and certainly never from Europe before.

---

Mr. C. Davies Sherborn, F.Z.S., exhibited a specimen of chert from the Middle Culm-measures (Carboniferous) of Christow Down, near Doddiscombe Leigh, Devonshire, showing numerous large and well-preserved Radiolaria.

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On behalf of Mr. R. Lydekker, the Secretary exhibited the tanned skin (without the legs and part of the tail) of a Wild Cat obtained by the Hon. Mason Mitchell, of the American Consular Service, in Sze-chuen, and sent by that gentleman to Mr. Rowland Ward. Compared with a light-coloured skin of *Felis temmincki* from Sikhim (B.M. No. 91.10.7.10), the Sze-chuen specimen differs by the much lighter colour of the upper parts, which are golden tawny, with a comparatively narrow dorsal streak of light rufous (in place of a broad one of mahogany rufous)—the tail being golden rufous above, different in tint from both the middle and sides. The under parts are white with a few brown spots, instead of pale buff with similar spots. The specimen is of interest as extending the range of the Bay Cat into Sze-chuen; and may be regarded as representing a local race, for which Mr. Lydekker suggested the name *F. temmincki mitchelli*. It was likewise pointed out that the Bay Cat presents striking resemblances to the African Tiger-Cat (*F. chrysothrix*, or *F. aurata*), from which it is distinguished by the broad white band between a pair of darker ones on each cheek, and a somewhat similar mark on the forehead. Sikhim and Nepal specimens exhibit both a bright rufous phase with pale and spotted under parts, and a wholly dark reddish-brown phase. A grey phase is represented by a skin (B.M. No. 0.6.30.1) from Upper Burma, presented by Mr. C. W. A. Bruce, and by the Cat from Foochow figured in plate i. of the Society's 'Proceedings' for 1898 by Dr. P. L. Sclater as a new species under the name of *F. dominicanorum*. This phase corresponds with the one of *F. chrysothrix* to which Mr. Lydekker gave the racial name *cottoni*. Whether the name *F. temmincki dominicanorum* can be used for the Foochow-Burma Bay Cat, or whether, as in the case of *cottoni*, it refers merely to a colour-phase, remains to be proved.

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Mr. J. T. Cunningham, M.A., F.Z.S., read a paper entitled "The Heredity of Secondary Sexual Characters in Relation to Hormones, a Contribution to the Theory of Heredity." The paper contained an examination and criticism of the most important recent investigations and theories on the subject by evolutionists of various schools, namely, the theory which attributes such characters to constitutional causes such as male katabolism, Prof Karl Pearson's biometrical investigation of sexual selection in man, Castle's Mendelian theory of the heredity of sex, and Geoffrey Smith's views on dimorphism of males and parasitic castration in Crustacea. The author maintained that all these contributions were more or less inconsistent with the known facts concerning the connection between the development of secondary sexual characters and the functional activity of the primary gonads. He drew attention to the recent discovery and experimental proof on the part of physiologists that the development of the characters was due to the stimulus of a chemical substance or hormone produced by the testis or ovary, and passed into the blood, and suggested that conversely hormones from parts of the soma might affect the gametes in the gonads. In this way the hypertrophy of a part of the body due to external stimulation might modifiy the corresponding determinants in the gametes so as to produce some hereditary effect in succeeding generations. Mr. Cunningham added that his theory was an interpretation in terms of modern physiology of Darwin's theory of pangenesis.

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The following papers were read:—

## 1. The Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland, M.A., in the Years 1901 & 1902.—The Calcareous Sponges. By C. F. Jenkin *.

[Received April 1, 1908.]

(Text-figures 81–104.)

The Collection, made by Mr. Cyril Crossland at Wasin and Zanzibar in 1901–2, passed through several hands and was finally entrusted to the writer in the autumn of 1907.

* Communicated by Professor Arthur Dendy, D.Sc., F.L.S., F.Z.S.

The collection consists of 25 specimens belonging to 14 species, 5 of which are new, as shown in the following list:—

| *Grade.* | *Family.* | *Genus.* | *Species.* | *No. of Specimens.* |
|---|---|---|---|---|
| Homocœla ... | Clathrinidæ ...... | Clathrina ... | primordialis (*H.*). | 2 |
| | | ,, | darwinii (*H.*). | 3 |
| | | ,, | contorta (*Min.*). | 3 |
| | | ,, | blanca (*Mik.*). | 1 |
| | Leucosoleniidæ | Leucosolenia | *irregularis*, sp. n. | 1 |
| Heterocœla ... | Sycettidæ ...... | Sycon ......... | ciliatum *Fabr.* | 2 |
| | | ,, | ampullum (*H.*). | 1 |
| | | ,, | *munitum*, sp. n. | 3 |
| | Grantiidæ ...... | Leucandra ... | ananas (*H.*). | 1 |
| | Heteropidæ ...... | Grantessa ... | *simplex*, sp. n. | 2 |
| | | ,, | *zanzibaris*, sp. n. | 1 |
| | Amphoriscidæ ... | Heteropegma | nodus gordii (*Pol.*). | 3 |
| | | Leucilla ...... | floridiana (*H.*). | 1 |
| | | ,, | *wasinensis*, sp. n. | 1 |
| | | | Total specimens ...... | 25 |

The classification is that proposed by Poléjaeff (**2**) for the Homocœla, and by Dendy (**3**) for the Heterocœla, with slight modifications by Minchin (**4**).

The identification of calcareous sponges is very difficult and unsatisfactory in the present state of our knowledge. Haeckel in his great work (**1**) laid down hard and fast definitions of the different species, which if they accorded with the facts would make identification very easy, but unfortunately actual specimens very seldom fall within his definitions. This has led to a useless multiplication of species, since each specimen which did not exactly comply with Haeckel's definition has been called by a new name. Haeckel has also omitted to mention many striking features of his species, such as the subgastral quadriradiates in many of the *Sycandra*, the characteristic dermal spicules of some species, and the hair-spicules in most of the species in which they occur (*e. g.* in *Sycandra ciliata*). He has also made numerous wrong identifications (see Minchin **5**). Under these circumstances no identification can be considered as certain and nothing very satisfactory can be done till Haeckel's work has been revised.

The specimens in the Crossland Collection are unfortunately not in a good state of preservation. It therefore seemed better to place the specimens among existing species, even if the identification was doubtful, rather than to make new species based on single specimens in a poor state of preservation. This has been done as far as possible, but there remained six specimens belonging to five species which could not be classed in this way; to these new names have been given.

*Description of the Specimens.*

CLATHRINA PRIMORDIALIS.

*Ascetta primordialis* H.

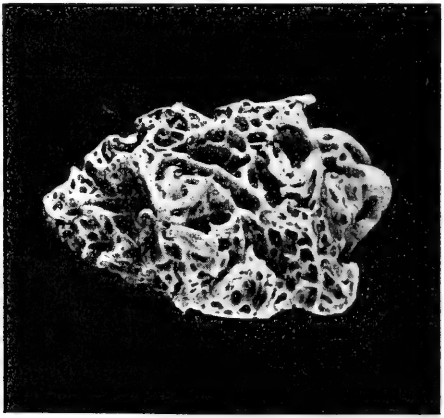
Two specimens of this sponge were dredged in 6 to 8 fathoms at Wasin. The dimensions of the spicules agree with those given by Haeckel of specimens from Australia. Most of the spicules have rays from 160–180 $\mu$ long × 16–20 $\mu$ thick.

CLATHRINA DARWINII. (Text-figs. 81, 82.)

*Ascaltis darwinii* H.

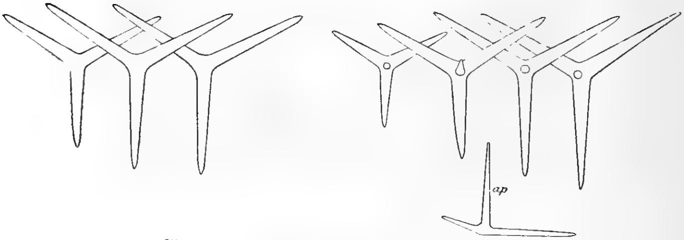
Three specimens of this sponge were dredged in 3 fathoms in Chwaka Bay, Zanzibar. The largest specimen is shown, twice

Text-fig. 81.



*Clathrina darwinii* (H.). × 2.

Text-fig. 82.




*Clathrina darwinii* (H.), spicules. × 130.
*ap.*, apical ray.

natural size, in text-fig. 81. They were bright lemon-yellow colour when alive, and are buff-white in spirits. All three specimens consist of solid lumps of the anastomosing tubes typical of the genus *Clathrina*. They are firm to the touch and similar in appearance to *C. coriacea* as it grows in the Channel Islands.

The facial rays of the tri- and quadriradiates (text-fig. 82) vary from 60–120 $\mu$ long $\times$ 12–16 $\mu$ thick, the commonest size being 110 $\times$ 15 $\mu$. The apical rays of the quadriradiates are nearly straight, about the same length as the facial rays and about 8 $\mu$ thick.

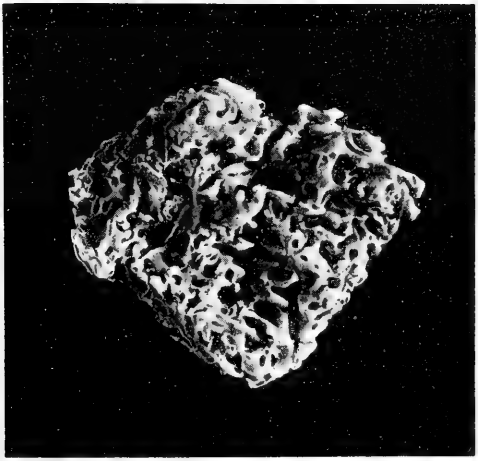
The spicules are considerably thicker than in *Clathrina contorta* var. *spinosa* (Min.), and agree better with Haeckel's *Clathrina darwinii*.

Clathrina contorta var. spinosa. (Text-figs. 83, 84.)

*Clathrina contorta* var. *spinosa* Minchin (**6**).

Three specimens of this sponge were dredged in 3 fathoms in Chwaka Bay, Zanzibar. They were pure white when alive and are translucent white in spirits. They are very delicate in texture, and readily fall to pieces. The largest specimen is a solid lump shown twice natural size in text-fig. 83; the others appear to be fragments only. They differ considerably in appearance from the specimens of *Clathrina darwinii* which were collected at the same time.

Text-fig. 83.



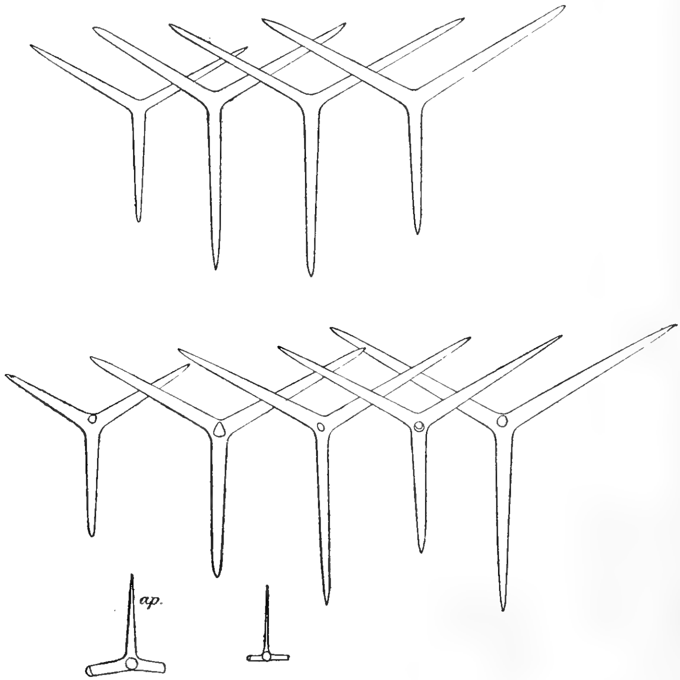
*Clathrina contorta* (Min.). $\times$ 2.

The spicules (text-fig. 84) agree fairly well with Minchin's (**6**) and von Lendenfeld's (**7**) descriptions of *Clathrina contorta* var. *spinosa*. No oxea were found.

The rays of the triradiates vary from 100–130 μ long × 10–12 μ thick, the commonest size being 125 × 11 μ.

The facial rays of the quadriradiates vary from 80–150 μ long × 10–12 μ thick, the commonest size being the same as of the triradiates 125 × 11 μ.

Text-fig. 84.




*Clathrina contorta* var. *spinosa*, spicules. × 180.
*ap.*, apical ray.

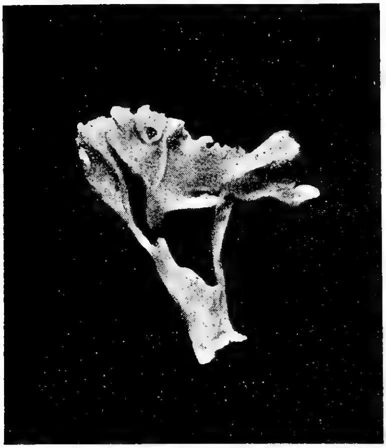
The apical rays are 50–65 μ long × 5–7 μ thick; they are thicker than those in Minchin's or von Lendenfeld's specimens.

CLATHRINA BLANCA. (Text-figs. 85–87.)

*Guancha blancha* Miklucho.
*Ascetta blanca* H.

One specimen of this sponge was dredged in 10 fathoms at Wasin. Its colour in spirits is pure white. Its shape is shown (natural size) in text-fig. 85. The sponge is formed of flat fan-shaped heads on the ends of a branching stalk. The largest head is shown (×5) in text-fig. 86. It consists of a flat mass of anastomosing tubes with several oscules on the outer edge; sections show that the head is about three tubes thick, and that the tubes are so arranged that the spaces in the meshwork never extend right through it. The stalk is somewhat flattened and

Text-fig. 85.



*Clathrina blanca* (Mik.). Nat. size.

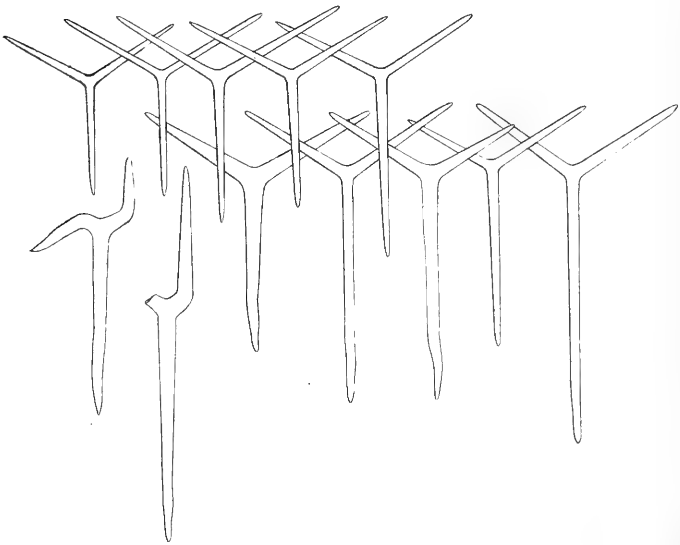
Text-fig. 86.

*Clathrina blanca* (Mik.). × 5.

is solid. The flat shape of the specimen is remarkable; the ordinary shape of the heads of *Clathrina blanca* is more or less spherical.

The skeleton consists of regular and sagittal triradiates (text-fig. 87). The spicules agree fairly well with the descriptions given by Haeckel (**1**) and von Lendenfeld (**7**).

Text-fig. 87.



*Clathrina blanca*, spicules. × 220.

The body-spicules are mostly regular, but some have the basal rays slightly the longest. Paired rays 65–70 μ × 4–6 μ. Basal ray 70–110 μ × 4–6·5 μ.

The stalk-spicules are almost all sagittal, the smaller ones on the outside and the larger ones inside, all arranged with the basal ray downwards. Paired rays 60–80 μ × 5–9 μ. Basal ray 100–160 μ × 70–110 μ.

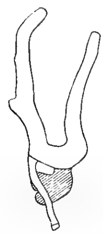
Leucosolenia irregularis, sp. n. (Text-figs. 88–90.)

One small specimen of this new species was found among the *Clathrina primordialis* dredged in 6–8 fathoms at Wasin. It consists of two erect tubes with a short rooting tube (text-fig. 88).

*The skeleton* (text-fig. 89) is rather remarkable. It contains no triradiates but is made up of two types of equiangular quadriradiates, lying without orientation, together with a few large oxea which project in all directions.

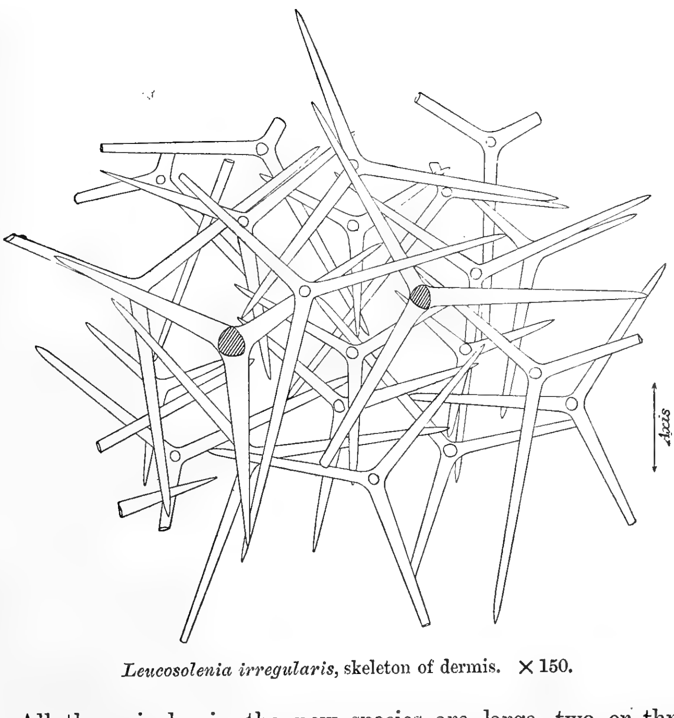
Most species of *Leucosolenia* contain triradiates as well as quadriradiates, and the facial rays of both sorts of spicule are usually alate and regularly placed with the basal ray downwards.

Text-fig. 88



*Leucosolenia irregularis.* × ½.

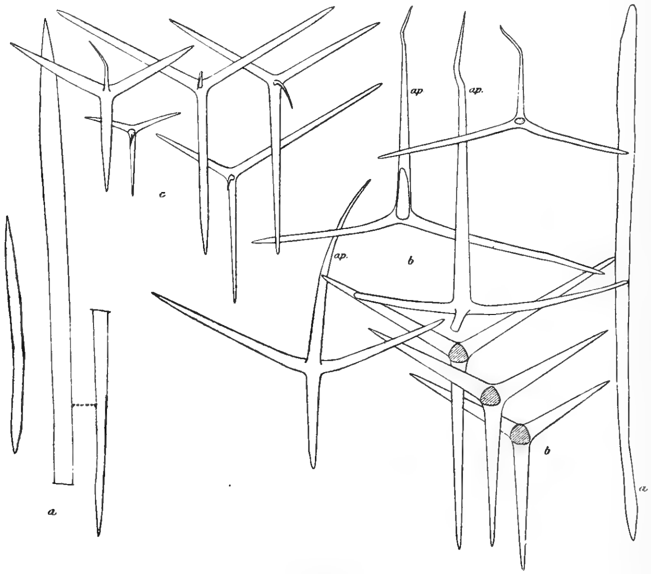
Text-fig. 89.




*Leucosolenia irregularis,* skeleton of dermis. × 150.

All the spicules in the new species are large, two or three times the size of those in the British species of *Leucosolenia*. The facial rays of the larger quadriradiates are usually of the same length, but those of the smaller quadriradiates are often of unequal lengths. The oscules of both tubes are too much damaged to furnish any indication of their structure.

Text-fig. 90.




*Leucosolenia irregularis*, spicules. × 110.
(For explanation of the letters see text below.)

*Spicules* (text-fig. 90).

The oxea are of one sort:—

(*a*) Nearly straight oxea sharply pointed at both ends, 300–800 μ long × 16–28 μ thick; the usual thickness is 21–24 μ.

The quadriradiates are of two sorts:—

(*b*) Large quadriradiates. Facial rays approximately regular, 150–220 μ long × 20 μ thick. Apical rays usually slightly bent near the point, 210–260 μ long × 16–20 μ thick.

(*c*) Small quadriradiates. Facial rays usually regular, occasionally of unequal lengths, 100–200 μ long × 10–16 μ thick. Apical rays very slender and sharply pointed, always bent near the point, 120–150 μ long × 7 μ thick.

SYCON CILIATUM Fab.

*Sycandra ciliata* H.

Two small specimens of this species were dredged in 7 fathoms in the Zanzibar Channel. Their dimensions are 8 × 2 mm. and 5 × 1¼ mm.

SYCON AMPULLUM.

*Sycandra ampulla* H.

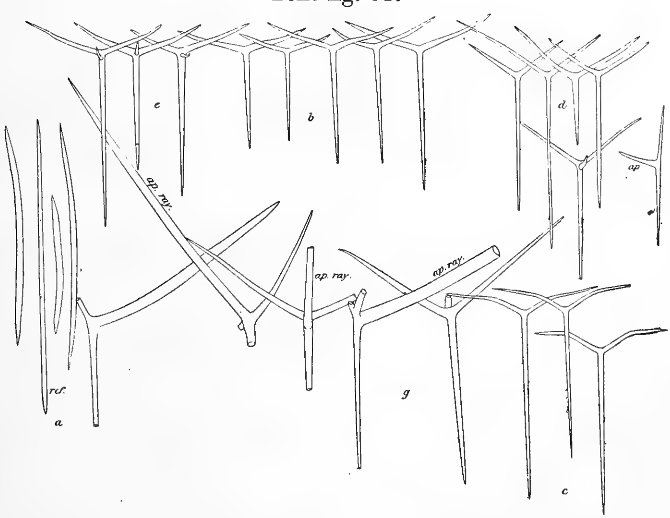
One small specimen of this species was dredged in 6–8 fathoms at Wasin. It is 11 mm. long × 5 mm. diameter. Its structure is typical of the genus. The spicules are too small for *Sycon raphanus*, and there are none of the thin subgastral tri- and quadriradiates which are the most characteristic features of that species. Comparing it with *Sycon ampullum* the spicules are rather thicker than the dimensions given by Haeckel and the oxea are also rather longer, but on the whole it agrees fairly well.

SYCON MUNITUM, sp. n. (Text-fig. 91.)

Three specimens of this new species were dredged in 7 fathoms in the Zanzibar Channel. In external appearance they resemble small specimens of *Sycon ciliatum*. Their dimensions are 7 × 3 mm., 5 × 3 mm., and 3 × 1 mm.

The peculiarity of the species is the presence of quadriradiates in the articulated tubar skeleton. Only a few species of *Sycon* are known with quadriradiates in this position; from these the new species is differentiated by having two sorts of gastral quadriradiates, viz., small quadriradiates with short apical rays and larger ones with very large apical rays.

Text-fig. 91.




*Sycon munitum*, sp. n., spicules. × 110.
(For explanation of the letters see text p. 444.)

*Skeleton.*—The *gastral skeleton* is a dense felt of small tri- and quadriradiates, fairly regularly arranged round the apopyles, with the basal rays aborally directed and the small apical rays projecting into the gastral cavity. The apical rays being short, many of them hardly reach further than just through the thick gastral layer. Among these spicules, every here and there, lies one of the large quadriradiates, with its large apical ray projecting far into the gastral cavity.

The articulated *tubar skeleton* is built up of tri- and quadriradiates. The short apical rays of the quadriradiates project into the flagellated chambers. The tops of the chambers are crowned with tufts of small oxea.

The oscule has a thick fringe of thin straight oxea. The flagellated chambers get shorter near the oscule and there is no collar. There are remains of a diaphragm across the oscule.

*Spicules* (text-fig. 91).

The oxea are of one sort:—

(*a*) Oxea from the ends of the flagellated chambers, nearly straight, pointed at both ends, 170–400 $\mu$ long $\times$ 8 $\mu$ thick. Some of these are more refringent than others. The refringent spicules are quite straight.

The triradiates are of three sorts:—

(*b*) Alate triradiates from the tubar skeleton. Basal rays straight, 110–170 $\mu$ long $\times$ 5–6 $\mu$ thick. Paired rays bent upwards, 60–100 $\mu$ long $\times$ 5–7 $\mu$ thick. Oral angle about 140°.

(*c*) Alate subgastral triradiates. Basal rays straight, 180–230 $\mu$ long $\times$ 6 $\mu$ thick. Paired rays bent downwards, 80–100 $\mu$ long $\times$ 4–6 $\mu$ thick.

(*d*) Alate triradiates from the gastral layer. Basal rays straight, 80–210 $\mu$ long $\times$ 6–8 $\mu$ thick. Paired rays bending upwards, sometimes unequal in length, 70–130 $\mu$ long $\times$ 6–8 $\mu$ thick.

The quadriradiates are of three sorts:—

(*e*) Alate quadriradiates from the tubar skeleton. The facial rays are similar to (*b*) but larger. Basal rays 140–220 $\mu$ long. Paired rays 70–100 $\mu$ long. Apical rays slender, slightly bent near the point, 50 $\mu$ long $\times$ 3 $\mu$ thick.

(*f*) Small alate quadriradiates from the gastral layer, similar to (*d*) with the addition of an apical ray 60 $\mu$ long $\times$ 6 $\mu$ thick.

(*g*) Large alate quadriradiates from the gastral layer. Basal rays straight, over 200 $\mu$ long $\times$ 10 $\mu$ thick. Paired rays nearly straight, 180 $\mu$ long $\times$ 9–10 $\mu$ thick. Apical ray slightly bent orally, 320–380 $\mu$ long, oval in section 16 $\mu$ deep $\times$ 8 $\mu$ thick.

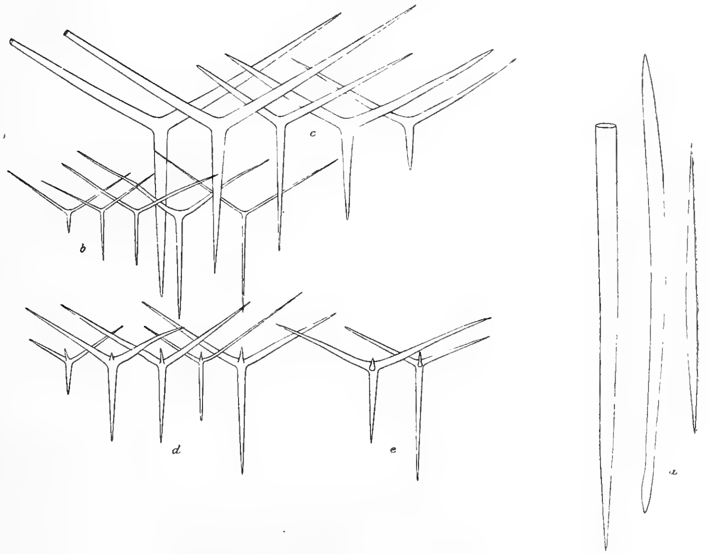
LEUCANDRA ANANAS H. (Text-fig. 92.)

*Leucandra ananas* H.

One specimen of this species was dredged in 3 fathoms in Chwaka Bay, Zanzibar. It is flask-shaped, 20 mm. long $\times$ 13 mm. diameter, with an oscule 5 mm. diameter. It was dirty white in colour when alive. The body-wall is about 3 mm. thick near the middle and surrounds a gastral cavity about 7 mm. diameter.

*Canal-system.*—There are large incurrent chambers under the dermis from which the large incurrent canals run radially inwards. The excurrent canals are also large and run radially between the others; they communicate with the gastral cavity through large ports.

Text-fig. 92.



*Leucandra ananas*, spicules. × 56.
(For explanation of the letters see text below.)

*Skeleton.*—The dermal skeleton consists of a thin layer of delicate triradiates lying without orientation. Tufts of large oxea project radially from slightly raised papillæ on the dermis. The body skeleton consists of irregularly placed large triradiates. The excurrent canals are lined with quadriradiates, the apical rays projecting into the canals. The gastral skeleton consists of a dense layer of quadriradiates with the apical rays projecting into the gastral cavity.

The specimen agrees fairly well with Haeckel's description of *Leucandra ananas*, though the spicules are rather larger, and the dermal skeleton differs from the body skeleton, which is not mentioned by Haeckel. Haeckel, however, makes a similar omission in other cases, *e. g.* in his description of *Leucandra fistulosa*.

*Spicules* (text-fig. 92).

The oxea are of one sort:—

(*a*) Nearly straight sharply-pointed oxea, 700–3000 μ long × 28–46 μ thick.

The triradiates are of two sorts:—

(*b*) Slender dermal triradiates, subregular. Rays 160–280 μ long × 5–10 μ thick.

(*c*) Subregular triradiates from the body. Basal ray straight, 120–400 μ long × 20–32 μ thick. Paired rays almost straight, 140–550 μ long × 16–26 μ thick.

The quadriradiates are of two sorts:—

(*d*) Subregular quadriradiates lining the excurrent canals.—Basal rays straight, 180–250 μ long × 10–20 μ thick. Paired rays nearly straight, 200–280 μ long × 6–17 μ thick. Oral angle 120°. Apical rays 170 × 6–8 μ thick.

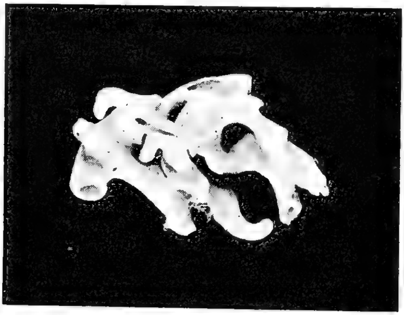
(*e*) Alate quadriradiates from the gastral skeleton, similar to (*d*) but with a larger oral angle, about 135°. Apical ray 50 μ long × 6–8 μ thick.

Grantessa simplex, sp. n. (Text-figs. 93–97.)

One specimen of this new species was dredged in 6–8 fathoms at Wasin, and one specimen was collected on the shore of Chwaka Bay, Zanzibar.

They both consist of a confused mass of anastomosing tubes (see text-fig. 93). The oscules are at the free ends. The tubes, as preserved, are a good deal flattened and vary in size from 2–5 mm. in diameter. Both external and internal surfaces are smooth.

Text-fig. 93.



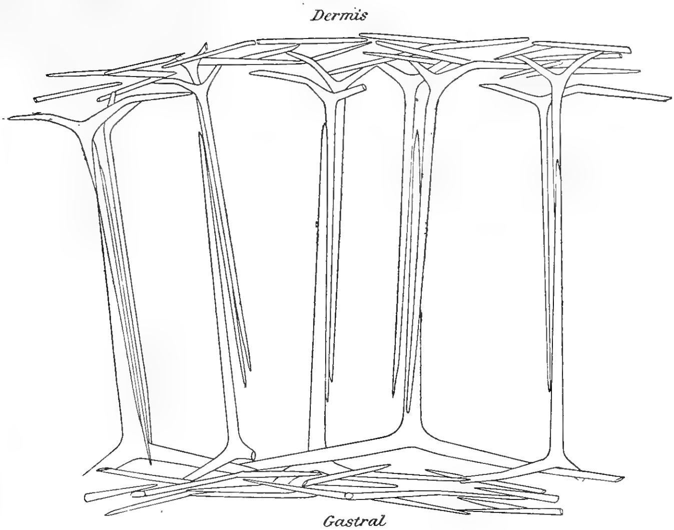
*Grantessa simplex*, sp. n. Nat. size.

The structure of the body-wall is very regular and typical of the genus *Grantessa* (see text-fig. 94).

The *skeleton* is formed entirely of triradiates. The dermal skeleton (text-fig. 95) consists of alate triradiates lying tangentially, without orientation. The subdermal triradiates (*c*, text-fig. 97) are modified dermal spicules; the centripetal ray is one of the paired rays, not the basal ray *; it is considerably longer

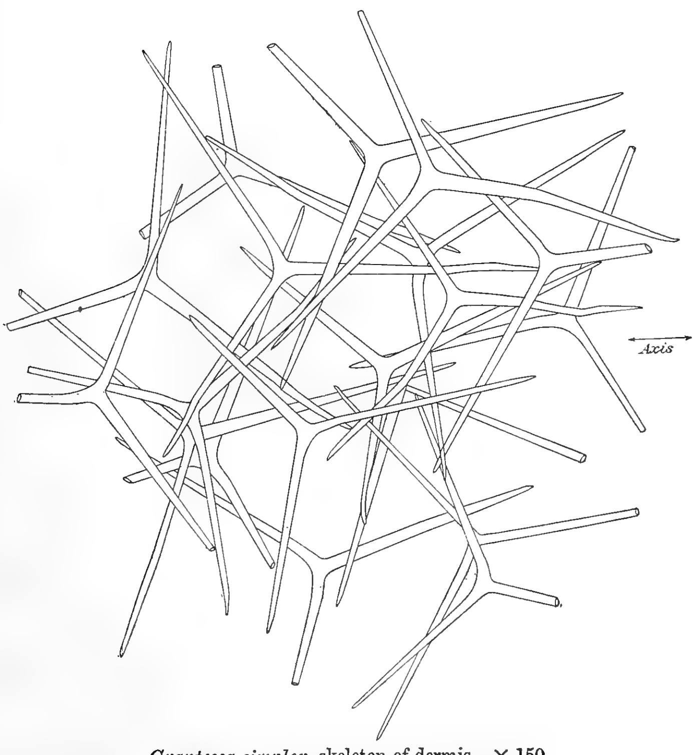
* *Cf.* Poléjaeff (**2**).

Text-fig. 94.



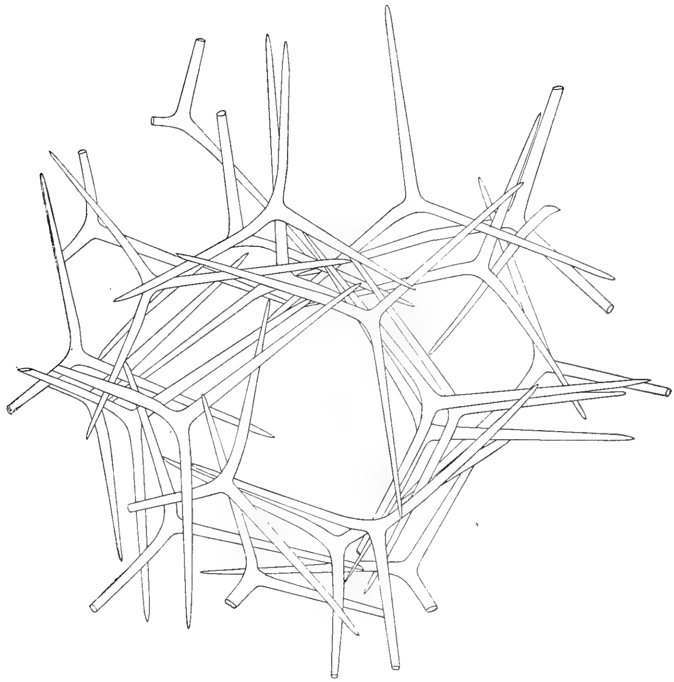

*Grantessa simplex*, skeleton of body-wall. × 100.

Text-fig. 95.



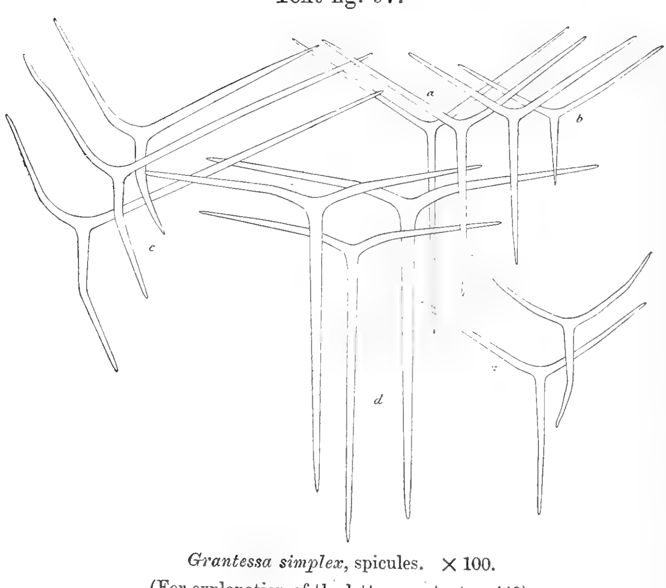

*Grantessa simplex*, skeleton of dermis. × 150.

Text-fig. 96.



*Grantessa simplex*, gastral skeleton. × 150.

Text-fig. 97.




*Grantessa simplex*, spicules. × 100.
(For explanation of the letters see text p. 449).

than the other paired ray. The basal ray is bent sharply near the root; but for this bend the point would project beyond the dermal layer. A few spicules of a similar form are found lying tangentially among the dermal triradiates. The subgastral triradiates are alate, with equal paired rays and an oral angle of 155°. The gastral skeleton (text-fig. 96) is a thick layer of alate triradiates similar to those in the dermis, but slightly smaller and rather more regularly placed. The oscule has no special skeleton. The body-wall ends abruptly, and there is hardly a trace of a collar.

*Spicules* (text-fig. 97).

The triradiates are of four sorts:—

(*a*) Alate triradiates from the dermis. Basal rays straight, 210–250 $\mu$ long $\times$ 10–12 $\mu$ thick. Paired rays straight, except for a slight curvature near the junction of the basal ray, which rounds the oral angle smoothly, 200 $\mu$ long $\times$ 8–10 $\mu$ thick. Oral angle 110°.

(*b*) Alate triradiates from the gastral layer, similar to (*a*) but smaller. Basal ray 180 $\mu$ (occasionally much shorter). Paired rays 140–150 $\mu$ long. Oral angle 115°–120°.

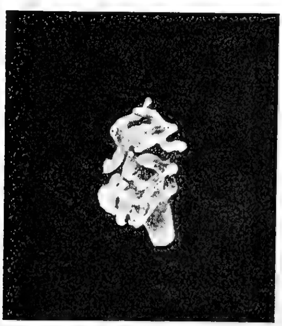
(*c*) Subdermal triradiates. Basal ray (lying in the dermis) straight, except for an angular bend near the root, 130–190 $\mu$ long $\times$ 14 $\mu$ thick. Centripetal paired ray straight, 240–420 $\mu$ long $\times$ 11–13 $\mu$ thick. Dermal paired ray considerably bent near the root, 160–190 $\mu$ long $\times$ 10–12 $\mu$ thick. Oral angle 100°.

(*d*) Subgastral triradiates. Basal ray straight, 360–390 $\mu$ long $\times$ 13–16 $\mu$ thick. Paired rays, equal, bent downwards near the root, 180–240 $\mu$ long $\times$ 10–12 $\mu$ thick. Oral angle 155°.

GRANTESSA ZANZIBARIS, sp. n. (Text-figs. 98–102.)

One specimen of this new species was dredged in 6–8 fathoms

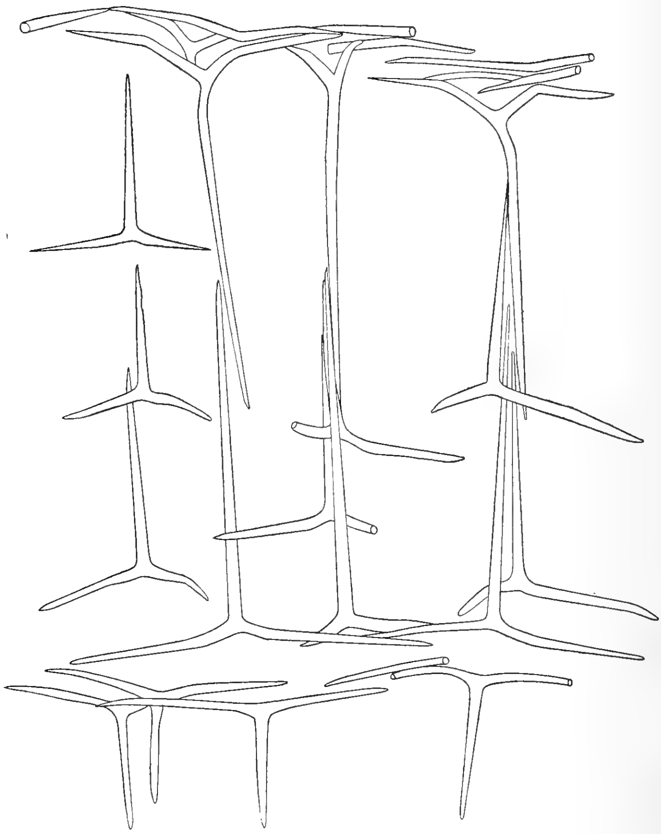
Text-fig. 98.



*Grantessa zanzibaris*, sp. n. Nat. size.

at Zanzibar. It consists of a mass of branching tubes of various sizes; there is no anastomosis between the branches (see text-fig. 98). The tubes, as preserved, are flattened so that the opposite sides touch; they vary in size from 1–3 mm. wide. The external surface is smooth; the internal surface is lined with quadriradiates with the apical rays projecting inwards.

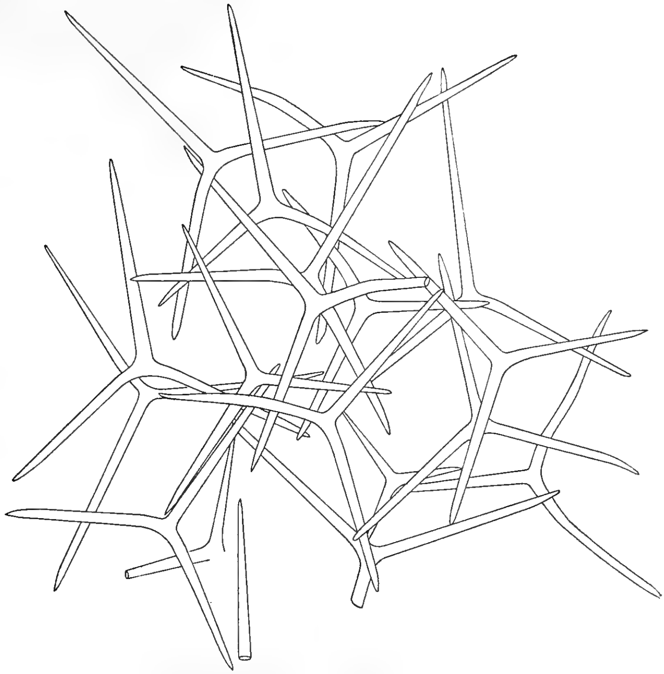
Text-fig. 99.



*Grantessa zanzibaris*, skeleton of body-wall. × 200.

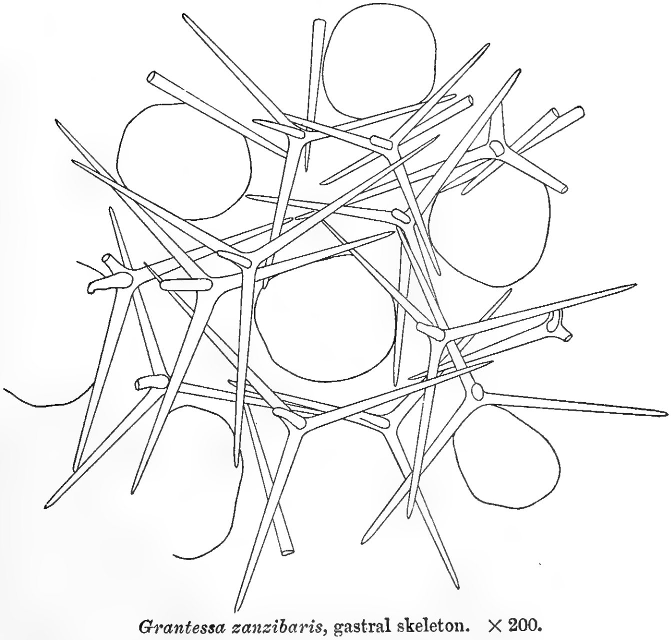
The structure of the body-wall is shown in text-fig. 99. The opposite rays of the subdermal and subgastral triradiates lie beside each other, forming a typical non-articulated skeleton; in addition there are two or three intermediate rows of triradiates, apparently the remains of an articulated skeleton. The structure agrees closely with that of *Grantessa intusarticulata* described and figured by Dendy (**3**).

Text-fig. 100.



*Grantessa zanzibaris*, skeleton of dermis. × 200.

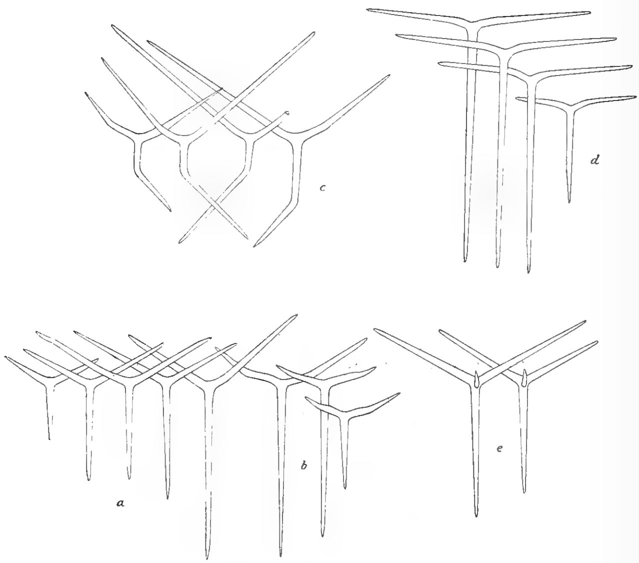
Text-fig. 101.



*Grantessa zanzibaris*, gastral skeleton. × 200.

*Skeleton.*—The dermal skeleton (text-fig. 100) consists of a thin layer of alate triradiates lying tangentially, without orientation. The subdermal triradiates are modified dermal spicules, as in *G. simplex*. The subgastral triradiates are alate, with equal paired rays and an oral angle of 165°. The gastral skeleton (text-fig. 101) consists of a thin layer of sub-regular alate quadriradiates, lying without orientation.

Text-fig. 102.




*Grantessa zanzibaris*, spicules. × 120.
(For explanation of letters see text below.)

*Spicules* (text-fig. 102).

The triradiates are of four sorts:—

(*a*) Alate triradiates from the dermis. Basal rays straight, 65–190 μ long × 8–10 μ thick. Paired rays nearly straight, except for a slight curvature near the junction of the basal ray, rounding the oral angle, 60–130 μ long × 8–9 μ thick. Oral angle 110° to 125°.

(*b*) Alate triradiates from the body similar to (*a*) but with doubly curved paired rays considerably folded. Oral angle 125° to 135°.

(*c*) Subdermal triradiates. Basal ray, lying in the dermis, straight, except for an angular bend near the root, 90–140 μ long × 8–9 μ thick. Centripetal paired ray straight, 120–200 μ long

× 6–8 μ thick. Dermal paired ray considerably bent near the root, 80–130 μ long × 6–8 μ thick. Oral angle 95° to 110°.

(*d*) Subgastral triradiates. Basal ray straight, 100–260 μ long × 7–9 μ thick. Paired rays equal, bent downwards near the root, 80–140 μ long × 7–8 μ thick. Oral angle 165°.

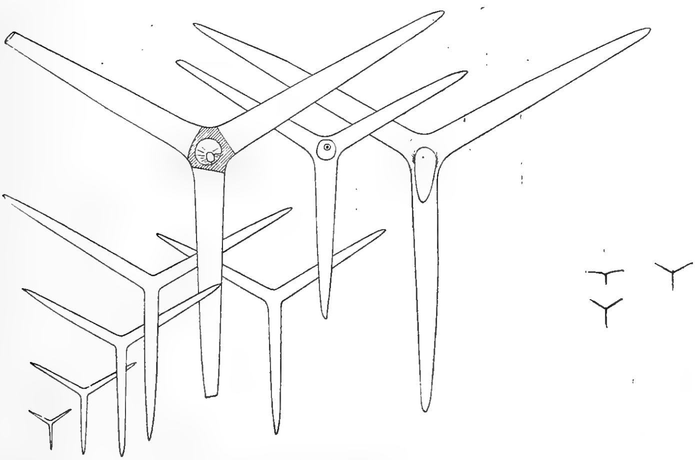
The quadriradiates are of one sort :—

(*e*) Quadriradiates from the gastral layer. Basal rays straight, 130–150 μ long × 9 μ thick. Paired rays straight, 90–130 μ long × 8–10 μ thick. Apical rays 80–130 μ long × 4 μ thick.

HETEROPEGMA NODUS GORDII Pol. (Text-fig. 103.)

Three specimens of this sponge were dredged in 6–10 fathoms at Wasin. In form and size they agree closely with Poléjaeff's description and figures (2). The spicules (text-fig. 103) also agree with his description with the following slight differences. The minute tri- and quadriradiates in the Wasin specimens are about 4 μ thick, whereas Poléjaeff gives 2 μ. There are none of the intermediate forms mentioned by Poléjaeff between the remarkable alate tri- and quadriradiates which line the gastral cavity and the regular tri- and quadriradiates which are scattered through the body.

Text-fig. 103.



*Heteropegma nodus gordii*, spicules. × 40.

LEUCILLA FLORIDIANA.

*Leucaltis floridiana* H.

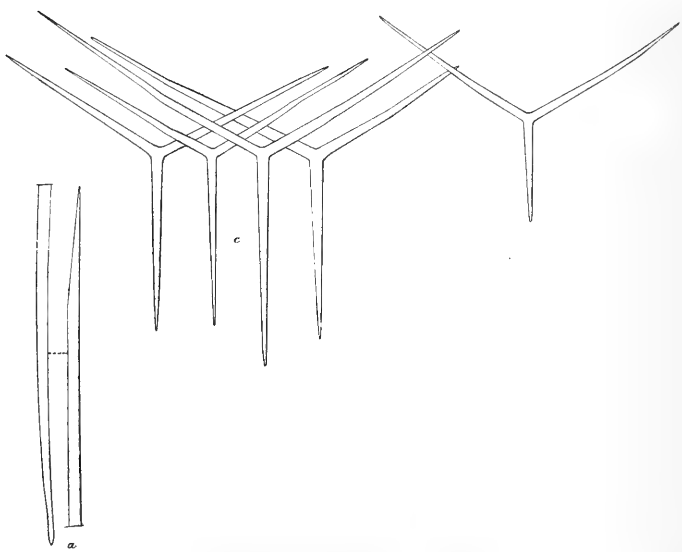
One specimen of this sponge was dredged in 10 fathoms at Wasin. It is irregular in shape, 10 × 7 × 5 mm., and has an oscule $\frac{3}{4}$ mm. diameter flush with the surface; there is no collar or fringe.

The spicules agree very well with Haeckel's description of *Leucaltis floridiana.* The apical rays of the large quadriradiates in the dermis point inwards, the species must therefore be placed in the genus *Leucilla.* The small quadriradiates line the excurrent canals, with their apical rays projecting into them.

Leucilla wasinensis, sp. n. (Text-fig. 104.)

One specimen of this new species was dredged in 6–8 fathoms at Wasin. It is ovoid in form, 16 mm. long × 7 mm. diameter, with a fringed oscule, 2 mm. in diameter. It is white, as preserved in spirit. The body-walls are about 2 mm. thick, leaving a gastral cavity 3 mm. diameter in the centre. Externally it is rough with the stumps of large projecting oxea. The oscule is protected by a dense fringe of thin oxea, surrounded by a few thick ones like those projecting from the dermis.

Text-fig. 104 A.



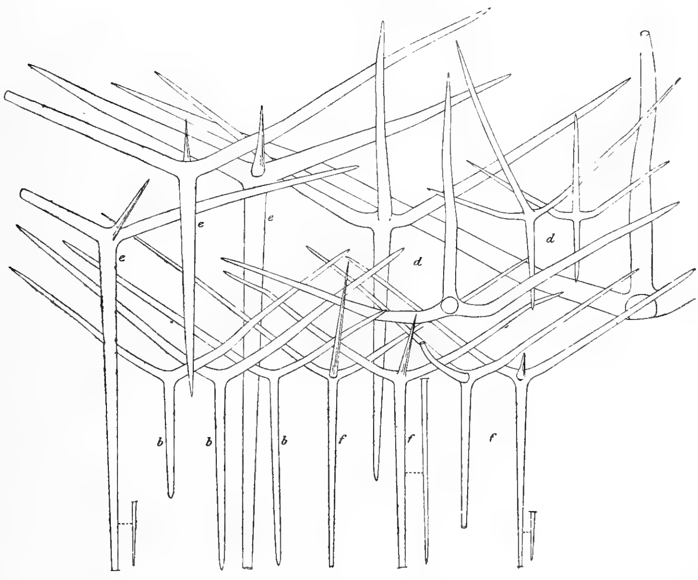

*Leucilla wasinensis,* spicules. × 40.
(For explanation of the letters see text p. 455.)

*Canal-system.*—There are large subdermal chambers from which branch the incurrent canals. The excurrent canals are also branched. The canal-system is similar to that most usual in the genus *Leucandra.*

*Skeleton.*—The dermal skeleton consists of a thin layer of alate triradiates lying tangentially without orientation; amongst them are a few quadriradiates, with the apical rays directed inwards, some of very large size. The gastral skeleton consists of a thick layer of large alate quadriradiates, regularly placed with the basal rays directed aborally and the apical rays projecting into the gastral cavity. The skeleton of the central mass of the body-wall between the dermal and gastral layers is a closely packed mass of irregularly placed tri- and quadriradiates. The quadriradiates, some of which are very large, are mostly arranged round the mouths of the excurrent canals, with the apical rays projecting into the canals. The large projecting oxea are bunched into little tufts. The inner ends usually pierce nearly through the wall, and occasionally right through into the gastral cavity.

But for the presence of the large dermal quadriradiates this sponge would be a typical *Leucandra.*

Text-fig. 104 B.




*Leucilla wasinensis*, spicules. × 110.
(For explanation of the letters see text below.)

*Spicules* (text-fig. 104 A & B).

The oxea are of one sort:—

(*a*) Nearly straight oxea, sharply pointed at the inner end, outer end snake-headed. The largest fragment is 2·8 mm. long × 45 $\mu$ thick.

The triradiates are of two sorts:—

(*b*) Alate triradiates from the dermis. Basal rays straight, 150–240 μ long × 10–13 μ thick. Paired rays, curving slightly upwards, 160–320 μ long × 9–13 μ thick. Oral angle 110°.

(*c*) Subregular triradiates from the body. Rays very sharply pointed, 600–950 μ long × 35–40 μ thick. Individual spicules often have their three rays of different lengths, but the angles are always approximately 120°.

The quadriradiates are of three sorts:—

(*d*) Subdermal quadriradiates. These spicules vary enormously in size, and are of peculiar form as shown in the drawing. The facial rays are folded inwards, *i. e.* towards the side from which the apical ray projects. The maximum facial ray found is 700 μ long × 26 μ thick. The maximum apical ray is 500 μ long × 26 μ thick.

(*e*) Alate quadriradiates from the lining of the excurrent canals. Basal rays straight, 280–480 μ long × 20–28 μ thick. Paired rays nearly straight, 340–420 μ long × 14–24 μ thick. Oral angle 130°.

(*f*) Alate quadriradiates from the gastral layer. Basal rays straight, 300–560 μ long × 10–12 μ thick. Paired rays, bending upwards, slightly irregularly bent, 240–450 μ long × 8–10 μ thick. Apical ray, curved orally, 180–260 μ long × 8 μ thick. Oral angle 110° to 120°.

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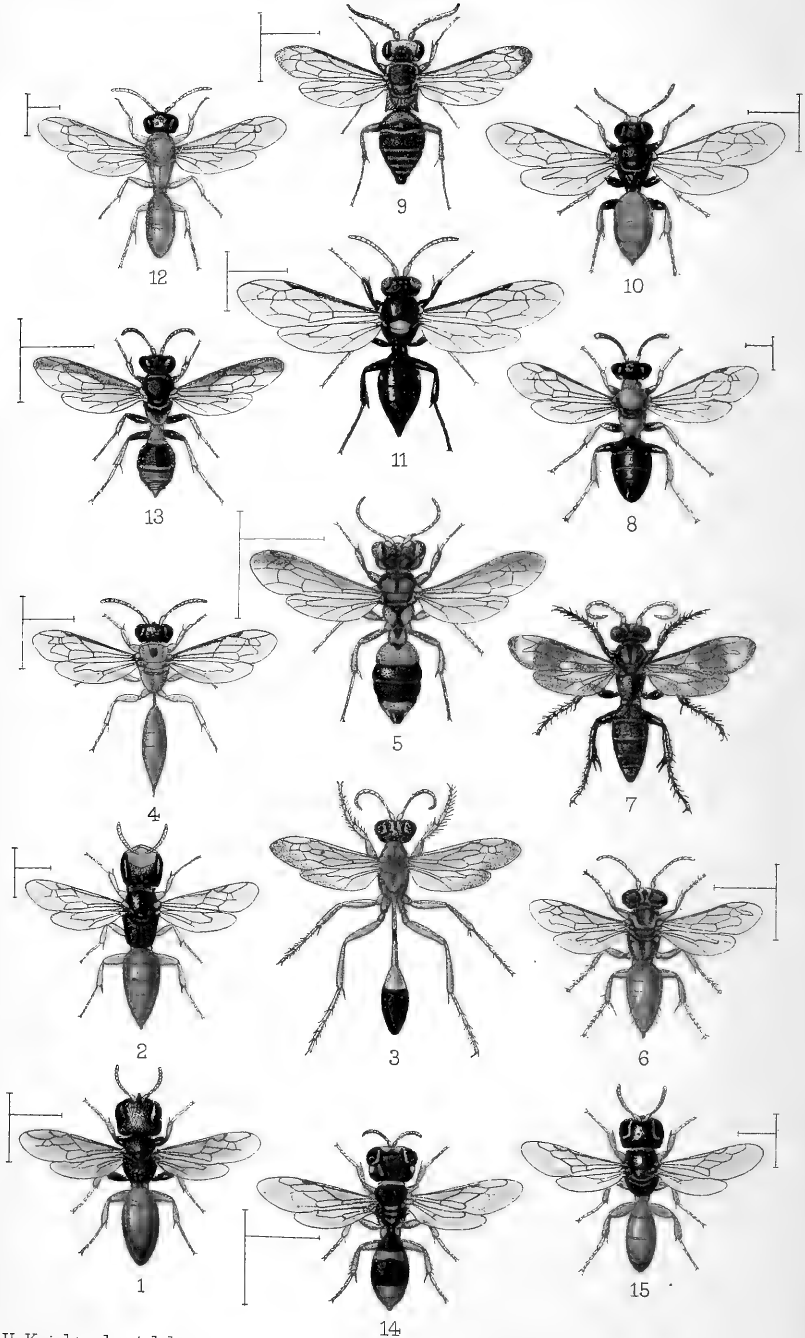



H. Knight ad nat. del.

West, Newman chr.

AUSTRALIAN SPHEGIDÆ.

## 2. Notes on the Australian Fossorial Wasps of the Family *Sphegidæ*, with Descriptions of new Species. By Rowland E. Turner, F.Z.S.

[Received April 6, 1908.]

(Plate XXVI.* and Text-figures 105–110.)

The Sphegidæ of Australia have attracted very little notice since the time of F. Smith; the only works in which any number of species have been dealt with being Kohl's Monograph of the genus *Sphex* and various papers by Handlirsch on *Bembex* and the allied groups. In consequence, it has been impossible to get any reliable idea as to the characteristic points which might attract notice as to the peculiarities of Australia in this group. The present paper, although necessarily very incomplete from want of sufficient material, is based upon the large collection formed by the late Gilbert Turner in North Queensland together with smaller additions from other sources. Considering the sandy nature of much of the continent, usually so favourable to fossorial wasps, Australia is rather poor in Sphegidæ, and several wide-ranging genera represented in almost every other region seem to be entirely absent. The most notable instances are the genera *Philanthus* and *Oxybelus*, but *Ampulex*, so conspicuous in the Indian and African regions, is also absent. Nor is it likely that the absence of these genera in collections is due to insufficient field-work, for North Queensland is the most likely part of the continent for these wide-ranging genera to occur in, the line of migration having been through New Guinea. Thus I am able to record two species of *Trypoxylon* closely allied to Indian and Malayan forms, no species of the genus having yet been discovered in the southern or western districts. On the contrary, genera peculiar to Australia are not numerous and seem to be poor in species, though probably more exhaustive collecting in Western Australia would add to the number. Most characteristic of the country are *Sericophorus* and the allied genera *Zoyphium* and *Sphodrotes*, also the large *Exeirus*; but the worldwide genus *Pison* is much richer in species in Australia than elsewhere. *Harpactophilus* is apparently a tropical genus, and will probably be found to have its headquarters in New Guinea. The small amount of material available from Central Australia seems to point to the plentiful occurrence of a few wide-ranging species, mostly identical with those of Western Australia.

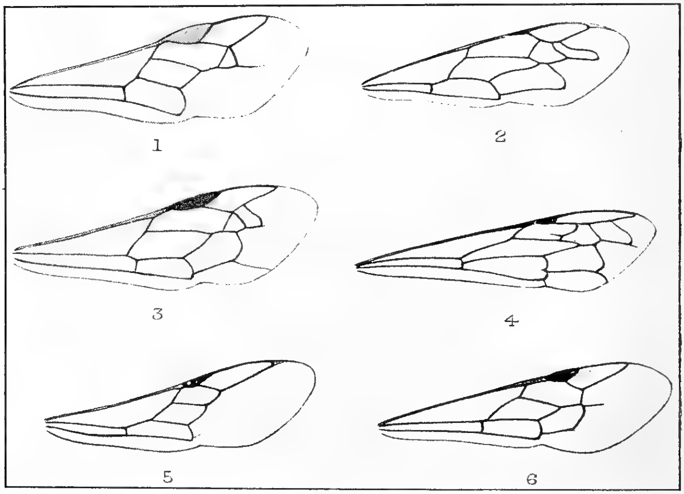
Stigmus queenslandensis, sp. n.

♀. Clypeus strongly convex, raised in the middle into a broad carina, which is more narrowly continued on the front to the anterior ocellus. Clypeus and vertex almost smooth, front finely

* For explanation of the Plate see p. 535.

and closely punctured-rugose, slightly concave, with a depressed row of large punctures, bordered within by a carina, along the inner margin of the eyes. Eyes large, reaching the base of the mandibles and slightly convergent towards the vertex, the posterior ocelli rather farther from each other than from the eyes. Antennæ inserted nearer to the eyes than to each other, the flagellum three times as long as the scape. Pronotum very short, much narrower than the head, the anterior margin raised and with prominent angles, a transverse row of large, deep punctures behind it; the propleuræ obliquely striated, the mesopleuræ rugose. Mesonotum and scutellum closely and very finely punctured. The median segment as long as the thorax, vertically

Text-fig. 105.




Neuration of fore wing.

1. *Stigmus queenslandensis*. 2. *Tachysphex pilosulus*. 3. *Zoyphium kohlii*. 4. *Gorytes icarioides*. 5. *Nitela kurandæ*. 6. *Pison* (*Parapison*) *aberrans*.

truncated posteriorly, coarsely transversely striated; a triangular space reaching from the base to the apex bordered by raised carinæ, with two parallel longitudinal carinæ close to the middle reaching from the base to the apex. Abdomen subsessile, not petiolate, smooth and shining, about as long as the thorax and median segment combined. The second cubital cell is very small, triangular, and almost petiolate, the recurrent nervure is received at about one-third from the apex of the first cubital cell, which is longer than is usual in the genus.

Black; the mandibles pale yellow; antennæ, legs, and tegulæ pale ferruginous. Wings hyaline, slightly iridescent; nervures pale ferruginous.

Length 5 mm.

*Hab.* Mackay, Queensland (*Turner*); April.

Differs from typical *Stigmus* in the non-petiolate abdomen.

Harpactophilus steindachneri Kohl.

♀. The posterior ocelli are nearer to the posterior margin of the head than to each other.

♂. The mandibles, antennæ, and legs are ferruginous; the front, cheeks, head beneath, and prosternum golden. The front is much more closely and finely punctured than in the female. The apical dorsal segment of the abdomen is strongly emarginate. As in all the species of the genus, there is a semicircular depression at the base of the second ventral segment.

*Hab.* Mackay, Queensland; October to May. Also from Cairns and Cooktown.

Harpactophilus bicolor Sm.

♀. Very near *H. steindachneri*, from which it differs in the greater breadth of the thorax, which is almost as wide as the head, the more prominent angles of the pronotum, and the fuscous colour of the wings.

*Hab.* Mysole.

Harpactophilus kohlii, sp. n.

♀. Mandibles bidentate at the apex, the teeth short and feeble, the inner tooth a little the longest. Clypeus convex, with a longitudinal carina from the base almost reaching the apex, at the extreme apex there is a small, smooth, triangular truncation; the sides of the clypeus are punctured. Above the clypeus is a very prominent, narrow, longitudinal carina, on each side of which are short curved striæ. The front between the eyes and the base of the antennæ is very closely punctured and covered with short, thin, greyish pubescence. Antennæ inserted very low down on the sides of the clypeus, far apart, as far from each other as from the eyes, the scape as long as the first five joints of the flagellum and equal in length to a little more than two-fifths of the distance between the eyes at the base of the antennæ. Vertex very coarsely rugose-striate, the cheeks very broad and coarsely striated. The ocelli situated in an almost equilateral triangle, the posterior ocelli almost in a straight line with the summit of the eyes, half as far again from the eyes as from each other, and more than twice as far from the posterior margin of the head as from each other. Eyes surrounded by a narrow sulcus, which is coarsely and closely punctured. The posterior margin of the head broadly emarginate, and about one-third broader than the mesonotum. Pronotum depressed below the level of the mesonotum and invisible from above. Mesonotum punctured-rugose, more than half as broad again as long; the scutellum almost smooth. Mesopleuræ rather finely rugose-striate. Median segment much broader than long, narrowed towards the apex and vertically truncate posteriorly, shorter than the mesonotum; a large triangular space occupying almost the whole of the dorsal surface very coarsely reticulate and enclosed by carinæ; the sides of the segment striated, the surface of the posterior truncation coarsely rugose. Abdomen smooth and shining, shorter than the thorax and median segment combined. Legs not spinose.

Black; the mandibles (except the extreme apex), the scape of the antennæ, the apical half of the femora, the tibiæ above, and the tegulæ yellow; the apex of the mandibles, the flagellum, the abdomen, the base of the femora, the tibiæ beneath, and the tarsi ferruginous. Wings hyaline, nervures pale ferruginous.

The second cubital cell is more pointed on the radial nervure than in *H. steindachneri* Kohl, from which it may also be distinguished by the small triangular truncation at the apex of the clypeus, the larger head, which is much more produced posteriorly, and the absence of a visible pronotum above. It is somewhat intermediate between *H. steindachneri* and *H. arator*, but is nearer to the former.

Length 7–8 mm.

*Hab.* Mackay, Queensland (*Turner*).

HARPACTOPHILUS SULCATUS, sp. n.

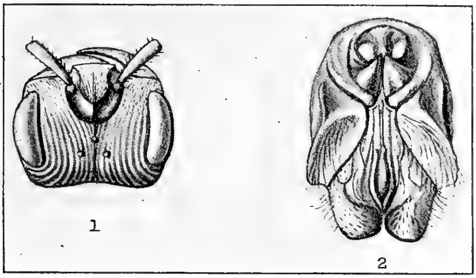
♀. Clypeus triangular, convex, with a longitudinal carina from the base not quite reaching the apex, where there is a very small oblique triangular truncation. Mandibles feebly bidentate at the apex, the outer tooth a little the longest. Antennæ a little longer than the head, the length of the scape equal to nearly half the distance between the eyes at the insertion of the antennæ; the first four joints of the flagellum much longer than broad, the second joint twice as long as the first and more than half as long again as the second. Head very large, coarsely longitudinally striated, the striæ curving round the summit of the eyes, a narrow depressed line divided by deep punctures round the margin of the eyes, the small space between the eyes and the base of the mandibles smooth. The posterior ocelli nearly twice as far from the eyes as from each other and about the same distance from the posterior margin of the head as from the eyes. The posterior margin of the head depressed and broadly emarginate. Pronotum depressed below the mesonotum; the mesonotum about one-third narrower than the head, about half as broad again as long, coarsely longitudinally striated in the middle, coarsely rugose on the sides. Mesopleuræ obliquely striated; scutellum almost smooth. Median segment a little shorter than the mesonotum, the large enclosed triangular area on the dorsal surface very coarsely rugose, the segment strongly narrowed to the apex and vertically truncate posteriorly, the sides coarsely striated. Abdomen shining and almost smooth. The carina on the front of the head, between the grooves for the scape, is less strongly developed than in the allied species.

Black; the base of the scape yellow in front; the mandibles (except the extreme apex), the antennæ, abdomen, tibiæ, tarsi, and the apex of the femora ferruginous. Wings fusco-hyaline, nervures dark ferruginous.

The second cubital cell on the radial nervure is about one-third of the length on the cubital nervure, the radial cell is longer than in the allied species, and the nervures both on the fore and hind wings are produced, reaching much nearer to the margin. The recurrent nervure is received just before the apex of the first cubital cell.

Length 8 mm.

Text-fig. 106.




1. *Harpactophilus sulcatus* (head). 2. *H. steindachneri* Kohl: ♂ organs.

*Hab.* Kuranda, near Cairns, Queensland (*Turner*); January.

Most nearly allied to *H. arator* and *H. kohlii*, but the head is much shorter and broader than in the former species; the antennæ are longer than in other species of the genus and the proportions of the basal joints of the flagellum very different.

Harpactophilus arator, sp. n. (Plate XXVI. fig. 1.)

♀. Mandibles bidentate at the apex, the teeth short and feeble. Clypeus very slightly advanced, obliquely triangularly truncate from the centre to the apex. Head very large, subquadrate, emarginate posteriorly, half as broad again as the mesonotum, exceedingly coarsely striated, the striæ longitudinal, curving round the summit of the eyes; a very strong longitudinal carina starting just below the anterior ocellus and produced in the shape of a ploughshare prominently overhanging the base of the clypeus. Eyes not quite reaching the base of the mandibles; the posterior ocelli nearly twice as far from the eyes as from each other and more than half as far again from the posterior margin of the head as from the eyes. Antennæ inserted lower than the base of the clypeus, far apart, as far from each other as from the eyes. Pronotum depressed below the mesonotum, which is coarsely longitudinally striated; the scutellum short, almost smooth, with a feebly impressed median line. Median segment shorter than the mesonotum, narrowed and truncate posteriorly, the dorsal surface exceedingly coarsely reticulate, the sides of the segment and the mesopleuræ coarsely obliquely striated. Mesosternum transversely striated. Abdomen hardly as long as the thorax and median segment combined, smooth and shining, only four segments visible from above, the fifth segment beneath very deeply emarginate, the sides almost encircling the apical segment. Tibiæ and tarsi not spinose. Black; the mandibles, antennæ, tibiæ, tarsi, posterior femora, and abdomen ferruginous. Wings hyaline, the basal half tinted with fulvous, nervures ferruginous. The stigma is larger than in the common *H. steindachneri* Kohl, and the recurrent nervure is received just before the apex of the first cubital cell.

Length 8 mm.

*Hab.* Cairns, Queensland (*Dodd*).

Described from three specimens in the British Museum.

HARPACTOPHILUS TRICOLOR, sp. n. (Plate XXVI. fig. 2.)

♀. Mandibles slender, bidentate, the inner tooth short. Clypeus smooth and shining, triangular, convex in the middle at the base, with a small triangular truncation anteriorly. Front very broad, with a short prominent carina above the base of the clypeus. Antennæ shorter than the head, the scape stout and nearly half as long as the flagellum and less than half as long as the distance between the eyes at the base of the clypeus, the antennæ at the base as far from each other as from the eyes. The posterior ocelli nearer to each other than to the eyes, situated on the vertex a little behind the summit of the eyes and fully half as far again from the posterior margin of the head as from each other. Front finely longitudinally striated, most strongly just below the ocelli; vertex almost smooth, very finely striated behind the eyes. Eyes not quite reaching the base of the mandibles. The posterior margin of the head strongly emarginate. Pronotum transverse, very short, narrower than the head by about one-third, the anterior angles acute and prominent. Mesonotum punctured, shorter than the median segment and a little longer than broad; scutellum short and broad, almost smooth. Median segment rectangular, longer than broad, vertically truncate posteriorly, as broad as the mesonotum, rugose; with a triangular space enclosed by carinæ and divided by a longitudinal carina from the base to the apex, the surface of the truncation coarsely transversely striated. Abdomen smooth and shining, as long as the thorax and median segment combined, the six dorsal segments all well defined. Mesopleuræ almost smooth. Legs without spines, except the apical spines of the tibiæ.

Black; the mandibles, clypeus, front, antennæ, cheeks, the head beneath, the tegulæ, and the anterior and intermediate legs yellow; the abdomen and the posterior legs light ferruginous. Wings hyaline, iridescent; nervures testaceous.

The neuration is similar to that of *H. steindachneri* Kohl, but the second cubital cell is not pointed on the radial nervure, being about one-third as long on the radial as on the cubital nervure.

Length 5–6 mm.

*Hab.* Mackay, Queensland (*Turner*); September–December. Described from two specimens.

This is a much slenderer species than *H. steindachneri* and is much less coarsely sculptured. The pronotum is less depressed and has the anterior angles strongly prominent, in these characters showing an approach to the genus *Spilomena*.

PSENULUS INTERSTITIALIS Cam. (Plate XXVI. fig. 4.)

*Psenulus interstitialis* Cam. Tijdsch. v. Ent. xlix. p. 222, 1906.

*Psen. lutescens* Turner, Ann. & Mag. Nat. Hist. (7) xix. p. 273, 1907.

*Hab.* Etna Bay, New Guinea; Mackay and Cairns, Queensland.

I have not seen Cameron's type, but his description is quite sufficient.

AMMOPHILA CLAVUS Fab.

*Sphex clavus* Fab. Syst. Ent. p. 348. n. 12, 1775.

♀. Mandibles quadridentate; clypeus shining, very sparsely punctured, with a few coarse black hairs, a broadly triangular, oblique truncation at the apex, the apical margin very feebly and rather broadly emarginate in the middle. Second joint of the flagellum half as long again as the first and third combined. Eyes parallel on the inner margins; the posterior ocelli nearly half as far again from the eyes as from each other. Head opaque, finely punctured; a fine, impressed and slightly curved, transverse line behind the posterior ocelli; the front concave, with a delicate sulcus from the anterior ocellus, clothed with rather sparse greyish pubescence. Pronotum and mesonotum coarsely transversely striated, the posterior half of the mesonotum with oblique striæ converging towards the middle of the posterior margin. Scutellum longitudinally striated; the mesopleuræ and metapleuræ vertically striate-rugose. Median segment transversely striated, the striæ somewhat oblique, the middle of the segment coarsely reticulate and rather strongly convex at the base; the extreme apex of the segment with a little short, pale, fulvous pubescence. Abdomen shining, the four apical segments pruinose; the petiole two-jointed, equal in length to the posterior tibia and basal joint of the tarsus combined. Tarsal ungues simple, without a pad; the comb of the anterior tarsi with four slender spines on the outer margin of the basal joint, excluding those on the apical process.

Black; the mandibles in the middle fusco-ferruginous; the scape and two basal joints of the flagellum, the tegulæ, the legs (except the coxæ and spines of the tarsi), the petiole and the first following segment of the abdomen bright ferruginous; the base of the second joint of the petiole black; the four apical segments steel-blue. Wings pale flavo-hyaline, lighter at the apex, nervures testaceous.

♂. Mandibles bidentate; clypeus and front clothed with fine, short, silvery pubescence; the clypeus as long as the breadth at the middle, broadly emarginate on the apical margin. Second joint of the flagellum only slightly longer than the first and third combined. Eyes rather strongly convergent towards the clypeus. The whole of the mesonotum transversely striated; mesopleuræ and metapleuræ rugose. Petiole very long, equal in length to the posterior tibia and three basal joints of the tarsus combined.

Black; the tegulæ, the second joint of the petiole beneath, and the first following segment of the abdomen at the base above and beneath ferruginous; the abdomen beyond the petiole pruinose, dark steel-blue. Wings hyaline, clouded on the outer margin; nervures black.

Length, ♀ 23 mm., ♂ 22 mm.

*Hab.* Mackay to Cape York, Queensland (*Turner*); November to May.

Very near *A. instabilis* Sm. in the female sex, but differs in the form of the clypeus and in the proportionate length of the joints of the flagellum. The petiole is also longer. Also near *A. basalis* Sm. from India.

A common species throughout the coastal districts of North Queensland. The male is very different from those of other Australian species, and allied to Indian forms.

Ammophila aurifera, sp. n. (Plate XXVI. fig. 3.)

♀. Mandibles with a very long acute apical tooth, the inner margin with three teeth, the one nearest the apex very short and broadly truncate, the second broad and rounded, the basal one very small and acute. Clypeus very slightly convex, depressed at the apex and subtruncate, very sparsely punctured, the punctures very large. Antennæ inserted about two and a half times as far from the eyes as from each other, about one-third further from the anterior ocellus than from the apex of the clypeus; the second joint of the flagellum about five times as long as the first and twice as long as the third. Posterior ocelli about one-quarter further from the eyes than from each other. Head opaque, almost smooth, with a longitudinal sulcus from the anterior ocellus to between the antennæ; the front round the base of the antennæ slightly concave. Pronotum coarsely transversely striated; mesonotum very obscurely transversely striated, the striæ almost obsolete on the disc, a deep and broad longitudinal sulcus from the anterior margin not reaching the posterior margin, a raised curved carina above the tegulæ. Mesopleuræ rugose; mesosternum transversely striated. Scutellum longitudinally striated; median segment transversely striated, the striæ arched in the middle and rather obscure, as long as the mesonotum and pronotum combined. Abdomen coriaceous, the petiole two-jointed and as long as the posterior tibia and first tarsal joint combined; the apical segment with long black hairs on the sides. Tarsal ungues simple, not bidentate, and without a pad.

Bright golden ferruginous; the head (except the basal half of the mandibles), the scape, and five basal joints of the flagellum black; the mesosternum, the four apical abdominal segments, a spot on the middle of the petiole, and part of the ventral surface of the petiole and the next segment black. Wings pale flavo-hyaline, very faintly tinged with fuscous at the apex; nervures ferruginous.

Length 28 mm., exp. 29 mm. Breadth of mesonotum between the tegulæ 3 mm.

*Hab.* Port Darwin (*Turner*); December.

Allied to *A. ardens* Sm., but is a much less robust species and less strongly sculptured.

The male has the mandibles bidentate, the clypeus longer than broad, the second joint of the flagellum less than twice as long as the third, the eyes convergent towards the clypeus, not parallel on the inner margins as in the female, the mesonotum and median segment much more strongly striated. The antennæ are almost wholly black, as are also the disc of the mesonotum and the sides of the median segment; the apical joints of the posterior tarsi are fuscous.

Length 24 mm.

AMMOPHILA EYRENSIS, sp. n.

♀. Mandibles quadridentate, the outer tooth very long and acute. Clypeus short and broad, the apical margin depressed, very shallowly emarginate in the middle; sparsely punctured and with a few long black hairs. Antennæ inserted close together; the second joint of the flagellum more than twice as long as the third, which is twice as long as the first. Eyes parallel on the inner margin, the posterior ocelli a little further from the eyes than from each other. Head subopaque, almost smooth, a very fine transverse sulcus behind the posterior ocelli and not extending beyond them, a longitudinal frontal sulcus from the anterior ocellus, the front between the base of the antennæ and the eyes clothed with short, thin, cinereous pubescence. Pronotum coarsely, mesonotum more finely transversely striated; a longitudinal median sulcus on the anterior half of the mesonotum, in which lies a short longitudinal carina. Scutellum longitudinally striated; the mesopleuræ and metapleuræ rugose-striate, the mesopleuræ with a short, fine and shallow, vertical sulcus below the anterior wings. Median segment transversely striated, the striæ slightly oblique, coarsely reticulate along the middle, broadly at the base and narrowly at the apex. Abdomen shining and almost smooth, the apical segments not pruinose; the petiole two-jointed, the first joint seen from above very slightly longer than the second, the two combined a little longer than the posterior tibia and the basal joint of the tarsus combined. Tarsal ungues simple, without pads, the comb of the anterior tarsi rather long, with four spines on the basal joint, excluding those on the apical process.

Light ferruginous; the head black; the mandibles except at the apex, the basal half of the antennæ and the mouth-parts ferruginous; the posterior half of the mesonotum, a median longitudinal line on the anterior half, and the spines and ungues of the tarsi black; the three apical abdominal segments shining steel-blue; a spot at the base of the second joint of the petiole black. Wings hyaline, the base of the anterior pair pale flavo-hyaline; nervures testaceous.

The second and third cubital cells are equal in length on the radial nervure.

Length 18 mm.

*Hab.* Killalpanima, S. Australia, 100 miles east of Lake Eyre (*H. J. Hillier*).

Type in British Museum. Described from two specimens.

Near *A. instabilis* Sm., but is a smaller and more slender insect; the second joint of the flagellum is longer in proportion, and the dorsal surface of the median segment is not sharply raised towards the median line as in typical *instabilis*.

AMMOPHILA INSTABILIS Sm.

*Ammophila instabilis* Sm. Cat. Hym. B. M. iv. p. 214. n. 36, 1856, ♀.

*Ammophila impatiens* Sm. Trans. Ent. Soc. London, p. 247. n. 1, 1868, ♂ (as ♀).

These are without much doubt the sexes of one species.

*Hab.* Champion Bay, W. Australia.

AMMOPHILA ARDENS Sm.

*Ammophila ardens* Sm. Trans. Ent. Soc. London, p. 247. n. 2, 1868.

*Hab.* Swan River (*Du Boulay*), Mackay, Queensland (*Turner*).

AMMOPHILA SUSPICIOSA Sm.

*Ammophila suspiciosa* Sm. Cat. Hym. B. M. iv. p. 214. n. 35, 1856.

This is the only Australian species known in which the petiole is one-jointed. It is, as Smith points out, scarcely distinct from the N.-African species *A. argentea* Brullé.

*Hab.* Melbourne; Lake Eyre district; Perth; Tasmania.

SPHEX (ISODONTIA) ALBOHIRTUS, sp. n.

♀. Mandibles broad and tridentate. Clypeus rather sparsely punctured, clothed with very short, close pubescence which shows as silver in some lights, with sparse, long, brown hairs; slightly convex at the base and subcarinate, very broadly and shallowly emarginate at the apex, with a small and narrow emargination in the middle of the apical margin, the angles of the emargination produced into minute spines. Second joint of the flagellum as long as the third and half of the fourth. Eyes slightly convergent towards the clypeus, separated on the vertex by a space equal to the length of the third and fourth joints of the flagellum combined, and by nearly the same distance on the clypeus; the posterior ocelli a little nearer to each other than to the eyes. Head shining, finely and rather sparsely punctured, the front with very short silvery pubescence, the sparse long hairs on the vertex brownish grey. Pronotum transverse and vertically depressed; the mesonotum sparsely, the mesopleuræ closely punctured; scutellum flat. Median segment punctured-rugose, with a short longitudinal sulcus near the apex, without a sulcus from the stigma. Petiole as long as the basal joint of the posterior tarsus; the pubescence on the petiole and the sides of the median segment long and whitish, on the dorsal surface of the median segment very pale brown and very sparse. Abdomen shining and almost smooth, the first segment as long as the second, the apical segment finely punctured and subopaque. The first recurrent nervure is received near the apex of the second cubital cell, the second near the base of the third cubital cell; the second cubital cell is very large, subrectangular, more than half as long again on the cubital nervure as high.

Black; the abdomen with obscure blue reflections. Wings dark fusco-hyaline flushed with purple, nervures black. A patch of short fulvous pubescence at the apex of the posterior tibiæ.

♂. Similar to the female, but the emargination on the middle of the apical margin of the clypeus is very faintly indicated; the abdomen is pruinose.

Length, ♀ 21 mm., ♂ 19 mm.

*Hab.* Mackay and Cairns, Queensland (*Turner*); December to March.

The wings are rather paler in Cairns specimens.

Allied to *S. ustulatus* Kohl, from Timor, also to *S. morosus* Sm. and *S. praslinius* Guér. The last two may prove to refer to one species. The emargination of the clypeus and the pale colour of the pubescence will serve to distinguish the present species.

Sphex (Isodontia) nigellus Sm.

*Sphex nigella* Sm. Cat. Hym. B. M. iv. p. 255, 1856.

*Hab.* Mackay and Cairns, Queensland (*Turner*).

This species seems to occur throughout Southern Asia and also in W. Australia.

Sphex (Isodontia) obscurellus Sm.

*Sphex obscurella* Sm. Cat. Hym. B. M. iv. p. 251, 1856.

*Hab.* Tasmania.

Very near *S. nigellus*, from which it may be distinguished by the much shorter petiole and by the shape of the third cubital cell, which is as long as the second on the radial nervure; the clypeus is also rather longer.

Sphex wallacei, nom. nov.

*Sphex nitidiventris* Sm. Proc. Linn. Soc., Zool. iii. p. 158, 1859 (nec Spinola).

Kohl states that *nitidiventris* Spin. also occurs in Java and

Luzon, though a S.-American species. The species in the British Museum which is identified as *nitidiventris* Spin., rightly in my opinion, though somewhat resembling Smith's species, has the petiole much longer and the clypeus different.

*Hab.* Aru (*Wallace*); Mackay to Cape York (*Turner*).

A common species in North Queensland.

Sphex gilberti, sp. n.

♀. Clypeus convex, triangularly flattened from the middle to the apex, the apical margin very feebly and narrowly emarginate in the middle, the length equal to about three-quarters of the breadth at the apex; sparsely and rather coarsely punctured, with a feeble longitudinal carina from the base not reaching the middle, very sparsely clad with long, stiff, black hairs, the sides in some lights showing silvery reflections on very short, fine pubescence. Front clothed with very short, fine pubescence, silvery below the base of the antennæ, golden above, with very sparse, long black hairs above the base of the clypeus; the vertex bare, opaque, and almost smooth. Antennæ twice as far from the eyes as from each other; the first joint of the flagellum very short, the second and first together about equal in length to the third and fourth. The inner margins of the eyes almost parallel, converging slightly on the vertex; the posterior ocelli are nearer to each other than to the eyes. Pronotum slightly depressed below the level of the mesonotum, very steeply sloped anteriorly, opaque and smooth, the posterior margin with very short silvery pubescence. Thorax opaque, very finely and closely punctured; the mesonotum slightly depressed anteriorly in the middle and with an obscure longitudinal sulcus on each side above the tegulæ; the scutellum flat, with a very faint longitudinal line in the middle; postscutellum transversely depressed at the base; the mesopleuræ subopaque and very shallowly punctured. Median segment opaque, sparsely punctured, with sparse, stiff, blackish hairs; an obscure longitudinal sulcus from the base to the apex, the dorsal surface bordered by a very narrow shallow sulcus; a deeper and broader sulcus, in which are regular transverse striæ, on the metapleuræ from the stigma to the posterior angle. Abdomen shining, sparsely and very finely punctured; the epipygium coarsely punctured, with sparse and very long black hairs, and convex; the petiole not quite equal in length to the third joint of the posterior tarsi. Tarsal ungues with two small teeth near the base; the spines of the anterior tarsus long. The length of the third cubital cell on the radial nervure is about equal to the distance of the first transverse cubital nervure from the stigma; the first recurrent nervure is received at about one-fifth from the apex of the second cubital cell, the second at two-fifths from the base of the third cubital cell.

Black; the abdomen steel-blue. Wings flavo-hyaline, broadly pale fusco-hyaline at the apex; nervures ferruginous.

Length 26–28 mm.

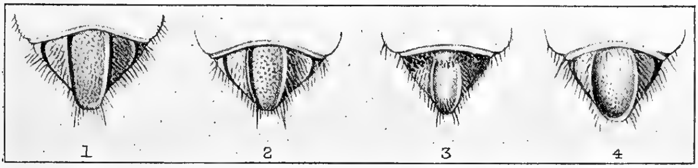
*Hab.* Mackay, Queensland (*Turner*); February.

Very near *S. diabolicus* Sm., the Oriental form of *rufipennis* Fab., but differs in the postscutellum, which is not longitudinally divided or raised into a small tubercle on each side near the middle; the petiole also is rather shorter, and the abdomen is shining instead of opaque.

CERCERIS INEXPECTATA, sp. n. (Plate XXVI. fig. 5.)

♀. Mandibles blunt at the apex, with a large triangular tooth on the inner margin nearer to the base than to the apex. Clypeus sparsely punctured, broadly truncate at the apex, the central lobe slightly convex, bluntly produced on the apical margin at the junction of the lateral lobes, nearly twice as broad at the apex as at the base. The antennæ are inserted above the clypeus, at a distance from its base equal to three-quarters of the greatest length of the clypeus; the second joint of the flagellum is at least twice as long as the first and half as long again as the third; at the base the antennæ are separated from the eyes by a distance equal to the length of the scape, and from each other by about two-thirds of that distance. The eyes are slightly convergent

Text-fig. 107.




*Cerceris*: pygidial area of ♀.

1. *C. inexpectata*. 2. *C. labeculata*. 3. *C. prædura*. 4. *C. multiguttata*.

towards the vertex; the posterior ocelli are about one-third further from the eyes than from each other, and as far from the posterior margin of the head as from the eyes. Head very broad, at least one-third broader than the mesonotum, the vertex coarsely punctured-rugose, the front sparsely and shallowly punctured, with an elevated carina between the antennæ. Pronotum very short, strongly rounded at the angles; mesonotum rather sparsely punctured, with a very shallow sulcus from the anterior margin not reaching the centre; mesopleuræ very coarsely punctured; scutellum short, very broadly truncate at the apex. Median segment strongly but not very closely punctured at the sides, with a sulcus from the base to the apex; the triangular space at the base smooth. Abdomen coarsely punctured, most closely on the third and fourth segments; the first segment rectangular, a little broader than long, nearly half as broad as the apex of the second segment; the dorsal pygidial area rugose, truncate at the apex, where it is half as broad as at the base.

Black; the base of the mandibles, clypeus, front as high as the base of the antennæ, the frontal carina, the sides of the pronotum, the postscutellum, a large spot on each side occupying the whole length of the median segment, the sides and apex of the first abdominal segment, the second segment except a triangular mark at the base, the apex of the fifth segment very broadly, and the two basal ventral segments yellow; the antennæ, the outer orbits of the eyes connected with a broad band on the posterior margin of the head, a large spot on each side occupying the greater part of the mesonotum, the scutellum, the apex of the fifth ventral segment, and the legs dull ferruginous; the coxæ above black. Wings pale flavo-hyaline, nervures light testaceous, a faint cloud in the radial cell.

Length 14 mm., exp. 24 mm.

*Hab.* Mackay, Queensland (*Turner*); November.

CERCERIS LABECULATA, sp. n.

♀. Mandibles simple, blunt at the apex. The central lobe of the clypeus slightly convex and feebly porrected at the apex, narrowly emarginate anteriorly, the angles of the emargination produced into short teeth, narrowly truncate at the base, the length almost as great as the greatest breadth. Antennæ inserted high up on the front, nearer to each other than to the eyes, from which they are separated by a distance less than the length of the scape, which is short; the second and third joints of the flagellum nearly equal in length. The antennæ are separated from the base of the clypeus by a distance equal to two-thirds of the length of the clypeus. Inner margin of the eyes parallel; the posterior ocelli nearly as far from each other as from the eyes and nearer to the posterior margin of the head than to each other. Front sparsely and shallowly punctured, the carina between the antennæ not very strongly raised; vertex, mesonotum, mesopleuræ, and sides of the median segment coarsely punctured-rugose. Pronotum strongly rounded at the angles; the triangular space at the base of the median segment finely obliquely striated. First abdominal segment longer than broad, depressed at the base; the abdomen deeply and closely punctured; the pygidial area finely punctured, narrowly truncate at the apex, where it is only half as wide as at the base, rather broader in the middle than at the base.

Black; the mandibles at the base, the clypeus except the base and the extreme apical margin, the apex of the interantennal carina, the inner orbits of the eyes as high as the base of the antennæ very broadly, and the scape of the antennæ pale yellow; the posterior margin of the pronotum interrupted in the middle, the postscutellum, the apical margin of the first, second, and fourth abdominal segments, and a short vertical streak on the mesopleuræ, orange-yellow; the flagellum, tegulæ, scutellum, first abdominal segment, the middle of the second, the apex of the fifth, the pygidium, and the legs (except the coxæ, trochanters, and base of the femora) ferruginous. Wings hyaline, stained with fuscous along the costa, nervures black.

♂. As in the female, but the clypeus is rather longer and not porrect at the apex, and the apical half of the fifth abdominal segment is yellow.

Length, ♀ 9 mm., ♂ 8 mm.

*Hab.* Cairns, Queensland (*Turner*); December and January.

Somewhat related to *C. antipodes* Sm., but the head is much narrower and it is a much smaller species. The clypeus is also very different.

CERCERIS MULTIGUTTATA, sp. n.

♀. Clypeus more than twice as broad as long on the central lobe, short, slightly porrect at the apex, the apical margin very slightly and broadly emarginate, with four minute teeth. Antennæ inserted nearer to each other than to the eyes, separated from the eyes by a distance equal to three-quarters of the length of the scape and about the same distance from the base of the clypeus; the second joint of the flagellum twice as long as the first and half as long again as the third. The inner orbits of the eyes very nearly parallel; the posterior ocelli a little further from the eyes than from each other, and about the same distance from the posterior margin of the head as from each other. Head, thorax, and median segment coarsely and closely punctured, the frontal carina strongly raised between the antennæ. Pronotum broadly rounded anteriorly; scutellum very broadly truncate at the apex. Median segment with a shallow sulcus from the base to the apex, the triangular space at the base smooth and shining. Abdomen coarsely punctured, the fourth and fifth more shallowly than the basal segments; the first segment broader in the middle than long, slightly narrowed to the base and apex and obliquely depressed at the base, not as long as the second segment. Pygidial area finely rugose, twice as long as broad, the sides nearly parallel, broadly rounded at the apex.

Black; the mandibles at the base, clypeus, outer orbits of the eyes, the inner orbits broadly to a little above the base of the antennæ, a narrow line from the anterior ocellus to the base of the clypeus, an oblique spot on each side of the vertex, the pronotum narrowly interrupted in the middle, the tegulæ, a spot on the mesopleuræ, a large round spot on each side of the scutellum, the postscutellum, a small spot on each side on the triangular space at the base of the median segment, a large spot on each side at the apex extending on to the sides, the first abdominal segment except at the base, the apical half of the second segment, the three apical abdominal segments (narrowly black at the base), the tibiæ, tarsi, and the apex of the femora all dull brownish yellow. Wings hyaline, tinged with fulvous, darker on the costa; nervures ferruginous.

Length 14 mm.

The male is similar to the female, but the central lobe of the clypeus is nearly as long as broad, truncate at the apex, and the yellow spots on the vertex are smaller.

Length 9 mm.

*Hab.* Mackay, Queensland (*Turner*); October.

CERCERIS PRÆDURA, sp. n.

♀. Clypeus depressed on the anterior margin, widely and shallowly emarginate, the central lobe twice as broad at the apex as long. Antennæ inserted half as far again from the eyes as from each other, the distance between them and the eyes equal to a little less than the length of the scape, the distance from the base of the clypeus nearly equal to the length of the scape and the first joint of the flagellum combined; the second joint of the flagellum is twice as long as the first and not quite half as long again as the third. The inner orbits of the eyes nearly parallel; the posterior ocelli about one-third further from the eyes than from each other, but as far from each other as from the posterior margin of the head. Clypeus and front shallowly punctured, the rest of the insect, except the scutellum, postscutellum, base of the median segment, and pygidium, very coarsely and deeply punctured. Pronotum very broadly and feebly rounded anteriorly, less deeply punctured than the mesonotum; scutellum transverse, shallowly punctured; postscutellum smooth. The triangular space at the base of the median segment is divided by a sulcus and is deeply but rather sparsely punctured. First abdominal segment about half as long again as broad, not as long as the second segment; pygidial area granulate, elongate-oval, and very narrowly truncate at the apex.

Black; the mandibles (except at the apex), the clypeus, front below the base of the antennæ, scape, the carina between the antennæ, the pronotum broadly interrupted in the middle, the tegulæ, scutellum, postscutellum, the base of the second abdominal segment broadly, the third segment (with the base broadly black in the middle), the fifth segment above, and the legs (except the base of the coxæ) yellow; the flagellum, the apex of the first abdominal segment, the pygidium, and the posterior femora ferruginous. Wings hyaline, the radial cell and the apex beyond it clouded with fuscous; nervures fusco-ferruginous.

♂. As in the female, but the clypeus is longer, being as long as the breadth of the central lobe at the apex and without the shallow emargination, the base a little nearer to the antennæ than in the female. The scutellum is black; the first abdominal segment ferruginous; the apex of the fifth and the whole of the sixth yellow; the femora and the apex of the posterior tibiæ ferruginous.

Length, ♀ 7 mm., ♂ 6 mm.

*Hab.* Mackay, Queensland (*Turner*); April and May.

Allied to *C. prædator* Sm. from Celebes, but the sculpture is different, also the shape of the pygidial area.

CERCERIS VENUSTA Sm.

*Cerceris venusta* Sm. Ann. & Mag. Nat. Hist. (4) xii. p. 413, 1873.

*Hab.* Mackay and Cairns, Queensland (*Turner*).

A species very variable in colour. In specimens from Cairns the yellow markings are much reduced in size.

In the male the yellow marks on the median segment are sometimes wholly absent. The posterior ocelli in this species are very near together, about twice as far from the eyes as from each other.

CERCERIS AUSTRALIS Sauss.

*Cerceris australis* Sauss. Mém. Soc. Phys. & Hist. Nat. Geneva, xiv. p. 1, 1854.

*Hab.* Tasmania (*Saussure*); Melbourne to Mackay (*Turner*).

LIRIS HÆMORRHOIDALIS Fab.

*Liris magnifica* Kohl, Verh. zool.-bot. Ges. Wien, xxxiii. p. 356, 1883.

Though the colour of the pile on the female is more brilliant and the sculpture on the median segment rather stronger in females from Australia, I cannot detect any appreciable difference in the male.

*Hab.* Mackay to Cape York, Queensland (*Turner*).

LARRA NIGRIPES Sauss.

*Larrada nigripes* Sauss. Reise d. Novara, Zool. ii. p. 1, Hym. p. 74, n. 3, 1867.

*Larra psilocera* Kohl, Verh. zool.-bot. Ges. Wien, xxxiii. p. 355, 1883.

*Hab.* Tasmania (*Saussure*); Adelaide, S. Australia; Mackay, Queensland; Adelaide River, Northern Territory.

Saussure's description seems to have been taken from a headless specimen, but I think there is little doubt that it is identical with Kohl's species. It is allied to *L. mansueta* Sm. from New Guinea.

LARRA FEMORATA Sauss.

*Tachytes femoratus* Sauss. Mém. Soc. Phys. et Hist. Nat. Geneva, xiv. p. 1, p. 20, n. 9, 1854.

*Hab.* Sydney, N.S.W.; Mackay and Cairns, Queensland.

North Queensland specimens differ a little from southern ones in the shape of the pygidium, pronotum, and third cubital cell; the antennæ also are a little stouter. But the differences are very slight and do not seem sufficient to merit specific rank. *L. rufipes* Sm. from Celebes and *L. mendax* Sm. from Halmaheira are slight geographical variations of the same species.

LARRA SCELESTA, sp. n.

♀. Clypeus very finely and closely punctured, the anterior margin shining and very slightly and broadly rounded. Mandibles strongly notched on the outer margin, very blunt at the apex, with a fringe of short stiff hairs on the outer margin. Antennæ inserted nearly as far from each other as from the eyes; the second joint of the flagellum only a little more than half as long again as the first, the third intermediate in length between the first and second. Eyes separated on the vertex by a distance not quite half as great again as the length of the second joint of the flagellum. Labrum bilobed. Front smooth and shining, with a longitudinal furrow on each side, the anterior ocellus lying in a broad and shallow transverse depression; the posterior ocelli very indistinct, with an irregular, shining, transverse depression behind them; the vertex minutely punctured. Thorax very finely and closely punctured, the pronotum longer and less abruptly depressed than in *L. nigripes* Sauss. Median segment much longer than the mesonotum, longer than in *L. nigripes*, finely rugose, with a carina from the base to the apex, most strongly marked at the base, vertically truncate posteriorly, the face of the truncation finely rugulose, with a median sulcus. Abdomen shining, very shallowly and minutely punctured, the three basal segments with a band of white pubescence on the sides; the pygidial area broadly triangular, rather sparsely but deeply punctured. Anterior tibiæ without spines. The second cubital cell is as long as the third on the radial nervure; the third is nearly three times as long on the cubital as on the radial nervure, the third transverse cubital is oblique and almost straight.

Black; the mandibles and the spines of the tibiæ fusco-ferruginous; tegulæ testaceous. Wings fusco-hyaline, faintly iridescent; nervures black.

Length 14 mm.

*Hab.* Mackay, Queensland (*Turner*); Adelaide River, Northern Territory (*J. J. Walker*).

Differs from *L. nigripes* in the shorter antennæ with differently proportioned joints, in the much closer approach of the eyes on the vertex, the longer pronotum and median segment, and the broader pygidium. The pronotum and abdomen differ markedly from those of *L. australis*, with which it agrees in the smooth anterior tibiæ, which are heavily spined in *L. nigripes*.

LARRA AUSTRALIS Sauss.

*Tachytes australis* Sauss. Mém. Soc. Phys. et Hist. Nat. Geneva, xiv. p. 19, 1854.

If my identification of this species is correct it is a *Larra*.

*Hab.* S. Australia; W. Australia.

LARRA PACIFICATRIX, sp. n.

♀. Clypeus very broadly truncate at the apex, opaque and almost smooth, with a row of large punctures before the apical margin. Second joint of the flagellum more than half as long again as the first, the second and third subequal and rather shorter than the fourth. Head subopaque, almost smooth, the front shining, the margins of the eyes broadly bordered with brilliant golden pubescence; the eyes separated on the vertex by a distance equal to three-quarters of the length of the second joint of the flagellum. Pronotum depressed below the level of the mesonotum, much higher in the middle than at the sides, almost vertical. Mesonotum and scutellum shining and almost smooth, only microscopically but very closely punctured; a large patch of short golden pubescence on the mesopleuræ below the base of the anterior wings. Median segment longer than broad, opaque, rather indistinctly transversely striated, the striæ more obscure towards the apex, a median carina from the base reaching beyond the middle, vertically truncate posteriorly, the face of the truncation coarsely transversely striated, with a deep median sulcus. Abdomen smooth and shining, highly polished, the pygidial area closely punctured; the second ventral segment strongly convex, flattened on the sides at the base and with a longitudinal carina from the base not reaching the middle, the apex of the first segment narrowly obliquely striated. The second cubital cell is pointed on the radial nervure, and about equal to the third in length on the cubital nervure; the two recurrent nervures are received before the middle of the second cubital cell, the first much further from the base of the cell than from the second. The tarsal ungues are long.

Black; the clypeus, scape, first joint of the flagellum, mandibles, and legs ferruginous; tegulæ testaceous. Wings fusco-hyaline, with a slight purple gloss and tinted with yellow; nervures black.

Length 17 mm., exp. 28 mm.

*Hab.* New Hebrides.

Type in Oxford University Museum ex coll. Saunders.

This species is very near *Notogonia.*

NOTOGONIA CHRYSONOTA Sm.

*Larrada chrysonota* Sm. Trans. Ent. Soc. London, p. 304, 1869.

*Larrada crassipes* Sm. Ann. & Mag. Nat. Hist. (4) xii. p. 294, 1873.

*Larra chrysonota* Kohl, Verh. zool.-bot. Ges. Wien, xxxiv p. 242, 1884.

*Hab.* Champion Bay, W. Australia; Adelaide, S. Australia.

NOTOGONIA REGINA, sp. n. (Plate XXVI. fig. 7.)

♀. Clypeus opaque, shining on the apical margin, which is slightly depressed, almost straight, very narrowly and shallowly emarginate in the middle; a carina from the base not reaching the apex. Head and thorax opaque, the front strongly raised on the inner orbits of the eyes, with a longitudinal median sulcus; the anterior ocellus lying in a broad depression which almost reaches the eyes; on the vertex the eyes are separated by a distance less than twice as great as the length of the first joint of the flagellum. The second joint of the flagellum is more than twice as long as the first and nearly half as long again as the third; the fourth and fifth joints about equal to the third. Pronotum depressed very much below the mesonotum, very steeply sloped anteriorly; mesonotum with a rather broad median depression from the anterior margin to the middle. Median segment a little longer than the mesonotum, nearly half as long again as broad, obscurely transversely striated, the striæ almost obsolete at the apex, vertically truncate posteriorly, the face of the truncation more strongly transversely striated, the sides of the segment indistinctly striated. Abdomen subopaque, the apical margins of the segments broadly depressed. Pygidial area pubescent, with an obscure median carina, the lateral carinæ strongly raised, separated at the apex by a distance not quite equal to the length of the first joint of the flagellum. Anterior tibiæ smooth, intermediate and posterior tibiæ with a double row of three or four widely separated and feeble spines; tarsi spinose, the ungues simple and very long.

Black; the antennæ orange; the pile on the head and abdomen silvery, the abdominal segments with broad bands of pile on the apical margin; a pale golden sheen on the pile on the front and a small patch of golden pubescence at the apex of the posterior tibiæ. Wings fusco-hyaline, the apex of the anterior wings and a broad band across beyond the middle fuscous, the apex of the posterior wings broadly pale fuscous. Nervures black; testaceous at the apex of the radial and third cubital cells.

The recurrent nervures are both received before the middle of the second cubital cell, the distance between them not exceeding one-sixth of the length of the cell on the cubital nervure. The third cubital cell is about four times as long on the cubital as on the radial nervure.

Length 19 mm., exp. 27 mm.

*Hab.* Cairns, Queensland (*Turner*); December to March. Mackay, Queensland; October. Cape York, Queensland; May.

The specimen from Cape York has the wings fuscous from the base, with a large hyaline patch near the apex of the anterior wings; the four apical joints of the flagellum are black and the spines on the tibiæ stronger.

The specimens from Mackay are smaller, measuring only 12–14 mm., the striæ on the median segment are almost entirely absent, except on the face of the truncation, and there is a delicate longitudinal carina from the base almost reaching the apex. The six apical joints of the flagellum are black.

NOTOGONIA BASILISSA, sp. n.

♀. Mandibles notched rather deeply on the outer margin; the clypeus opaque, very minutely punctured, clothed with rather coarse silvery pubescence, the apical margin transverse, very feebly emarginate in the middle and broadly smooth and shining. The second joint of the flagellum is a little less than twice as long as the first, a little longer than the third, and a little shorter than the fourth. Head opaque, the front clothed with rather coarse silvery pubescence; the eyes separated on the vertex by a distance rather less than the third joint of the flagellum. Pronotum steeply, but not nearly vertically sloped, higher in the middle than at the sides; the mesonotum broadly but shallowly depressed anteriorly, with sparse pubescence of a dull silver colour on the sides and in the depression. Median segment opaque, with a short longitudinal carina from the base not reaching the middle, very finely and closely punctured and very sparsely covered with short grey pubescence, a few short transverse striæ near the apical angles, the face of the posterior truncation very shallowly and irregularly transversely striated, with a deep and broad median sulcus, the sides of the segment almost smooth, delicately obliquely striated at the base; the segment much longer than broad. The four basal abdominal segments with broad bands of rather dull silvery pubescence on the apical margin; the pygidial area rounded at the apex, rather broad, and clothed with shining whitish pubescence; the second and third ventral segments convex, the second subcarinate at the base. The distance between the two recurrent nervures is less by about one-third than that between the first recurrent nervure and the base of the second cubital cell; the third cubital cell is more than half as long again as the second on the cubital nervure.

Black; the five or six apical joints of the flagellum, the apex of the joints of the tarsi, and the whole of the apical joint beneath fulvous; tegulæ testaceous. Wings subhyaline, nervures fusco-ferruginous.

Length 13 mm.

*Hab.* Mackay, Queensland (*Turner*); March.

NOTOGONIA AGITATA, sp. n.

♀. Clypeus opaque, clothed with silvery pubescence, the apical margin broadly smooth and shining, transverse. Second joint of the flagellum a little more than half as long again as the first, the second and third subequal, shorter than the fourth. Head opaque, the front clothed with short silvery pubescence; the eyes separated on the vertex by a distance equal to three-quarters of the length of the second joint of the flagellum. Mesonotum closely and microscopically punctured, longitudinally and rather broadly depressed in the middle anteriorly, with a short and fine longitudinal sulcus in the depression, the disc with sparse and very short cinereous pubescence, the sides with closer pubescence of a silvery colour slightly tinged with pale golden. Median segment opaque, very finely granulated, much longer than broad; the surface of the posterior truncation strongly transversely striated, with a deep median sulcus; a very obscure longitudinal carina from the base of the segment not reaching the middle. Abdomen subopaque; the four basal segments with broad apical bands of silvery pubescence; the pygidial area narrowly truncate at the apex, clothed with silvery pubescence; the second ventral segment smooth and convex, with a longitudinal carina on the basal third. The third cubital cell is half as long again as the second on the radial nervure and as long as the second on the cubital nervure; the two recurrent nervures are received by the second cubital cell before the middle, the first more than twice as far from the base of the cell as from the second.

Black; the scape beneath fusco-ferruginous; the tegulæ and the apical margin of the fifth abdominal segment testaceous, the tarsi beneath, the apical joint of the tarsi above, and the tarsal ungues ferruginous. Wings hyaline, the outer margin bordered with pale fuscous, iridescent; nervures fusco-ferruginous.

Length 10-11 mm.

*Hab.* Mackay and Cairns, Queensland (*Turner*); December to May.

NOTOGONIA SERENA, sp. n.

♀. Mandibles very feebly notched on the outer margin; the clypeus very broadly rounded at the apex, clothed densely with rather coarse silver-grey pubescence, almost flat. Scape clothed with short, shining pubescence, the apex beneath smooth and shining; the first joint of the flagellum half as long as the second, the fourth a little longer than the third and about equal in length to the second. Eyes separated on the vertex by a distance equal to the length of the third joint of the flagellum. Head opaque; the pubescence on the front silver-grey and rather coarse, that on the broad depressed space round the anterior ocellus pale golden-brown. Pronotum very sharply sloped, almost vertical, much higher in the middle than at the sides; mesonotum very minutely punctured-rugulose; clothed with pubescence, which is rather coarse and silver-grey flushed with pale golden on the sides, darker and shorter on the middle; longitudinally depressed from the middle to the anterior margin. Median segment longer than broad, with a delicate longitudinal carina from the base to the middle, rather obscurely transversely striated, the striæ most distinct at the base and the sides, more opaque than the thorax, vertically truncated posteriorly, the face of the truncation indistinctly transversely striated, with a low carina from the base not quite reaching the apex, the apical margin of the segment at the base of the truncation slightly raised. Abdomen opaque, pruinose, the apical margins of the four basal segments with broad bands of silvery pubescence, which is coarser on the sides than in the middle; the pygidial area more than twice as long as the breadth at the base, about half as wide at the broadly rounded apex as at the base, clothed with rather coarse golden pubescence. The two recurrent nervures are received very close together before the middle of the second cubital cell, the first is slightly curved outwardly near its apex, the second very strongly curved outwardly near its base; the second cubital cell is half as long on the radial nervure as the third.

Black; the apex of the fifth abdominal segment and of the pygidium testaceous, the tegulæ testaceous brown. Wings hyaline, the apex very faintly tinged with fuscous; nervures fusco-ferruginous.

Length 15 mm.

*Hab.* Mackay, Queensland (*Turner*); April.

NOTOGONIA OBLIQUETRUNCATA, sp. n.

♀. Mandibles rather deeply incised on the outer margin; the clypeus opaque at the base, with a carina from the base to the middle, clothed with short, fine, silvery pubescence, very broadly rounded or almost truncate at the apex, the apical margin broadly smooth and shining. The second joint of the flagellum equal in length to the third and more than twice as long as the first. Eyes separated on the vertex by a distance equal to the length of the second and half of the first joints of the flagellum. Head opaque, the front clothed with very short silvery pubescence. Pronotum very steeply sloped, much higher in the middle than at the sides; the mesonotum microscopically punctured, depressed in the middle anteriorly, the sides and posterior margin clothed with very pale golden pubescence. Median segment opaque, with short transverse striæ at the apical angles, vertically truncated posteriorly, the face of the truncation transversely striated, with a longitudinal sulcus from the base to the apex. Abdomen subopaque, the apical margins of the four basal segments with bands of silver-grey pubescence, broadly interrupted in the middle on the fourth; the pygidial area almost pointed at the apex, long and narrow, shining and sparsely punctured at the base, finely punctured and clothed with short, pale, fulvous pubescence at the apex. The first recurrent nervure is received almost as far from the second as from the base of the second cubital cell; the second is moderately rounded outwardly. The second cubital cell is much longer than the third on the cubital nervure and equal to it in length on the radial nervure, the third transverse cubital nervure oblique and scarcely curved, the radial cell short and broad, obliquely truncate at the apex.

Black; the mandibles, the scape beneath, and the anterior femora and tibiæ beneath fusco-ferruginous, the apical margin of the abdominal segments narrowly testaceous. Wings hyaline, faintly tinted with fuscous at the apex, most strongly in the radial cell; nervures black, the stigma fusco-ferruginous.

Length 10 mm.

*Hab.* Port Darwin (*Turner*); November.

NOTOGONIA RETIARIA, sp. n.

♀. Mandibles shining, deeply notched on the outer margin. Clypeus transverse, clothed with silvery pubescence, almost flat, the centre very slightly convex, the anterior margin bare and shining, feebly produced in the middle, and narrowly and shallowly emarginate. Antennæ inserted at the base of the clypeus, a little nearer to each other than to the eyes; the second joint of the flagellum fully twice as long as the first, slightly longer than the third, about equal in length to the fourth, but a little shorter than the fifth. Eyes separated on the vertex by a distance equal to the length of the fifth joint of the flagellum. Head subopaque, very minutely and closely punctured; the front with a longitudinal depression on each side, the orbit of the eyes elevated, the anterior ocellus lying in a broad depression, the posterior ocelli indistinct, with a triangular depression behind them. Pronotum higher in the middle of the posterior margin than at the sides, the middle on a level with the mesonotum, steeply but not vertically sloped anteriorly. Mesonotum microscopically and very closely punctured and opaque, the mesopleuræ and scutellum subopaque, the former more distinctly punctured. Median segment scarcely longer than the mesonotum, a little longer than broad, coarsely reticulate, with an ill-defined carina from the base to the apex, sharply but not quite vertically truncate posteriorly, the face of the truncation transversely striated, with a median carina. Abdomen shining, microscopically punctured, the three basal segments with a band of white pubescence on the apical margin, interrupted on the basal segment; the pygidial area elongate triangular, narrowly truncate at the apex. The sides of the median segment are finely obliquely striated. The legs are slender, the anterior tibiæ unarmed, and the tarsal ungues long. The two recurrent nervures are received very close together, before the middle of the second cubital cell. The second cubital cell is at least half as long again on the radial nervure as the third, the second transverse cubital nervure is slightly curved inwards, the third is oblique and straight.

Black; the mandibles fuscous; the pubescence on the pygidial area very pale fulvous. Wings light fusco-hyaline, nervures black, the tegulæ fuscous.

Length 9 mm.

*Hab.* Perth, W. Australia.

Type in British Museum.

NOTOGONIA COMMIXTA, sp. n.

♀. Clypeus opaque and very finely punctured at the base, with a delicate carina not reaching the apex, the apex broadly smooth and shining, the margin very broadly rounded, with a very narrow and shallow emargination in the middle. Antennæ rather stout, the second joint of the flagellum twice as long as the first and about one-quarter longer than the third. Head opaque, the front and the base of the clypeus clothed with short fine silver pubescence, which is only visible in certain lights; the eyes separated on the vertex by a distance equal to one-third more than the length of the first joint of the flagellum. Pronotum very steeply sloped, not very strongly raised in the middle; the mesonotum and scutellum subopaque, very closely and microscopically punctured, a very short, impressed, longitudinal line on each side of the mesonotum twice as far from the middle as from the tegulæ. Median segment a little longer than broad, rather indistinctly transversely striated, the striæ more distinct at the base than at the apex, with an obscure carina from the base to the apex; the posterior truncation finely transversely striated, with a deep median sulcus. Abdomen subopaque, the three basal segments with bands of dull silvery pubescence on the apical margin; the pygidial area rather broad at the base, narrowly rounded at the apex, clothed with pale fulvous pubescence; the apex of the first ventral segment finely obliquely striated, the second and third sparsely clothed with very short, fine, grey pubescence. The third cubital cell is nearly twice as long as the second on the radial nervure and a little longer than the second on the cubital nervure; both recurrent nervures are received before the middle of the second cubital cell, the first more than twice as far from the base of the cell as from the second.

Black; the tarsal ungues fusco-ferruginous. Wings fusco-hyaline, faintly flushed with opalescent blue; nervures black.

Length 13 mm.

*Hab.* Cairns, Queensland (*Turner*); February to May.

The mesonotum is only very slightly depressed in the middle on the anterior margin.

NOTOGONIA ABBREVIATA, sp. n.

♀. Mandibles very shallowly notched on the outer margin; the clypeus opaque, very finely and closely punctured, the apical margin transverse and strongly depressed in the middle, the base bare, the middle with rather long, sparse, silvery pubescence changing to fulvous at the apex. Scape with a little short white pubescence beneath; the first joint of the flagellum half as long as the second, the fourth slightly longer than the second or third, which are nearly equal in length to each other. Head opaque, the front clothed with silvery pubescence; the eyes separated on the vertex by a distance equal to three-quarters of the length of the second joint of the flagellum. Pronotum almost vertical, much higher in the middle than at the sides; mesonotum very broadly and shallowly depressed in the middle anteriorly, opaque and very minutely punctured; the pubescence short, sparse and cinereous, that on the mesopleuræ also cinereous, with a patch of silver-white pubescence below the base of the anterior wings. Median segment more opaque than the mesonotum, very shallowly and obscurely transversely striated, the striæ only visible in a strong light, with a rather shallow sulcus from the base to the apex, vertically truncate posteriorly, with a deep longitudinal sulcus on the face of the truncation, the segment is as broad at the base as long, narrowed posteriorly. Abdomen opaque, with broad bands of silvery pubescence on the apical margins of the three basal segments; the pygidial area rather broadly rounded at the apex, more than twice as broad at the base as at the apex, clothed with sparse, stiff, black pubescence. The second ventral segment has a longitudinal carina from the base to the middle. The two recurrent nervures are received very near together, just beyond one-third from the base of the second cubital cell; the third cubital cell is longer by one-third than the second on the radial nervure.

Black. Wings light fusco-hyaline, nervures black.

Length 16 mm.

*Hab.* Cairns, Queenslaud (*Turner*); February.

The median segment is shorter and broader than in most species of *Notogonia*, but otherwise it shows all the characteristic points of the genus.

TACHYTES RUBELLUS, sp. n.

♂. Clypeus closely punctured, depressed and shining at the apex, the margin slightly recurved. Head closely and very minutely punctured; the front covered with shining white pubescence, a deep longitudinal sulcus on the vertex broadened just behind the posterior ocelli into a small triangular depression. Eyes convergent above, separated on the vertex by a distance about equal to the length of the first and second joints of the flagellum combined; the third joint of the flagellum of almost the same length as the second. Thorax very minutely and closely punctured, the sides thinly clothed with white pubescence; the mesonotum depressed in the middle anteriorly; the median segment about one-fourth shorter than the mesonotum, narrowed and truncate posteriorly, a deep longitudinal sulcus on the surface of the truncation. Abdomen shining, minutely punctured; the apical margin of the segments with interrupted bands of white pubescence. The mesopleuræ, the sides of the median segment, and the femora beneath with silvery pubescence.

Black; the mandibles, the anterior tibiæ beneath, the anterior tarsi, the three or four apical joints of the intermediate and posterior tarsi, the spines of the tibiæ, and a spot at the apex of the intermediate and posterior tibiæ ferruginous; the tegulæ testaceous; the abdomen entirely ferruginous red, paler on the apical margin of the segments.

Length 7 mm.

*Hab.* Port Darwin (*Turner*); December.

TACHYTES FORMOSISSIMUS, sp. n. (Plate XXVI. fig. 6.)

♀. Head, thorax, and median segment densely covered with shining golden pubescence; the clypeus transverse and finely punctured, the anterior margin shining and without pubescence. A longitudinal sulcus on the vertex behind the ocelli; the eyes convergent above, separated on the vertex by a distance slightly exceeding the length of the two basal joints of the flagellum. Pronotum depressed below the mesonotum, which is depressed in the middle of the anterior margin; scutellum short, broadly truncate at the apex. Median segment about one-third shorter than the mesonotum, narrowed posteriorly and truncate, a deep median sulcus starting from just above the base of the truncation and continued along its surface to the apex. Abdomen extremely minutely punctured, without pile.

Head and thorax black; the apex of the clypeus, the mandibles, and the scape of the antennæ ferruginous brown; the scutellum and median segment fusco-ferruginous; abdomen and legs light testaceous red, the apical margin of the abdominal segments paler; pubescence golden. Wings hyaline; nervures black, testaceous red at the base and on the costa.

Length 10 mm.

*Hab.* Mackay, Queensland (*Turner*); February.

This beautiful species is allied to *fervida* Sm., but is much smaller and less stoutly built.

TACHYTES APPROXIMATUS, sp. n.

♀. Clypeus closely punctured, transversely depressed and truncate on the apical margin; the clypeus and front clothed with pale shining pubescence, with a faint golden sheen. Antennæ inserted nearer to each other than to the eyes; the second joint of the flagellum about three times as long as the first and equal in length to the first and third combined, the fourth, fifth, and sixth equal in length to each other, each slightly shorter than the third. Eyes separated on the vertex by a distance about equal to the length of the third joint of the flagellum; the vertex very minutely punctured, with a fine longitudinal sulcus from the posterior ocelli to the posterior margin of the head. Pronotum very much depressed and very small; the thorax and median segment very minutely punctured; a broad line of short, pale golden pubescence on the sides of the mesonotum, very narrowly continued on the posterior margin, with a quadrate, narrowly divided patch on each side of the middle of the anterior margin; the pubescence on the postscutellum and the sides of the median segment pale and shining, the segment only a little more than half as long as the mesonotum, steeply but not quite vertically sloped posteriorly, with a median sulcus on the posterior face. Abdomen shining, finely punctured and pubescent, the pubescence short, thin, and dark, the apical margins of the four basal dorsal segments with a broad band of pale and somewhat obscure golden pubescence; the pygidial area long and not very narrow, narrowly rounded at the apex and clothed with brilliant golden pubescence. The basal joint of the anterior tarsus with five spines on the outer margin. The third cubital cell is a little longer than the second on the radial nervure, and about as long as the second on the cubital nervure, narrow and much curved.

Black; the mandibles fusco-ferruginous; the tegulæ, tibiæ, tarsi, the apex of the femora, and the apical margin of the fifth abdominal segment very narrowly ferruginous. Wings hyaline, nervures ferruginous.

♂. As in the female, but the pubescence on the head and thorax is longer and duller, the anterior margin of the clypeus is more rounded, the apical margin of the abdominal segments is broadly dull ferruginous with the band of pubescence as in the female on the four basal segments, the pubescence on the apical segment is whitish, and the posterior femora are black at the base only. The abdomen is more closely punctured than in the female. The eyes are yellowish green in both sexes in life.

Length, ♀ 14 mm., ♂ 13 mm.

*Hab.* Mackay, Queensland (*Turner*); February and March.

### *Key to the Australian Species of* Tachysphex.

| | |
|---|---|
| A. Abdomen wholly black. | |
| *a*. Tibiæ and tarsi light ferruginous | *T. imbellis.* |
| *b*. Tibiæ and tarsi almost entirely black | |
| $a^2$. Abdomen opaque, covered with very short pubescence. | |
| $a^3$. Mesonotum not visibly punctured; abdomen subopaque | *T. fortior.* |
| $b^3$. Mesonotum very distinctly punctured; abdomen opaque | *T. mackayensis.* |
| $b^2$. Abdomen more or less shining, pubescent on the apical margin of the segments only. | |
| $a^3$. Dorsal surface of the median segment longitudinally striated | *T. walkeri.* |
| $b^3$. Dorsal surface of the median segment not striated. | |
| $a^4$. Thorax and median segment strongly pubescent. | *T. pilosulus.* |
| $b^4$. Thorax and median segment not pubescent. | |
| $a^5$. Median segment longer than the mesonotum... | *T. tenuis.* |
| $b^5$. Median segment not longer than the mesonotum. | |
| $a^6$. Mesonotum subopaque | *T. debilis.* |
| $b^6$. Mesonotum shining. | |
| $a^7$. Pronotum sharply sloped. | |
| $a^8$. Second joint of the flagellum much longer than the third. Length 8 mm.. | *T. pacificus.* |
| $b^8$. Second joint of flagellum shorter than the third. Length 13 mm. | *T. nigerrimus* Sm. |
| $b^7$. Pronotum gradually sloped. | |
| $a^8$. Head shining, almost smooth. Wings and antennæ short | *T. pugnator.* |
| $b^8$. Head opaque, finely punctured. Wings and antennæ of moderate length | *T. hypoleius* Sm. |
| B. Two basal segments of abdomen ferruginous red | *T. truncatifrons.* |

TACHYSPHEX TRUNCATIFRONS, sp. n.

♀. Mandibles very strongly incised on the outer margin. Clypeus broadly truncate on the apical margin, slightly convex in the middle, obliquely and broadly triangularly truncate from the middle to the apex, the base opaque and indistinctly punctured, the surface of the truncation shining, with a few scattered punctures. Antennæ inserted as far from each other as from the eyes; the second, third, and fourth joints of the flagellum about equal in length, each at least three times as long as the first joint

Eyes separated on the vertex by a distance equal to the length of the first two joints of the flagellum; the posterior ocelli situated on a convexity, divided by a fine longitudinal sulcus, with a rather large, shallow, subtriangular depression on the vertex behind them. Head opaque, the vertex very finely and closely punctured, the depression behind the ocelli smooth and shining, the front very delicately rugulose, slightly raised in the middle above the base of the antennæ, where it is divided by a longitudinal sulcus; the front almost flat. Thorax subopaque, very closely and delicately punctured; the pronotum not very much below the level of the mesonotum, and very gradually sloped anteriorly. Median segment opaque, a little shorter than the mesonotum, very finely rugulose, truncate posteriorly, with a deep median sulcus on the face of the truncation. Abdomen shining and almost smooth, the three basal segments depressed on the apical margin, narrowly at the sides, broadly in the middle; the pygidial area elongate and pointed, shining, with scattered punctures. The tibiæ are very feebly spined; the comb of the anterior tarsi is long, but thin. The third transverse cubital nervure is rather feebly curved.

Black; the apical joint of the tarsi fusco-ferruginous; the two basal abdominal segments above and beneath bright ferruginous red. Wings hyaline stained with fuscous, nervures fuscous.

Length 9 mm.

*Hab.* Queensland.

Type in Oxford University Museum ex coll. Saunders.

Allied to *T. rufo-niger* Bingh. from India.

TACHYSPHEX IMBELLIS, sp. n.

♀. Mandibles incised on the outer margin; clypeus shining, very sparsely punctured, the punctures large, feebly convex, the apical margin subtruncate. Head, thorax, and abdomen shining and almost smooth; a very delicate longitudinal sulcus reaching from the anterior ocellus nearly to the base of the clypeus; the posterior ocelli subovate, situated on a very slight elevation, with a small and fairly deep depression on the vertex behind them; the eyes separated on the vertex by a distance about equal to the length of the first two joints of the flagellum. Antennæ inserted nearer to each other than to the eyes; the second, third, and fifth joints of the flagellum nearly equal in length, each less than twice as long as the first, the fourth joint very slightly longer than the others. Pronotum depressed below the mesonotum, a little more than half as wide as the head. Median segment at the base a little more than half as broad again as long, at the apex only as broad as long, opaque and finely shagreened, almost vertically truncate posteriorly, the face of the truncation finely and obscurely transversely striated with a deep rounded depression at the base. The apical segment of the abdomen shining, finely and very sparsely punctured, pointed at the apex. The comb of the anterior tarsi is very poorly developed, the setæ being very few and far apart. The third cubital cell is not much extended on the cubital nervure, being more than half as long on the radial as on the cubital nervure; the radial cell is short, not more than equal to the length of the second cubital cell on the cubital nervure.

Black; the mandibles except at the apex, the tegulæ, tibiæ, tarsi, and the apex of the femora light ferruginous, the scape of the antennæ beneath fuscous. Wings hyaline, nervures fuscous.

A little grey pubescence on the sides of the abdominal segments, otherwise bare.

Length 6 mm., exp. 10 mm.

*Hab.* Mackay, Queensland (*Turner*); November.

TACHYSPHEX FORTIOR, sp. n.

♀. Clypeus shining, strongly but sparsely punctured at the apex, moderately convex at the base, then almost vertically depressed, and subtruncate on the apical margin. Antennæ inserted as far from each other as from the eyes; the second joint of the flagellum twice as long as the first, a little shorter than the third or fourth and about equal to the fifth. Eyes separated on the vertex by a distance scarcely greater than the length of the third joint of the flagellum. Head opaque, very minutely punctured; the front very feebly convex, divided by a rather strong longitudinal sulcus which reaches the anterior ocellus and is continued behind it to the posterior margin of the head. Posterior ocelli subovate, situated on a convexity, with a small deep depression behind them. Pronotum depressed below the mesonotum, the slope almost vertical; mesonotum subopaque, nearly twice as broad as long. Median segment opaque, shorter than the mesonotum, finely shagreened, vertically truncate posteriorly, the face of the truncation rather finely transversely striated, with a median sulcus. Abdomen subopaque; the apical margin of the segments feebly depressed, very broadly in the middle, and thinly clothed with grey pubescence; the apical segment smooth, with a few scattered punctures near the base, subcarinate longitudinally in the middle and pointed at the apex. Tarsi strongly spinose, the comb of the anterior tarsi well developed; the legs stout. The first recurrent nervure is received almost as far from the second as from the base of the second cubital cell; the third cubital cell is strongly curved on the outer margin and reaches on the cubital nervure nearly two-thirds of the way from the apex of the second cubital cell to the outer margin of the wing.

Black; the pubescence greyish white; the tegulæ, the anterior tarsi, the two apical joints of the posterior and intermediate tarsi, and the extreme base of the tibiæ ferruginous.

Length 10 mm.

*Hab.* S.W. Australia (*Du Boulay*).

Type in British Museum.

Allied to *T. debilis* described in this paper, but is a much more stoutly built insect and the legs are stronger and much more spinose.

TACHYSPHEX MACKAYENSIS, sp. n.

♀. Clypeus finely punctured at the base, very coarsely and closely punctured, the apical margin very narrowly depressed and shining, very narrowly emarginate in the middle. Antennæ inserted a little further from the eyes than from each other; the second joint of the flagellum twice as long as the first, but a little shorter than the third or fourth. Eyes separated on the vertex by a distance slightly greater than the length of the third joint of the flagellum; the posterior ocelli situated on a convexity with a small depression behind them. Head opaque, very finely and shallowly punctured; the clypeus at the base and the front below the base of the antennæ closely, the front above the base of the antennæ very sparsely, clothed with moderately long white pubescence. Thorax very closely punctured; the pronotum strongly depressed below the level of the mesonotum, almost vertical, a little higher in the middle than at the sides. Median segment almost as long as the mesonotum, narrowed towards the apex and vertically truncate posteriorly, opaque and finely punctured-rugose, with a little scattered pubescence; the face of the truncation finely transversely striated, with a deep median sulcus not reaching the apex. Abdomen opaque, covered with extremely short grey pubescence, which is rather longer and whiter on the depressed apical margin of the segments; the pygidial area shining, with large and scattered punctures, almost pointed and rather narrow; the ventral segments smooth and shining. The posterior tibiæ are rather strongly spined, the comb of the anterior tarsi is long but rather thin. The third cubital cell is very long on the cubital nervure, reaching nearly two-thirds of the way from the apex of the second cubital cell to the margin of the wing; the third transverse cubital nervure is much curved; the second cubital cell is longer than the third on the radial nervure, but scarcely as long on the cubital.

Black; the tegulæ and the comb of the anterior tarsi testaceous.

Length 12 mm., exp. 19 mm.

*Hab.* Mackay, Queensland (*Turner*).

Allied to *T. fortior* described above, but the eyes are further apart on the vertex, and the sulcus on the vertex is absent, the mesonotum is punctured, the median segment longer and more strongly narrowed posteriorly, the pygidium narrower, and the posterior tibiæ more strongly armed.

TACHYSPHEX WALKERI, sp. n.

♀. Clypeus shining, sparsely punctured, very finely at the base, more coarsely at the apex, obliquely depressed from the middle to the apex, where it is broadly truncate. Antennæ long and slender, nearly as long as the head, thorax, and median segment combined, inserted further from the eyes than from each other; the second joint of the flagellum more than twice as long as the first and about one-quarter shorter than the third. Eyes separated on the vertex by a distance not quite equal to the length of the second joint of the flagellum; the posterior ocelli subovate, situated on a convexity, with a small triangular depression on the vertex behind them. Head opaque, the vertex smooth, the front slightly convex, finely shagreened, with a delicate, longitudinal, median sulcus; the space round the base of the antennæ clothed with short silver pubescence. Thorax subopaque, the scutellum shining; the pronotum much depressed below the mesonotum, gradually sloped anteriorly. Median segment as long as the mesonotum, narrowed posteriorly, opaque and rather irregularly longitudinally striated, the sides finely obliquely striated, vertically truncate posteriorly, the face of the truncation transversely striated, with a median sulcus. Abdomen microscopically punctured, the apical margin of the three basal segments slightly depressed, with a band of short, rather thin, silver pubescence; the pygidial area polished, with a few fine and scattered punctures, elongate triangular. The posterior tibiæ very feebly spined, the comb of the anterior tarsi only feebly developed. Third cubital cell narrow, the third transverse cubital nervure rather strongly curved inward; the second cubital cell much shorter than the third on the radial nervure, the radial nervure strongly continued, the appendiculate cell being clearly defined and reaching nearer to the outer margin than the cubital nervure.

Black; the scape beneath fusco-ferruginous; the apex of the tegulæ and the comb of the anterior tarsi testaceous.

Length 7 mm.

*Hab.* Sand Islet, Long Reef, N.W. Australia (*Walker*); June.

Type in British Museum.

TACHYSPHEX PILOSULUS, sp. n.

♀. Clypeus very broadly rounded anteriorly, clothed with dark grey pubescence, changing to silver in some lights, the apical margin bare and recurved, with a shining transverse depression before it. Antennæ inserted about half as far again from the eyes as from each other; the second joint of the flagellum twice as long as the first and about equal in length to the third and the fourth singly. Eyes separated on the vertex by a distance scarcely exceeding the length of the second joint of the flagellum; the posterior ocelli oblong and oblique, situated on a convexity, with no depression or sulcus on the vertex behind them. Front rather strongly convex, clothed with long and rather close silver-grey pubescence, a very fine longitudinal sulcus below the anterior ocellus. The whole head opaque, very minutely punctured. Pronotum very much depressed below the level of the mesonotum, very steeply sloped anteriorly. Thorax and median segment finely shagreened, opaque, with sparse and rather long cinereous pubescence; the mesonotum large, about half as long again as the median segment, which is scarcely narrowed posteriorly, and vertically truncate, the surface of the truncation indistinctly transversely striate-rugulose, with an almost obsolete median sulcus. Abdomen subopaque, the two apical segments and the whole ventral surface shining, the basal segment with sparse and rather long grey pubescence at the base, the three basal segments with a broad band of shining silvery pubescence faintly flushed with golden on the apical margin, the fourth segment with a similar band on the sides only. Pygidial area elongate-triangular, very narrowly truncate at the apex, microscopically punctured and less polished than the fifth segment. The comb on the anterior tarsi is very long. The first recurrent nervure is received at the same distance from the base of the second cubital cell as from the second recurrent nervure, which is received just beyond the middle of the cell. The second cubital cell is about half as long again as the third on the radial nervure; the third is much produced on the cubital nervure, reaching two-thirds of the way from the apex of the second to the margin of the wing; the second and third transverse cubital nervures are both strongly curved. The cubital nervure of the posterior wings branches off immediately beyond the apex of the anal cell.

Black; the spines of the tibiæ and tarsi whitish; the tegulæ and the comb of the anterior tarsi testaceous. Wings hyaline; nervures ferruginous at the base, fuscous at the apex. Anterior tarsi fusco-ferruginous.

♂. Similar, but slenderer, the head and thorax less strongly pubescent, the eyes a little nearer together on the vertex, and the apical abdominal segments more opaque. The eyes in life are bright green.

Length, ♀ 11 mm., ♂ 10 mm.

*Hab.* ♀, Cape York, Queensland; ♂, Cairns and Mackay, Queensland (*Turner*); November to April.

TACHYSPHEX TENUIS, sp. n.

♀. Clypeus shining, almost smooth at the base, punctured near the apex, moderately convex, the apical margin transversely depressed and shallowly emarginate in the middle. Antennæ inserted nearer to each other than to the eyes; the second joint of the flagellum less than twice the length of the first and distinctly shorter than the third or fourth. Eyes separated on the vertex by a distance equal to the length of the first and third joints of the flagellum combined; the posterior ocelli ovate and oblique, placed on a convexity, with a small, deep, triangular depression on the vertex behind them. Head opaque, very minutely punctured, the front slightly convex, with an obscure longitudinal sulcus from the anterior ocellus; the space round the base of the antennæ clothed with short white pubescence. Pronotum moderately depressed below the mesonotum, not very steeply sloped. Thorax slightly shining and almost smooth; the median segment opaque, a little longer than the mesonotum and longer than broad, vertically truncate posteriorly, the face of the truncation finely transversely striated, with a deep median sulcus. Abdomen slender, slightly shining, and very minutely punctured; the apical margin of the three basal segments depressed, most broadly in the middle, with a little short grey pubescence on the sides. Pygidial area shining and sparsely punctured, narrow and almost pointed at the apex. The comb on the anterior tarsi is not very strongly developed. The second cubital cell is very short on the radial nervure, only half as long as the third; the first recurrent nervure is received at the same distance from the base of the cell as from the second recurrent nervure, which is received close to the middle of the cell. The third cubital cell is not much prolonged on the cubital nervure, reaching only about two-fifths of the way from the apex of the second cell to the margin of the wing. The second and third transverse cubital nervures are scarcely curved.

Black; the apical half of the flagellum and the apical joint of the tarsi fuscous; the tegulæ testaceous. Wings hyaline, nervures ferruginous.

Length 6 mm.

*Hab.* Port Darwin (*Turner*); December.

TACHYSPHEX DEBILIS, sp. n.

♀. Mandibles strongly incised on the outer margin; clypeus short and broad, strongly transversely depressed on the apical margin and feebly emarginate in the middle, opaque at the base, shining at the apex, and sparsely punctured. Front round the base of the antennæ clothed with very short silvery pubescence, with a shallow longitudinal sulcus reaching very obscurely to the anterior ocellus. Head opaque, the front slightly convex; the posterior ocelli subovate, situated on an elevation, with a small and rather deep rounded depression behind them. Antennæ inserted much nearer to each other than to the eyes; the second joint of the flagellum a little shorter than the third, the third and fourth equal in length, the fifth equal to the second. Eyes strongly convergent, separated on the vertex by a distance equal to the length of the first two joints of the flagellum combined. Pronotum scarcely more than half as broad as the head, depressed below the level of the mesonotum, which is opaque and microscopically punctured; the scutellum shining, very minutely punctured. Median segment very opaque, finely shagreened, nearly twice as broad at the base as long, almost vertically truncate posteriorly; the face of the truncation indistinctly transversely striated, with a median sulcus. Abdomen shining, minutely punctured, the apical margin of the segments with broadly interrupted bands of obscure silver pubescence; the apical segment pointed, shining, and very sparsely punctured. The tibiæ are very feebly spined, the anterior tibiæ smooth; the tarsi more feebly spined than is usual in the genus, the comb of the anterior tarsi only moderately developed.

Black, the tegulæ fuscous. Wings hyaline, nervures fuscous. The third cubital cell is narrow and strongly extended along the cubital nervure towards the margin of the wing.

Length 7 mm.

*Hab.* Cairns, Queensland (*Turner*); February.

Tachysphex pacificus, sp. n.

♀. Clypeus very broadly truncate at the apex, strongly and closely punctured at the apex, sparsely and more finely at the base. Antennæ inserted as far from each other as from the eyes; the second joint of the flagellum three times as long as the first and about one-third longer than the third, the fourth and fifth almost equal in length to the third; the distance between the eyes on the vertex equal to the length of the second joint of the flagellum; the posterior ocelli elongate-ovate, situated on a very feeble elevation, a small depression on the vertex behind them. Head subopaque, closely and finely punctured, with a delicate longitudinal sulcus on the front. Thorax shining, very closely and minutely punctured; scutellum smooth and shining. Median segment opaque, very finely shagreened, the apex shining, almost vertically truncate posteriorly; the face of the truncation finely transversely striated, with a delicate median sulcus. Abdomen smooth and shining, the apical margin of the segments broadly and feebly depressed, the apical segment triangular, the sides longer than the base, sparsely punctured. The comb on the anterior tarsi is composed of very few setæ. The third cubital cell is strongly produced towards the margin of the wing, being nearly four times as long on the cubital as on the radial nervure. The sides of the median segment are obliquely striated.

Black; the mandibles and tegulæ fuscous. Wings hyaline, faintly tinted with fuscous; nervures black.

Length 8 mm.

*Hab.* Melbourne.

Type in British Museum ex coll. Smith.

Near *T. debilis* described above, but the proportion of the joints of the antennæ is very different, and the thorax and abdomen are more polished, and the sculpture, especially on the sides of the median segment, is different.

Tachysphex nigerrimus Sm.

*Tachytes nigerrimus* Sm. Cat. Hym. B. M. iv. p. 302. n. 26, 1856.

*Astata nigerrima* White; Butler, Zool. Voy. Ereb. & Terror, ii. pl. 7. fig. 14, 1875.

*Hab.* New Zealand.

I have received a specimen said to be from Victoria, but the locality may be a mistake.

Smith took the name from White's MS. referring to the above work, of which the portion containing the Hymenoptera was not published till many years later.

Tachysphex pugnator, sp. n.

♀. Clypeus shining and sparsely punctured, convex, strongly depressed, and bent inwards on the apical margin, giving the appearance of a wide and shallow emargination. Antennæ inserted almost as far from each other as from the eyes, short and rather stout; the second joint of the flagellum not much more than twice as long as the first, and about equal to the third in length but not quite as thick, the fourth and fifth joints as long as the third. Eyes separated on the vertex by a distance about equal to the length of the third and fourth joints of the flagellum combined. Head shining and almost smooth, a very delicate sulcus reaching from the anterior ocellus almost to the base of the clypeus. Posterior ocelli ovate, with a small deep depression behind them, from which a rather deep sulcus runs to the posterior margin of the head. Thorax narrower than the head, smooth and shining; the pronotum depressed below the mesonotum, gradually but not very steeply sloped; the mesonotum with a longitudinal sulcus on each side, and a very short longitudinal sulcus from the middle of the anterior margin. Median segment opaque, shorter than the mesonotum, abruptly but not quite vertically truncate posteriorly, the face of the truncation finely transversely striated, with a deep median sulcus not reaching the apex. Abdomen almost smooth, the ventral surface highly polished; the segments depressed on the apical margin, the three basal segments very strongly so and much more broadly on the middle than on the sides, the second segment obscurely transversely furrowed before the depression; the margins of the three basal segments with scant white pubescence (probably thicker in fresh specimens); the pygidial area shining and sparsely punctured, very long and narrow, almost pointed at the apex. The comb on the anterior tarsi well developed. The radial nervure reaches nearer to the outer margin of the wing than the cubital; the first recurrent nervure is received nearer to the second than to the base of the second cubital cell.

Black; the flagellum fuscous, the apex of the scape beneath fusco-ferruginous; tarsi fuscous at the base, the apical joints fusco-ferruginous; the comb of the anterior tarsi ferruginous. Wings hyaline, tinged with fuscous; nervures black.

Length 11 mm.

*Hab.* Adelaide, S. Australia.

Type in British Museum.

Somewhat allied to *T. nigerrimus* from New Zealand, but the thorax is narrower in proportion to the head, and the antennæ are very different.

TACHYSPHEX HYPOLEIUS Sm.

♀. Clypeus slightly convex, depressed towards the anterior margin, which is broadly subtruncate, very minutely punctured. Antennæ inserted further from each other than from the eyes, the space between them shining and almost smooth, above the shining space is a very short longitudinal carina with a very small tubercular prominence on each side of it. The first joint of the flagellum very short, not more than one-quarter of the length of the second, the second and third about equal in length, the fourth a little shorter. Mandibles notched on the outer margin. Eyes separated on the vertex by a distance equal to the length of the second joint of the flagellum. Front slightly convex, subopaque, finely and shallowly punctured; the front below the base of the antennæ, the inner margin of the eyes as high as the ocelli and the outer margin clothed with short silvery pubescence. Posterior ocelli elongate-ovate, situated on a slight convexity, with a shallow depression on the vertex behind them. Thorax smooth and shining, mesopleuræ subopaque; mesosternum shining, with a few scattered punctures; the pronotum depressed below the mesonotum, very gradually sloped. Median segment distinctly longer than the mesonotum, opaque and shagreened, with a very shallow longitudinal depression near the apex, vertically truncate posteriorly; the face of the truncation transversely striated, with a deep median sulcus. Abdomen shining and almost smooth, the apical margin of the segments depressed, with a band of short silver pubescence broadly interrupted in the middle; the first segment rounded towards the base; the pygidial area very sparsely punctured, very slightly convex in the middle, elongate, blunt at the apex. Intermediate coxæ very widely separated; the comb of the anterior tarsi very strongly developed. The first recurrent nervure is received rather nearer to the base of the second cubital cell than to the second recurrent nervure, which is received close to the middle of the cell; the third cubital cell is produced, reaching on the cubital nervure much more than halfway from the apex of the second cell to the margin of the wing.

Entirely black. Wings hyaline, tinted with fuscous, nervures black.

Length 14 mm., exp. 22 mm.

*Hab.* S. Australia; W. Australia.

Type in British Museum.

The median segment, although broader than long, is longer than is usual in the genus.

ZOYPHIUM ERYTHROSOMA, sp. n.

♀. Mandibles very deeply notched on the outer margin. Clypeus broad, slightly convex in the middle, the anterior margin depressed transversely, with two minute teeth on each side, almost smooth, with thin and very fine silvery pubescence on the sides. Antennæ inserted about half as far again from each other as from the eyes, scarcely longer than the head, gradually thickened to the apex, the length of the scape no greater than the distance between the antennæ; the first joint of the flagellum globose, a little shorter than the second, the third half as long again as the second, the fourth a little longer than the third, the apical joint very large and massive, as long as the first and second combined. The inner margin of the eyes almost straight, the distance between the eyes on the vertex slightly exceeding two-thirds of the length of the flagellum. The posterior ocelli rather more than half as far again from each other as from the eyes. Front depressed round the base of the antennæ; head a little broader than the mesonotum. Head and thorax opaque, very closely and microscopically punctured. Pronotum depressed, seen from above linear and transverse, sharply obliquely depressed anteriorly. Mesonotum much longer than the median segment, the punctures on the mesopleuræ a little more distinct than on the mesonotum. Median segment rounded, with a median longitudinal sulcus from the base to the apex, a short carina lying in the sulcus at the base; along the base of the segment are a number of short oblique striæ. Abdomen a little longer than the thorax and median segment combined, closely and minutely punctured, the apical margin of the segments broadly depressed and smooth. The pygidial area is triangular, much more strongly punctured, with short, stiff hairs springing from the punctures. The first recurrent nervure is received at one-quarter before the apex of the first cubital cell, otherwise the neuration is as in Kohl's figure.

Obscure blackish blue; the clypeus, the base of the mandibles, the scape of the antennæ, the apex of the femora, the tibiæ, and the tarsi yellow; the flagellum, the abdomen, and stains on the tibiæ and tarsi light ferruginous; the tegulæ fuscous. Wings hyaline, faintly iridescent, nervures ferruginous.

Length 8–9 mm.

♂. Clypeus blue-black; hypopygium pointed, with a spine on each side close to the apex. Otherwise as in the female.

Length 7 mm.

*Hab.* Townsville, Queensland (*Dodd*); Mackay, Queensland (*Turner*); February and March.

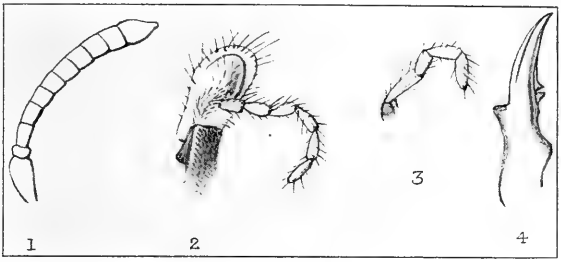
Described from two males and two females.

Near *Sericophorus bicolor* Sm., from W. Australia, but the radial cell in that species is appendiculate and the head much broader.

ZOYPHIUM RUFONIGRUM, sp. n. (Plate XXVI. fig. 8.)

♂. Mandibles deeply notched on the outer margin, acute at the apex, not bidentate. Clypeus very broadly rounded at the apex, the apical margin depressed, without minute lateral teeth. Antennæ about one-third as far again from each other at the base as from the eyes, the first joint of the flagellum shorter than the second, globular, the second shorter than the third, the apical joint massive and longer than the others, the antennæ are a little longer than head and are gradually thickened to the apex. The inner orbits of the eyes are nearly parallel, very slightly convergent towards the vertex. The eyes on the vertex separated by a distance scarcely equal to two-thirds of the length of the flagellum; the posterior ocelli twice as far from each other as from the eyes. Head and thorax minutely and closely punctured, the front clothed with short, silvery pubescence. Head broader than the thorax; the pronotum short but not linear, strongly depressed anteriorly. Mesopleuræ rather more strongly punctured than the mesonotum. The median segment rounded at the apex, with a deep median sulcus; the sides of the segment and the mesopleuræ clothed with silvery pubescence. Abdomen minutely punctured, the apical margins of the segments rather broadly depressed and smooth; the hypopygium subtruncate, with a minute apical spine.

Text-fig. 108.




*Zoyphium rufonigrum*, ♂.
1. Antenna. 2. Maxilla and palpus. 3. Labial palpus. 4. Mandible.

Black; the mandibles, clypeus, pro- and mesothorax, and median segment ferruginous red; the tibiæ, tarsi, scape of the antennæ, the first and part of the apical joint of the flagellum testaceous yellow. Wings hyaline, iridescent, nervures fuscous.

Length 4 mm.

*Hab.* Port Darwin (*Turner*); December.

Described from two specimens.

Zoyphium kohlii, sp. n.

♀. Mandibles acute at the apex, deeply notched on the outer margin at one-third from the base, with two small teeth narrowly divided from each other on the inner margin also at one-third from the base. Clypeus short and broad, opaque and smooth, the anterior margin transversely depressed, with a tooth on each side opposite the two small teeth on the mandibles. Antennæ nearly half as far again from each other at the base as from the eyes, gradually thickened to the apex; the first joint of the flagellum globular, shorter and stouter than the second, the second a little longer than the third, the apical joint large and longer than any two of the others combined. Eyes moderately convergent towards the vertex, where they are separated by a distance equal to about half the length of the flagellum; the posterior ocelli nearly twice as far from each other as from the eyes. Head and thorax opaque, almost smooth, the front covered with very short golden pubescence. Pronotum much narrower than the head, depressed slightly below the level of the mesonotum and strongly depressed anteriorly. Median segment shorter than the mesonotum, rounded posteriorly, with a median carina lying in a shallow depression reaching from the base almost to the apex, with very short oblique striæ at the base, shining at the apex, the intermediate space opaque. Abdomen elongate-ovate, minutely and rather sparsely punctured, the apical margin of the segments narrowly depressed, the pygidial area triangular with sparse pubescence.

Black; the mandibles, antennæ, tegulæ, and legs pale ferruginous brown. Wings hyaline, iridescent; nervures fuscous.

Length 6 mm.

*Hab.* Mackay, Queensland (*Turner*); January.

ZOYPHIUM FRONTALE, sp. n.

♀. Clypeus very broad, truncate at the apex; the antennæ inserted at the base of the clypeus, twice as far from each other as from the eyes, thickened to the apex and no longer than the head. Eyes very slightly convergent towards the vertex; the posterior ocelli more than twice as far from each other as from the eyes. Front very broad, slightly concave at the sides, a little elevated in the middle. Head, thorax, and abdomen very minutely punctured, the abdomen shining. Pronotum short, narrower than the head, and depressed below the mesonotum. Mesonotum large, as broad as long and as broad as the head. Median segment rounded at the sides, abruptly truncate posteriorly, much shorter than the mesonotum, delicately obliquely striated, with a median carina from the base situated in a depressed sulcus. Abdomen subconical, the second segment a little broader than the first.

Black; the clypeus, the front and the scape of the antennæ yellow; the mandibles, flagellum, tegulæ, and legs ferruginous; the apex of the scutellum and the postscutellum fusco-ferruginous. Wings hyaline, iridescent; nervures fusco-ferruginous.

There are only two cubital cells, the second transverse cubital nervure being obsolete; the second cubital cell nearly twice as long on the cubital as on the radial nervure, the length on the radial about equal to the length of the first transverse cubital nervure.

Length 5 mm.

*Hab.* Mackay, Queensland (*Turner*); March.

GORYTES DUBOULAYI, sp. n.

♀. Clypeus short and broad, closely and minutely punctured. Head very minutely punctured, the front almost smooth, concave, with a longitudinal sulcus from the anterior ocellus to the base of the clypeus. Eyes very large, diverging towards the clypeus and the vertex; the posterior ocelli twice as far from each other as from the eyes. Antennæ inserted further from each other than from the eyes, thickened to the apex; the second joint of the flagellum half as long again as the third. Pronotum linear, transverse, nearly as broad as the head. Thorax very minutely and shallowly punctured; the mesonotum half as broad again as long. Median segment with a smooth, shining triangular space at the base; from the apex of the triangle a deep sulcus runs to the apex of the segment, the remainder of the segment shining, with microscopic punctures. Abdomen oval, as long as the thorax and median segment combined; the first segment narrow at the base, no longer than the second segment which is very broad; all the segments finely and very closely punctured; the pygidium elongate-triangular, with sparse, short pubescence.

Black; the mandibles at the base, clypeus, scape of the antennæ, pronotum, tegulæ, a spot on the mesopleuræ beneath the anterior wings, a short transverse line at the apex of the scutellum, the postscutellum, a large spot on each side of the second abdominal segment, a transverse band very narrowly interrupted in the middle at the apex of the fourth segment, the apex of the anterior femora, and a line on all the tibiæ above, pale yellow; the flagellum, the apex of the mandibles, the legs, the first abdominal segment (except at the base), and the two apical segments ferruginous.

The first recurrent nervure is received near the apex of the first cubital cell, the second close to the apex of the second. The first cubital cell is longer on the cubital nervure than the second and third combined; the second as long as the third, but much shorter on the radial nervure.

Length 7 mm.

*Hab.* Australia, N.W. Coast (*Du Boulay*).

Type in British Museum.

This and the two following species form a group of allied forms approaching the subgenus *Miscothyris* Sm., from which they may be distinguished by the shorter and more oval abdomen and the very large and broad second abdominal segment.

GORYTES SANGUINOLENTUS, sp. n. (Plate XXVI. fig. 10.)

♀. Clypeus broad, slightly convex, about two and a half times as broad on the apical margin as long, truncate at the apex, the labrum slightly prominent; minutely punctured. Eyes large, strongly divergent towards the clypeus and towards the vertex, separated on the front by a distance rather less than one and a half times the length of the scape. The posterior ocelli twice as far from each other as from the eyes, separated from the eyes by a distance about equal to the length of the third joint of the flagellum. Antennæ inserted on the front, above the base of the clypeus, about equal in length to the head, nearer to the eyes than to each other; the scape as long as the first three joints of the flagellum combined; the second joint of the flagellum longer than the third, the apical joints thickened. Head opaque, very minutely punctured, vertex flattened. Pronotum linear and transverse, nearly two-thirds of the breadth of the head; mesonotum more than half as broad again as long, finely punctured; scutellum large and broad, truncate at the apex. Median segment of about the same length as the scutellum, rounded and steeply sloped posteriorly, the sides finely and not very closely punctured; a smooth, shining, triangular area at the base, produced at the apex of the triangle into a narrow shining median line on the posterior slope. Abdomen ovate, closely and finely punctured, the second segment the broadest and half as long again as the third; the first segment steeply sloped anteriorly, not truncate, about half as long as the second; the apical segment small and pointed, with a fine longitudinal carina.

Black; the base of the mandibles, the clypeus, the scape of the antennæ, pronotum, a spot on the mesopleuræ near the base of the anterior wings, the base of the tegulæ, the tibiæ above, and an obscure spot on each side near the apical angles of the second abdominal segment, pale yellow; the flagellum, the tibiæ beneath, the tarsi, and the abdomen ferruginous. Wings hyaline, iridescent; nervures ferruginous at the base and on the costa, black at the apex.

The first recurrent nervure is received near the apex of the first cubital cell, the second at the apex of the second cubital cell, almost interstitial with the second transverse cubital nervure. The second cubital cell is of about the same length as the third on the cubital nervure, less than half as long on the radial as on the cubital nervure. The cubital nervure on the hind wing originates far beyond the apex of the submedian cell.

Length 7 mm., exp. 12 mm.

*Hab.* Mackay, Queensland (*Turner*); March.

This is nearer to *Miscothyris* than to any other section of *Gorytes*, but differs much from *thoracicus* Sm., the antennæ being shorter, the second joint of the flagellum not unusually elongate; the eyes much more strongly divergent; the first abdominal segment narrower and not truncate, the second segment much larger and the apical segment pointed, not broadly subtruncate as in *thoracicus*. Smith describes *thoracicus* as a male, but the type, the only specimen I have seen, is a female and has the antennæ twelve-jointed, not thirteen-jointed as in Smith's figure.

GORYTES LUCIDULUS, sp. n. (Plate XXVI. fig. 11.)

♀. Clypeus very broad, truncate anteriorly, finely and closely punctured. Antennæ inserted above the base of the clypeus, nearer to the eyes than to each other, about as long as the thorax; the scape as long as the first two joints of the flagellum combined, the second joint of the flagellum much longer than the third. Eyes diverging towards the clypeus and towards the vertex; the posterior ocelli further from each other than from the anterior ocellus and twice as far from each other as from the eyes. Head shining, almost smooth, with a delicate sulcus from between the antennæ to the anterior ocellus. Pronotum almost vertically depressed, the posterior margin nearly on a level with the mesonotum. Mesonotum half as broad again as long, finely and closely punctured; scutellum short and transverse. Median segment very short, steeply sloped, with a deep median sulcus posteriorly, shining with a smooth triangular space at the base, the sides and apex very finely punctured. Abdomen subovate, scarcely longer than the thorax and median segment combined, the second segment the broadest, the apical segment lanceolate. The first recurrent nervure is received by the first cubital cell a little before the apex, the second is interstitial with the second transverse cubital nervure. The second cubital cell is scarcely more than half the length of the third, the first is longer than the second and third combined. The second on the radial nervure is a little more than half as long as on the cubital.

Black; the clypeus, the scape of the antennæ, a large spot on the mesopleuræ beneath the anterior wings, the scutellum, post-scutellum, and a spot on each side near the apical angles of the second abdominal segment yellow. The tarsi and anterior tibiæ fuscous. Wings hyaline, nervures fusco-ferruginous.

Length 8 mm., exp. 13 mm.

*Hab.* Mackay, Queensland (*Turner*); October.

The intermediate tibiæ have two spines at the apex; the tarsal ungues are long, curved, and simple. The form is very similar to *sanguinolentus*, but the scutellum is shorter and the whole insect less robust.

A colour variety from Cairns is without the yellow spot on the second abdominal segment and has the apical half of the clypeus dark brown.

Gorytes icarioides, sp. n.

♀. Clypeus broadly truncate at the apex, subtriangular, but truncate at the base, almost smooth. Eyes very large, diverging towards the vertex, approaching each other most closely at the base of the clypeus, where they are separated by a distance about equal to the length of the scape of the antenna. Antennæ inserted rather high up on the front, as near to the eyes as to each other; the second joint of the flagellum nearly half as long again as the third and quite as long as the scape, the four or five apical joints forming a strong club, the joints broader than long. The posterior ocelli far apart, two and a half times as far from each other as from the eyes, from which they are separated by a distance equal to the length of the first joint of the flagellum. Head opaque, the space round the ocelli rather coarsely punctured. Thorax and median segment closely punctured; the pronotum depressed below the level of the mesonotum, the posterior angles widely separated from the tegulæ. Median segment as long as the mesonotum, truncate at the apex, with a longitudinal carina on the surface of the truncation, the triangular area at the base of the segment rather obscurely defined and very finely rugose. Abdomen petiolate, the first segment half as broad again at the apex as at the base, and nearly twice as long as the breadth at the apex; second and third segments large and broad; the whole abdomen rather closely punctured and opaque; the apical margin of the first segment smooth and shining, with sparse punctures. Pygidial area triangular, with the margins slightly raised, covered with short, stiff pubescence. Both recurrent nervures are received by the second cubital cell beyond the middle, the second near the apex. The radial cell is narrow and pointed; the first cubital cell incompletely divided by a branch from the first transverse cubital nervure, the second three times as long on the cubital as on the radial nervure, the third nearly as long as the first on the cubital and more than half as long again on the cubital as on the radial nervure. The cubital nervure of the posterior wing originates before the apex of the submedian cell. The posterior tarsi are nearly twice as long as the tibiæ.

Black; the clypeus, the front below the base of the antennæ, the scape of the antennæ, and the posterior angles of the pronotum yellow; the mandibles, the four basal joints of the flagellum, the tegulæ and a curved line above them, a transverse spot on the postscutellum, the apex of the first and third abdominal segments rather broadly and of the fourth and fifth more narrowly, and the legs (except the coxæ and the posterior femora) ferruginous. Wings hyaline; nervures black, ferruginous at the base.

Length 10 mm., exp. 19 mm.

*Hab.* Mackay, Queensland (*Turner*).

Nearest to *G. decoratus* Handl. (*ornatus* Sm.), from West Australia.

Gorytes cygnorum, sp. n.

♂. Clypeus broadly subtruncate at the apex, clothed with silvery pubescence. Head finely and rather sparsely punctured, with a delicate sulcus from the anterior ocellus nearly reaching the base of the clypeus. Eyes strongly divergent towards the vertex, less strongly towards the clypeus, separated from each other on the front at the nearest point by a distance about equal to the length of the scape and the first joint of the flagellum combined; the posterior ocelli about half as far again from each other as from the eyes. Antennæ shorter than the thorax and median segment combined, moderately and very gradually thickened to the apex, much nearer to the eyes than to each other. Pronotum transverse and linear, slightly raised, and as broad as the head. Thorax rather sparsely punctured; the postscutellum coarsely longitudinally striated. Median segment much shorter than the mesonotum, almost vertically truncate posteriorly, rugose, with a median sulcus on the truncation, the area at the base coarsely longitudinally striated. Abdomen elongate-ovate, very finely and closely punctured; the first segment of about the same length as the second, broadened to the apex, where it is more than half as broad as the second segment. Both recurrent nervures received by the second cubital cell, the distance between them nearly two-thirds of the length of the cell. The second cubital cell is as long on the cubital nervure as the third, but is much narrowed on the radial nervure; the cubital nervure is sharply bent before the reception of the first recurrent nervure and has from that point the appearance of being continuous with the recurrent rather than with the cubital nervure. The cubital nervure of the posterior wing originates far beyond the apex of the submedian cell.

Black; the clypeus pale yellow; the mandibles, the scape of the antennæ, the two basal joints of the flagellum, the pronotum, tegulæ, scutellum, legs, the apical half of the first and second abdominal segments, the apical margins of the remaining segments (most broadly on the fifth), the second ventral segment (except the extreme base), and the apical margin of the remaining segments (except the first) orange. Wings hyaline, iridescent, slightly tinged with fuscous; nervures fusco-ferruginous.

Length 7 mm.

*Hab.* Swan River (*Du Boulay*).

Type in British Museum.

GORYTES FRENCHII, sp. n.

♂. Clypeus slightly emarginate in the middle of the apical margin, about twice as broad at the apex as long, minutely punctured and thinly clothed with silver-grey pubescence. Head delicately and closely punctured, with a fine sulcus from the anterior ocellus nearly reaching the base of the clypeus. Eyes strongly divergent towards the vertex and less strongly towards the clypeus, separated at the base of the clypeus by a distance not exceeding the length of the scape; the posterior ocelli rather more than half as far again from each other as from the eyes. Antennæ rather shorter than the thorax and median segment combined, slightly thickened towards the apex; the second joint of the flagellum twice as long as the first, and half as long again as the third. Pronotum transverse and linear; thorax as broad as the head, sparsely punctured; scutellum transverse. Median segment short and rounded, the sides coarsely obliquely striated, the triangular dorsal area coarsely longitudinally striated. Abdomen subopaque, very minutely and closely punctured, more than half as long again as the thorax and median segment combined, the first segment half as broad at the apex as the second segment and slightly constricted, the third segment nearly as long as the second; the hypopygium pointed. Both recurrent nervures received by the second cubital cell, separated from each other by nearly two-thirds of the length of the cell; the first transverse cubital nervure sends out a short obscure branch into the first cubital cell; the second cubital cell is longer than the third on the cubital nervure and is incompletely separated from it, the second transverse cubital nervure only reaching a little more than halfway to the radial nervure. The cubital nervure of the posterior wing originates beyond the apex of the submedian cell.

Black; the extreme apex of the scape of the antennæ, the pronotum, a rather narrow band at the apex of the first, second, fourth, fifth, and sixth dorsal abdominal segments, very narrowly interrupted on the first and fourth, yellow; the tegulæ, tibiæ, tarsi, and the extreme apex of the femora ferruginous. Wings hyaline, nervures black.

Length 10 mm.

*Hab.* Victoria (*French*).

Type in British Museum.

Belongs to the *mystaceus* group.

BEMBEX VARIABILIS Sm.

*Bembex variabilis* Sm. Cat. Hym. B. M. iv. p. 325, n. 39,1856, ♀.

*Bembex crabroniformis* Sm. Ann. Mag. Nat. Hist. xii. p. 296, 1873, ♂.

Var. *Bembex raptor* Sm. Cat. Hym. B. M. iv. p. 326. n. 40, 1856, ♂.

I have not been able to dissect a male of *B. raptor*, but cannot find any perceptible difference in structure between it and *variabilis*. The colour-differences are not reliable, though to a certain extent, at all events, local. The variety *raptor* occurs at Roeburne, W. Australia, and in various localities in Central Australia; the abdominal fasciæ are continuous, not interrupted as in the typical form, which occurs along the Eastern Coast and at Port Darwin. The second joint of the flagellum in the male is a little shorter in var. *raptor* than in the typical form.

BEMBEX FLAVIPES Sm.

♂. Colour as in the female, the clypeus white, black at the base. Clypeus very prominent from the base, then vertically and broadly semicircularly truncate and subconcave. The penultimate joint of the flagellum is strongly produced beneath at the apex, the apical joint strongly hooked and pointed. Anterior tarsi normal, intermediate femora not serrate. Second ventral segment carinate longitudinally, the carina produced into a large compressed tubercle, truncate broadly at the apex; the sixth segment with a black triangular plate, pointed at the apex.

*Hab.* Mackay, Queensland (*Turner*).

BEMBEX LITTORALIS, sp. n.

♂. Clypeus moderately convex, clothed with very short pubescence, which only shows in strong lights, in which it is silver; shining and finely punctured. Mandibles tridentate, the two inner teeth very small, the labrum normal. Antennæ inserted a little further from each other than from the eyes, the front between them slightly raised; the last joint of the flagellum slightly curved, the second joint fully half as long again as the third. Cheeks very narrow; the head finely punctured, with sparse, long, grey pubescence. Thorax and abdomen finely and closely punctured; the apical dorsal segment of the abdomen broadly rounded and more sparsely punctured; the second ventral segment rather coarsely punctured, with a prominent, compressed, curved tubercle, pointed at the apex; the sixth segment with a raised triangular plate, pointed at the apex, the seventh with a longitudinal median carina; the eighth segment terminating in a short spine. Anterior tarsi simple, the basal joint with six slender spines on the outer margin; the intermediate tibiæ not serrate.

Black; the mandibles (except at the apex), the labrum, the extreme base of the scape, the flagellum beneath, a spot on each side on the front below the anterior ocellus, the posterior margin of the pronotum very narrowly, the tegulæ, the tibiæ and tarsi beneath, and the femora beneath at the apex, testaceous brown; a narrow transverse band, broadly interrupted in the middle, on abdominal segments 2–5 pale olivaceous grey. Wings hyaline, nervures black.

Length 13 mm.

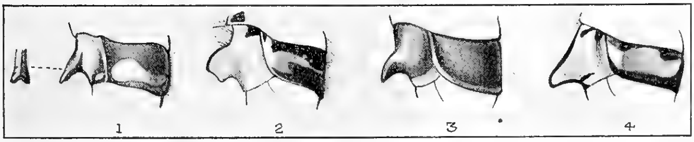
*Hab.* Port Darwin (*Turner*); December.

Allied to *B. musca* Handl., and also to *B. atrifrons* Sm., of which it may possibly prove to be the male, but the species in the group are very closely allied, and *atrifrons* will probably prove to be distinct.

BEMBEX TUBERCULIVENTRIS, sp. n.

♂. Eyes slightly divergent towards the clypeus. The clypeus strongly convex at the base, very prominent at about one-third from the base, thence almost vertically depressed to the apex, shining and very sparsely punctured. Antennæ inserted as far from each other as from the eyes, the front between them with a low longitudinal carina; the seventh joint of the flagellum very

Text-fig. 109.




*Bembex*, ♂: second ventral segment.

1. *B. furcata* Erichs. 2. *B. tuberculiventris.* 3. *B. littoralis.* 4. *B. palmata* Sm.

feebly prominent at the base beneath. Mandibles tridentate, the intermediate tooth very small and short. Head finely punctured and clothed with long grey pubescence. Thorax and abdomen very finely and closely punctured, the punctures on the ventral segments larger and shallow; second ventral segment longitudinally carinate, the carina produced downwards into a large, compressed prominence, curved anteriorly and truncate broadly at the apex; the sixth segment with a flattened triangular plate, prominent and bluntly pointed at the apex; the seventh segment tricarinate longitudinally, broadened towards the apex; the eighth segment very small and pointed. Anterior tarsi normal, the basal joint with eight long and rather slender spines on the outer margin; the intermediate tibiæ not serrate. Third cubital cell broader at the apex than at the base, longer than the second. The apical dorsal segment of the abdomen is broadly rounded at the apex.

Black; the mandibles (except at the apex), the labrum, the clypeus (except a broad transverse mark at the base), the outer orbits of the eyes narrowing to nearly the summit, the inner orbits more broadly, not reaching to the summit, a median line on the front broadening between and round the base of the antennæ, with a spot on each side of it at its base, the posterior margin and the sides of the pronotum, with a large black spot close to the posterior angles and a smaller one before it, a spot on the mesopleuræ below the anterior wings with a large curved mark below it, the ventral segments of the abdomen (except the base of the fifth and sixth segments and a black spot on each side of the first and of the second at the base), the prosternum, the legs (except the tarsal ungues, a black line at the base of all the tibiæ and on the anterior and posterior femora), pale yellow. A narrow transverse band interrupted in the middle and on the sides on the first abdominal segment, a broader band (curved and narrowly interrupted in the middle) on segments 2–6, and the sides of the apical segment narrowly pale, dull, greenish grey. Wings hyaline; nervures black, ferruginous at the base. Antennæ yellow beneath.

Length 13 mm., exp. 22 mm.

*Hab.* Cooktown, Queensland (*Turner*); October.

Allied to *B. musca* Handl., but has the clypeus more prominent and more spines on the anterior tarsi.

Bembex palmata Sm.

*Bembex palmata* Sm. Cat. Hym. B. M. iv. p. 325. n. 38, 1856, ♂; Handlirsch, Sitz. Akad. Wiss. Wien, cii. p. 751, n. 28, 1893, ♂ ♀.

*Bembex tridentifera* Sm. Ann. & Mag. Nat. Hist. (4) xii. p. 298, 1873, ♀.

*Hab.* Mackay and Cairns, Queensland (*Turner*).

Bembex pectinipes Handl.

*Bembex pectinipes* Handl. Sitz. Akad. Wiss. Wien, cii. p. 875. n. 108, 1893, ♀.

*Bembex palmata* Sm. Ann. & Mag. Nat. Hist. (4) xii. p. 298, 1873, ♂ (nec Smith, 1856).

This is not identical with *B. saussurei* Handl., in my opinion. As in true *palmata*, the labrum has no median longitudinal sulcus at the base, but the anterior tarsi of the female have twelve spines on the outer sides of the first joints and the mandibles are tridentate. In the male the basal joints of the anterior tarsi are very broad, with eighteen long spines on the outer margins, the second joints produced into a broad lobe on the outer margins, but the third and fourth not so. The sixth joint of the flagellum is produced beneath at the apex and the seventh at the base, the latter very gradually narrowed towards the apex with an emargination in the middle. The second ventral segment is longitudinally carinate with a tubercle at the apex, less strongly produced than in *flavifrons* Sm. The intermediate femora are not toothed, and the epipygium is truncate at the apex.

*Hab.* Port Darwin (*Walker*).

Bembex flavifrons Sm.

*Bembex flavifrons* Sm. Cat. Hym. B. M. iv. p. 324. n. 36, 1856, ♀.

*Bembex saussurei* Handl. Sitz. Akad. Wiss. Wien, cii. p. 873. n. 107, 1893, ♀.

This may be distinguished from *pectinipes* Handl. by the longitudinal grooves on the sides of the clypeus, feebly continued on the labrum, and by a short median longitudinal sulcus at the base of the labrum.

♂. The clypeus is very deeply longitudinally grooved on the sides, the grooves strongly continued on the labrum, which also has a deep, median, longitudinal sulcus near the base. The antennæ have the sixth joint of the flagellum strongly produced beneath at the apex and the seventh at the base. The anterior tarsi have the first joints strongly broadened and flattened, with sixteen long spines on the outer margin, the following joints are not strongly lobed. The intermediate femora are distinctly serrated. The second ventral segment is very strongly longitudinally carinated beneath, the carina produced at the apex into a very prominent tubercle, more strongly developed than in *pectinipes*. The markings on the disc of the thorax are almost obsolete, the band on the first abdominal segment very broadly, on the other segments very narrowly interrupted. Epipygium narrowly truncate at the apex.

*Hab.* Mackay, Queensland (*Turner*).

Nysson (Acanthostethus) punctatissimus, sp. n. (Plate XXVI. fig. 9.)

♀. Clypeus broadly truncate at the apex, the apical margin narrowly transversely depressed, the angles very feebly produced; sparsely and rather deeply punctured, without carinæ, short and broad. Antennæ inserted nearly half as far again from the eyes as from each other; the scape as long as the first two joints of the flagellum combined, the second joint half as long again as the first and about the same length as the third, the fourth joint longer and thicker, the apical joint nearly twice as long as the second. Eyes separated at the base of the clypeus by a distance equal to about one-third of the length of the antennæ, strongly divergent towards the vertex and broadly and shallowly emarginate on the inner margin near the summit. The posterior ocelli a little further from the eyes than from each other, and half as far again from each other as from the anterior ocellus. Head rather closely, but not very deeply punctured, the punctures large. A short longitudinal carina on the front reaching from between the base of the antennæ much less than halfway to the anterior ocellus, forked above, the branches reaching nearly halfway to the eyes. Thorax coarsely punctured; the pronotum short and steeply sloped anteriorly, very broadly emarginate posteriorly; prosternum produced posteriorly into two broad projections pointed at the extremity and overlying the anterior coxæ; mesosternum punctured, mesopleuræ coarsely punctured-rugose, the intermediate coxæ broadly, the posterior coxæ narrowly separated. Scutellum subrectangular, laterally produced at the anterior angles, half as broad again as long; postscutellum very short and divided at distant intervals by longitudinal carinæ. Median segment a little shorter than the scutellum, strongly produced at the posterior angles into stout spines, strongly punctured; the enclosed space bordered by strongly raised carinæ, converging towards the apex, marked with about six rather lower longitudinal carinæ; vertically truncate posteriorly, the face of the truncation with several longitudinal carinæ. First abdominal segment rather longer than the second, rounded broadly anteriorly and strongly punctured, the second segment less deeply punctured, the punctures on the remaining segments finer and very shallow. Pygidial area granulated, broadly subtriangular, rather narrowly truncate at the apex. First ventral segment with a strong median carina, broadly emarginate at the apex and much shorter than the second segment, which is coarsely but sparsely punctured, the remaining segments finely punctured. The posterior tibiæ are serrate from near the base, emarginate on the outer margin, and smooth near the apex.

Black; the clypeus covered with very short silvery pubescence; the front and orbits of the eyes, pronotum, mesopleuræ, and scutellum with very short pale golden pubescence; the mesonotum with silvery pubescence; the sides of the median segment outside the enclosed space with very pale golden pubescence; the vertex, mesonotum, and median segment dark blackish brown; the apical margins of the abdominal segments above, most broadly at the sides, luteous yellow, the base of the first segment with a large rounded spot of very short golden pubescence on each side; the legs, mandibles, antennæ, tegulæ, and the apex of the pygidium ferruginous. Wings hyaline, slightly iridescent; nervures black.

There are only two cubital cells; the second is pointed on the radial nervure; the first recurrent nervure is received at about one-sixth from the apex of the first cubital cell, the second close to the apex, almost interstitial with the first transverse cubital nervure. The angles of the ventral segments are not spined.

Length 9 mm.

*Hab.* Mackay, Queensland (*Turner*); February.

NYSSON (ACANTHOSTHETHUS) SPINIGER, sp. n.

♀. Clypeus depressed to the apex, and broadly but shallowly emarginate anteriorly, clothed with very short silvery pubescence. Antennæ inserted a little further from each other than from the eyes; the three apical joints of the flagellum much thickened, the apical joint twice as long as the second, which is longer than the third. Eyes separated from each other at the base of the clypeus by a distance equal to about two-fifths of the length of the antennæ, strongly divergent towards the vertex, but not emarginate; the posterior ocelli half as far again from the eyes as from each other. Head strongly and very closely punctured; an indistinct, very short, longitudinal carina between the antennæ; the front and pronotum with very short and sparse white pubescence. Thorax punctured-rugose; the pronotum short, gradually sloped, the anterior angles prominent; the mesopleuræ strongly and closely, the mesosternum feebly and sparsely punctured. Scutellum subrectangular, very little broader than long. Median segment very short, in the middle only about half as long as the scutellum; the posterior angles strongly produced, ending in an acute spine directed outwards and backwards, the enclosed space with convergent lateral carinæ and marked with about six longitudinal carinæ; vertically truncate posteriorly, with several longitudinal carinæ on the surface of the truncation; the sides of the segment finely and sparsely punctured, the dorsal surface outside the enclosed area clothed with silvery pubescence. Abdomen closely punctured; the first segment longer than the second, subtruncate at the base, and more strongly punctured than the second segment; the pygidial area granulate, subtriangular, and narrowly truncate at the apex. The first ventral segment with a very strong median carina and a long spine on each side at the apical angles; the second segment much longer than the first and strongly punctured. Posterior tibiæ almost unarmed, slightly emarginate near the apex.

Black; the mandibles, the basal third of the antennæ, the tegulæ, the legs, the basal segment of the abdomen, the apical margin of the remaining segments obscurely, and the sides and ventral surface of the pygidium, dark ferruginous; a short, obscure, transverse band on the sides of the first and second abdominal segments yellow. Wings hyaline, nervures black.

The second cubital cell is almost petiolate, the first recurrent nervure is received by the first cubital cell at about one-fifth from the apex, the second close to the apex, almost interstitial with the first transverse cubital nervure. The anal cell of the hind wing is short.

♂. As in the female, but without the spine at the angles of the first ventral segment, and the apical segment is widely emarginate at the apex.

Length 5 mm.

*Hab.* Mackay, Queensland (*Turner*); October.

Nitela kurandæ, sp. n.

♀. Clypeus strongly convex, with an elevated carina from the base to the apex finely continued on the front, and reaching halfway from the base of the clypeus to the anterior ocellus. Eyes more strongly convergent towards the vertex than in other species of the genus; the posterior ocelli very close to the eyes, fully twice as far from each other as from the eyes. Head opaque, the vertex almost smooth, the front very minutely and closely punctured-striate. Pronotum much narrower than the head, the anterior and posterior margins raised, the short space between indistinctly transversely striated, the tubercles at the posterior angles reach back to the tegulæ. Mesonotum and scutellum opaque. Median segment longer than the mesonotum, narrowed towards the apex and vertically truncate posteriorly, coarsely reticulate, with a faint median carina; the face of the truncation transversely striated. Abdomen smooth and shining, the second segment slightly transversely depressed at the base, the apical segment compressed and pointed.

Black; the scape of the antennæ, the basal half of the flagellum, the mandibles, the tegulæ, and the legs pale ferruginous. Wings hyaline, iridescent; nervures testaceous. The recurrent nervure is almost interstitial with the transverse cubital nervure.

Length 5 mm.

*Hab.* Cairns, Queensland (*Turner*); January.

Nitela reticulata, sp. n.

♀. Clypeus strongly convex, with an elevated carina from the base to the apex, shining and very minutely punctured. Front rugose, vertex almost smooth with a few indistinct transverse striæ; the eyes moderately convergent towards the vertex, the posterior ocelli about half as far again from each other as from the eyes; a delicate carina from the anterior ocellus not reaching the base of the clypeus. Pronotum short and transverse, much narrower than the head, the anterior and posterior margins strongly raised, the short intervening space strongly rugose and divided in the middle by a carina. Mesonotum coarsely rugose, irregularly transversely striated anteriorly, with an indistinct carina from the middle to the posterior margin. Median segment longer than the mesonotum, narrowed towards the apex and vertically truncate posteriorly, longitudinally striated, the space between the striæ very coarsely punctured, giving an appearance of coarse reticulation. Abdomen smooth and shining, shorter than the thorax and median segment combined; the first segment long, truncate at the base, the second segment strongly depressed at the base, the apical segment pointed.

Black; the mandibles, the antennæ, except the four apical joints which are fuscous, the tegulæ and the legs ferruginous. Wings hyaline, nervures pale ferruginous. The recurrent nervure is interstitial with the transverse cubital nervure.

Length 5 mm.

*Hab.* Mackay, Queensland (*Turner*); May.

The antennæ are inserted very low down close to the sides of the clypeus. The tubercles at the posterior angles of the pronotum do not reach the tegulæ, differing in this point from typical *Nitela*.

PISON SCABRUM, sp. n.

♀. Clypeus rather more than twice as broad as long; the anterior margin broadly rounded, narrowly and bluntly produced in the middle, closely punctured and clothed with long greyish pubescence, changing to silver in strong lights. Antennæ inserted about as far from each other as from the eyes, as long as the thorax and median segment combined, very slightly thickened to the seventh joint of the flagellum; the second joint of the flagellum three times as long as the first and one-third longer than the third. Eyes deeply emarginate, the distance between them on the vertex slightly exceeding the length of the two basal joints of the flagellum combined, the distance between them at the base of the mandibles nearly half as great again as on the vertex. Posterior ocelli nearly half as far again from the eyes as from each other, a little nearer to each other than to the anterior ocellus. Head closely and rather finely punctured, thinly clothed with cinereous pubescence; a short, longitudinal, median carina on the front above the base of the antennæ. Pronotum very short, depressed below the level of the mesonotum. Thorax shining, closely punctured, with an obscure longitudinal carina on the scutellum. Median segment not more than two-thirds of the length of the mesonotum, punctured-rugose, without a median carina, with a small shining spot at the apex, truncate posteriorly, with a median sulcus not reaching the apex, and with a few transverse striæ at the apex. Abdomen very minutely and closely punctured, the third segment as long as the second, the apical margin of the segments depressed, with a band of silvery pubescence, the apical segment elongate and very sharply pointed.

Black; the tegulæ, the apical margin of the fifth abdominal segment, and the spines of the posterior tibiæ fusco-ferruginous. Wings hyaline, faintly tinged with fuscous, a little darker at the apex; nervures black.

The recurrent nervures are interstitial with the first and second transverse cubital nervures; the second cubital cell reaches halfway from the cubital to the radial nervure; the third cubital cell is more than half as long on the radial as on the cubital nervure.

Length 15 mm., exp. 25 mm.

*Hab.* Mackay, Queensland (*Turner*).

This is allied to *P. spinolæ*, but differs in the sculpture of the median segment, in the stronger punctures on the head and thorax, and the greater breadth between the eyes. The clypeus is also broader. Also allied to *P. fuscipenne* Sm. from W. Australia and *P. nitidum* Sm. from Mysole, but the distance between the eyes is much greater than in either species, and the antennæ are much longer than in *fuscipenne*.

Pison insulare Sm. st. priscum, n. st.

♀. Clypeus nearly twice as broad as long, bluntly produced in the middle of the anterior margin. Antennæ as long as the thorax and median segment combined, inserted a little further from each other than from the eyes; the second joint of the flagellum a little longer than the third, and about two and a half times as long as the first. Eyes narrowly and deeply emarginate, fully half as far again from each other at the base of the mandibles as on the vertex, the distance between them on the vertex exceeding the length of the second joint of the flagellum. The posterior ocelli as far from the eyes as from each other. Head opaque, the clypeus and the front round the base of the antennæ clothed with shining white pubescence. Thorax shining, minutely punctured. Median segment shorter than the mesonotum, almost vertically truncate posteriorly, very finely and sparsely punctured, shining, with an almost obsolete median sulcus; the face of the truncation with a deep depression at the base, finely punctured at the base, with a few indistinct transverse striæ at the apex. Abdomen shining, minutely punctured, the first segment oblique and slender at the base, much longer than the second, the second segment not depressed at the base; the apical margin of the segments feebly depressed, with a little greyish-white pubescence on the sides.

Entirely black. Wings hyaline, faintly tinted with fuscous, especially at the apex, and slightly iridescent; nervures black.

The first recurrent nervure is received close to the apex of the first cubital cell, the second is interstitial with the second transverse cubital nervure. The second cubital cell does not reach halfway from the cubital to the radial nervure; the third is about half as long on the radial as on the cubital nervure.

Length 12 mm., exp. 20 mm.

*Hab.* Mackay, Queensland (*Turner*); November.

The eyes on the vertex of typical *P. insulare*, from the New Hebrides, are nearer together than the length of the second joint of the flagellum; the clypeus is not bluntly produced in the middle of the apical margin; the median segment is less abruptly truncate posteriorly, and the median sulcus on it is well defined. The wings are also more hyaline.

These differences hardly seem of full specific importance, though quite sufficient to constitute a good geographical race.

Pison infumatum, sp. n.

♀. Clypeus twice as broad as long, bluntly produced on the middle of the apical margin, thinly covered with short grey pubescence. Head opaque, with a very obscure longitudinal sulcus on the front. Eyes deeply emarginate, separated on the vertex by a distance equal to the length of the two basal joints of the flagellum, more than half as far again from each other at the base of the mandibles; the posterior ocelli very near the eyes, nearly twice as far from each other, but much nearer to each other than to the anterior ocellus. Antennæ inserted a little nearer to each other than to the eyes; the second joint of the flagellum more than twice as long as the first and about one-third longer than the third. Pronotum not much more than half as broad as the head, steeply depressed anteriorly, the posterior margin straight. Thorax subopaque. Median segment almost smooth, very minutely punctured, with very short striæ at the base, and a very obscure median carina from the base to the apex. Abdomen very minutely punctured, the apical margin of the segments broadly depressed, the second segment not depressed at the base.

Entirely black; the tegulæ testaceous brown; the pubescence white on the inner margin of the eyes below the emargination, on the sides of the postscutellum, on the sides of the median segment near the apex, and very sparsely on the sides of the abdominal segments. Wings hyaline at the base, the apical two-thirds fusco-hyaline; nervures black.

The recurrent nervures are almost interstitial with the first and second transverse cubital nervures. The second cubital cell extends more than halfway from the cubital to the radial nervure; the third is about three times as long on the cubital as on the radial nervure.

Length 7 mm., exp. 10 mm.

*Hab.* Port Darwin (*Turner*); December.

Pison ignavum, sp. n.

♀. Clypeus broadly rounded anteriorly, about twice as broad at the apex as long, clothed with shining white pubescence. Antennæ inserted about the same distance from each other as from the eyes, about twice as long as the mesonotum, thickened to the eighth joint of the flagellum; the second joint of the flagellum a little shorter than the scape, fully twice as long as the first joint of the flagellum and very slightly longer than the third. Eyes deeply emarginate, about one-third further from each other at the base of the mandibles than on the vertex, the distance between them on the vertex equal to about twice the length of the second joint of the flagellum; the posterior ocelli nearer to each other than to the anterior ocellus, a little further from each other than from the eyes, with a depressed transverse line on the vertex behind them. Head opaque, a very faint longitudinal sulcus below the anterior ocellus, the front round the base of the antennæ and the inner orbits of the eyes as high as the emargination clothed with shining white pubescence. Thorax minutely punctured; the pronotum transverse, with white pubescence; the mesonotum more than half as broad again as long. Median segment a little shorter than the mesonotum, broader at the base than long, the sides steeply sloped, truncate posteriorly, obliquely striated, with a longitudinal median carina; the face of the truncation rather coarsely transversely striated, with a median sulcus, the sides of the segment raised, forming carinæ, a little white pubescence at the apex. Abdomen ovate, closely and minutely punctured, the second segment transversely depressed at the base; the apical margin of all the segments feebly depressed, most broadly in the middle, with interrupted bands of silvery pubescence.

Black; the spines of the tibiæ testaceous; tegulæ fuscous. Wings hyaline, faintly clouded at the apex, nervures black.

First recurrent nervure received near the apex of the first cubital cell, second at the middle of the second cubital cell. The second cubital cell reaches more than halfway from the cubital to the radial nervure; the third is extremely short on the radial nervure.

♂. Similar in all respects to the female.

Length, ♀ 9 mm., ♂ 7 mm.; exp., ♀ 14 mm., ♂ 12 mm.

*Hab.* Mackay and Cairns, Queensland (*Turner*); March. Also from Melbourne.

Near *P. westwoodi* Shuck. from Tasmania, but differs in the presence of a carina on the median segment and in the position of the recurrent nervures. I have not seen the type of *P. westwoodi*, nor any specimen quite answering to the description. The present species is also near *P. iridipennis* Sm. from Hawaii, but the antennæ are longer and the eyes further apart on the vertex, the clypeus is also different. *P. pallidipalpe* Sm., from Ceram, is a larger species, and has the clypeus very different.

Pison iridipenne Sm.

Described by Smith from Honolulu.

*Hab.* Mackay and Cairns, Queensland (*Turner*).

In the female the posterior ocelli almost touch the eyes, which are very close together on the vertex.

Pison punctulatum Kohl.

*Pison punctulatum* Kohl, Verh. zool.-bot. Ges. Wien, xxxiii. p. 336, 1883, nec Cameron.

*Hab.* Peak Downs, Queensland (*Kohl*); Mackay, Queensland (*Turner*).

Pison auriventre, sp. n.

♀. Clypeus very short, at least three times as broad as long, convex, clothed with golden pubescence, changing to silver at the angles. Antennæ nearer to the eyes than to each other; the second joint of the flagellum scarcely longer than the third, about twice as long as the first. Eyes shallowly and rather broadly emarginate, the depth of the emargination about equal to the length of the first joint of the flagellum; about half as far again from each other at the base of the mandibles as on the vertex.

Posterior ocelli as far from the anterior ocellus as from each other, nearly half as far again from each other as from the eyes. Head opaque, the front closely covered with golden pubescence. Pronotum about two-thirds of the breadth of the head, the posterior margin straight, the angles not rounded, covered with pale shining pubescence. Thorax opaque. Median segment as long as the mesonotum, with sparse golden pubescence, silvery on the sides, obscurely obliquely striated, with a median carina; the posterior truncation irregularly transversely striated, with a median sulcus, the sides closely and finely punctured. Abdomen ovate, very minutely and closely punctured, the sides and apical margins of the segments covered with short golden pubescence, the pubescence at the apical angles of the basal segment silvery. The first segment is subtruncate at the base, the second is the longest and broadest.

Black; the mandibles ferruginous; the spines of the tibiæ, the tarsal ungues, and the apical margin of the abdominal segments very narrowly fusco-ferruginous. Wings hyaline, iridescent, clouded with fuscous at the apex; the nervures black.

The first recurrent nervure is received by the first cubital cell very near the apex, the second is interstitial with the second transverse cubital nervure. The third cubital cell is three times as long on the cubital as on the radial nervure.

Length 8 mm.

*Hab.* Victoria (*French*).

Allied to *P. marginatum* Sm., from which it may be distinguished by the more shallow emargination of the eyes, the front is also much narrower. As in *marginatum* the two or three apical joints of the antennæ are slenderer than the preceding ones. The allied West-Australian species *tibiale* is a much stouter built insect with a much shorter median segment. The median segment is also longer than in *P. simillimum* Sm., in which species the eyes are deeply emarginate as in *P. marginatum*.

PISON VIROSUM, sp. n.

♀. Clypeus large, not more than twice as broad as long at the broadest point, narrowed towards the apex, where it is subtruncate, feebly convex, clothed with dull golden pubescence. Head and thorax opaque; the front broad, with a shallow, longitudinal, median sulcus above the base of the clypeus, not nearly reaching the anterior ocellus. Eyes separated at the base of the clypeus by a distance half as great again as that separating them on the vertex; the emargination shallow and rather broad, not equal in depth to the length of the first joint of the flagellum. Posterior ocelli a little further from each other than from the eyes, with a delicately impressed transverse line above and touching them. Antennæ as long as the thorax and median segment combined, inserted near together, twice as far from the eyes as from each other, very slightly thickened to the apex; the second joint of the flagellum as long as the scape, twice as long as the first joint and nearly half as long again as the third. Pronotum straight, strongly depressed anteriorly, about two-thirds of the width of the head. Median segment not quite as long as the mesonotum, narrowed and almost vertically truncate posteriorly, closely obliquely striated, with a median carina from the base to the apex; the face of the truncation transversely striated, with a deep median sulcus. Abdomen very minutely punctured, the apical margin of the segments rather broadly depressed, the second segment a little longer than the first or third, the first subtruncate at the base.

Black; the front covered with fine golden pubescence, the posterior margin of the pronotum with fine silvery pubescence; the antennæ (except the apical joint), the mandibles, tegulæ, tarsi, tibiæ, the apex of the femora, and the abdomen (except the base of the first segment) ferruginous. Wings hyaline, faintly iridescent; nervures fuscous.

The first recurrent nervure is received close to the apex of the first cubital cell, the second at the middle of the second cubital cell. The third cubital cell is twice as long on the cubital as on the radial nervure, and the second cubital cell reaches a little more than halfway from the cubital to the radial nervure.

♂. The clypeus produced into a point on the middle of the apical margin, the pubescence on the front paler than in the female, and the apical abdominal segment narrowly emarginate at the apex. Otherwise as in the female.

Length, ♀ 9 mm., ♂ 7 mm.

*Hab.* Mackay, Queensland (*Turner*); September to February.

This seems to be near *P. pelletieri* Le Guillou, but is a smaller species and the sculpture of the median segment is very different. I have not seen *P. pelletieri.*

Pison ruficorne Sm.

♀. Clypeus large, not more than half as broad again as long, truncate at the apex, clothed with short silvery pubescence, very slightly convex. Head and thorax opaque, the front above the base of the antennæ and the inner margin of the eyes below the emargination clothed with silvery pubescence. Eyes more strongly convergent towards the clypeus than towards the vertex, separated on the vertex by a distance about one-third greater than the distance separating them at the base of the clypeus, the emargination narrow and exceeding in depth the length of the first joint of the flagellum by about one-half. Antennæ inserted a little nearer to the eyes than to each other; the second joint of the flagellum as long as the scape, twice as long as the first joint but only slightly longer than the third, the apical joints moderately thickened. Pronotum very short, the posterior margin straight, depressed below the level of the mesonotum, about one-quarter narrower than the head, and thinly clothed with short white pubescence. Median segment rather shorter than the mesonotum, narrowed and vertically truncate posteriorly.

rather coarsely obliquely striated, with a rather ill-defined median carina from the base to the apex; the surface of the posterior truncation transversely striated, with a deep median sulcus. Abdomen not quite as long as the thorax and median segment combined, almost smooth, the apical margin of the segments depressed, with a little fine pubescence on the sides; the first segment subtruncate at the base, the second a little longer than the first or third, transversely depressed at the base.

Black; the mandibles, palpi, antennæ (except at the extreme apex), tegulæ, tibiæ, tarsi, the apex of the femora, and the abdomen (except the basal half of the first segment and the extreme base of the second) ferruginous. Wings hyaline, nervures black.

The first recurrent nervure is received by the first cubital cell about one-fifth before the apex, the second at the middle of the second cubital cell. The second cubital cell does not reach quite halfway to the radial nervure from the cubital nervure; the third cubital cell is a little less than twice as long on the cubital as on the radial nervure.

Length 8 mm.

*Hab.* Victoria (*French*).

In another specimen the second, third, and fourth abdominal segments are strongly stained with black. The type was from the Macintyre River, Queensland, and has much more black on the abdomen. The specimen in the British Museum collection is from that locality and is probably the type, though not marked. I have taken the description from a Victorian specimen. In Queensland specimens the eyes are nearly, if not quite, as far apart on the clypeus as on the vertex. In specimens from Mackay the median segment is much more finely striated and the abdomen is brighter in colour and entirely ferruginous. These differences, although apparently constant, do not seem to me sufficient to deserve even subspecific rank; it is probable that connecting forms will be found to occur in intermediate localities.

PISON MELANOCEPHALUM, sp. n. (Plate XXVI. fig. 12.)

♀. Clypeus subtriangular, truncate at the base, convex, obliquely triangularly depressed from the centre to the apex. Head opaque, almost smooth, with a shallow longitudinal sulcus reaching from the anterior ocellus to near the base of the clypeus. Eyes deeply and narrowly emarginate, convergent towards the base of the antennæ, where they are separated by a distance about equal to the length of the scape of the antennæ, separated on the vertex by a distance nearly twice as great; the posterior ocelli nearly twice as far from each other as from the eyes. Antennæ inserted at the base of the clypeus, very close to the eyes; the scape short, about equal in length to the two basal joints of the flagellum; the second and third joints of the flagellum about equal to each other in length, each more than half as long again as the first joint, the apical joints slightly thickened. The eyes reach to the posterior margin of the head. Pronotum about two-thirds of the width of the head, strongly depressed anteriorly. Thorax and median segment impunctate, subopaque; the median segment slender, half as long again as broad at the base, narrowed posteriorly and oblique, with a median sulcus from the base not reaching the apex. First abdominal segment slender at the base, with a longitudinal sulcus not reaching the apex, nearly as long as the second segment; the second and third segments strongly transversely depressed at the base. The tarsi are without spines.

Light ferruginous brown; the head black; the antennæ (except the two apical joints) castaneous. Wings hyaline, nervures pale ferruginous.

The second cubital cell is very small, only extending along the transverse cubital nervure for less than one-third of its length, the second recurrent nervure is received close to the base of the cell; the first cubital cell more than three times as long as the third on the cubital nervure, receiving the first recurrent nervure beyond two-thirds from the base.

Length 5 mm.

*Hab.* Cairns, Queensland (*Turner*); February.

This is closely allied to some of the species of the *Parapison* section in which the second cubital cell is wholly absent. The strong convergence of the eyes towards the base of the clypeus is remarkable.

PISON (PARAPISON) NOCTULUM, sp. n.

♀. Clypeus narrowly convex in the middle, nearly twice as broad as long, the apical margin very broadly rounded, clothed with very short silvery pubescence. Antennæ as long as the head, thickened towards the apex, inserted a little further from each other than from the eyes; the second joint of the flagellum twice as long as the first and half as long again as the third. Eyes rather deeply emarginate, half as far again from each other at the base of the mandibles as on the vertex, separated on the vertex by a distance about equal to the length of the two basal joints of the flagellum. Head opaque, with a delicate longitudinal sulcus below the anterior ocellus. Posterior ocelli half as far again from each other as from the eyes, and as far from each other as from the anterior ocellus. Thorax opaque, very minutely punctured; pronotum narrowed anteriorly and oblique, longer than in most of the species of the genus, the posterior margin as broad as the head and on a level with the mesonotum. Median segment shorter than the mesonotum, narrowed and truncate posteriorly, very delicately transversely striated, with a small smooth triangular mark at the apex, from the apex of the triangle a carina reaches almost to the apex of the segment; the surface of the truncation is almost smooth, with a broad median sulcus. Abdomen almost smooth, the apical margin of the segments depressed, with sparse grey pubescence on the sides; the second segment feebly transversely depressed at the base, equal in length to the third. The mesopleuræ are opaque, very minutely punctured, with the longitudinal sulcus below the base of the wings much more feebly marked than in *P. erythrocerum* Kohl.

Black; the tegulæ fuscous. Wings hyaline, faintly clouded at the apex; nervures fuscous.

Length 7 mm.

*Hab.* Mackay, Queensland (*Turner*); February.

The pronotum is shaped as in *erythrocerum* Kohl, but more strongly narrowed anteriorly, and much less depressed than in other species.

PISON (PARAPISON) PERTINAX, sp. n.

♀. Head and thorax opaque, not visibly punctured, a short and obscure longitudinal sulcus below the anterior ocellus. Clypeus short, fully twice as broad as long, convex, very broadly rounded anteriorly, and covered with short silvery pubescence. Antennæ a little longer than the head, inserted at the base of the clypeus, nearly half as far again from each other as from the eyes; the scape short, scarcely longer than the second joint of the flagellum, which is about half as long again as the first or third; the first joint is stout and equal in length to the third. Eyes narrowly emarginate, the depth of the emargination about equal to the length of the first joint of the flagellum; the distance between the eyes on the vertex equal to about three-quarters of the distance between them at the base of the clypeus. The posterior ocelli a little nearer to the eyes than to each other, situated very near to the posterior margin of the head, which is slightly transversely raised behind them. Pronotum short and strongly depressed anteriorly, the posterior margin straight; scutellum broadly truncate at the apex. Median segment rather slender, much longer than broad, a little longer than the mesonotum, delicately obliquely striated, a carina from the base to the apex lying in a depressed sulcus, the lateral margins of the segment marked by a carina; narrowed posteriorly and abruptly truncated, the surface of the truncation transversely striated, with a deep median sulcus. Abdomen as long as the thorax and median segment combined, shining; the apical margins of the segments depressed, most broadly in the middle, the second segment constricted at the base, longer and broader than the first or third.

Black; the mandibles, antennæ (except the two apical joints), tibiæ, tarsi, and abdomen (except the middle of the third segment) ferruginous. Wings hyaline, iridescent; nervures black.

The first recurrent nervure is received by the first cubital cell beyond two-thirds from the base, the second at the extreme base of the second cubital cell, which is almost pointed on the radial nervure, being less than a quarter of the length of the cell on the cubital nervure.

Length 7 mm.

*Hab.* Mackay, Queensland (*Turner*); January to May.

In some specimens the abdomen is wholly ferruginous.

Pison (Parapison) tenebrosum, sp. n.

♀. Mandibles acute at the apex; clypeus short, more than twice as broad as long, narrowly convex or subcarinate in the middle, with a small blunt tubercle just before the apex, subtruncate at the apex, clothed with short silvery pubescence. Head, thorax, and abdomen opaque; the eyes narrowly and shallowly emarginate, separated on the clypeus by a distance about one-quarter greater than that separating them on the vertex. Antennæ scarcely longer than the head, inserted a little further from each other than from the eyes, the scape as long as the first two joints of the flagellum combined; the first joint of the flagellum two-thirds of the length of the second, the second and third almost equal. Posterior ocelli twice as far from each other as from the eyes. Pronotum almost straight, transverse, about three-quarters of the breadth of the head; mesonotum with a broad, shallow, longitudinal, median depression not reaching the posterior margin. Median segment a little shorter than the mesonotum, narrowed from the base, obliquely truncate posteriorly, with a longitudinal carina from the base lying in a shallow depression and not reaching the apex, obscurely obliquely striated; the face of the truncation minutely and very closely punctured, with a deep median sulcus. The sides and apical margin of the abdominal segments with sparse grey pubescence. The first segment subtruncate at the base, nearly as long and broad as the second.

Black; the mandibles dark ferruginous; the spines of the tibiæ testaceous; the tegulæ, the anterior tibiæ, and the tarsi fuscous. Wings hyaline, nervures fusco-ferruginous.

The second cubital cell is small, triangular, pointed on the radial nervure, less than one-third of the length of the first on the cubital nervure, receiving the second recurrent nervure near the base. The first cubital cell receives the first recurrent nervure beyond two-thirds from the base.

Length 5 mm., exp. 8 mm.

*Hab.* Mackay, Queensland (*Turner*); January.

Pison (Parapison) caliginosum, sp. n.

♀. Mandibles short and very broad, shallowly and widely emarginate at the apex. Clypeus half as broad again as long, very feebly convex, strongly rounded at the apex. Head and thorax opaque, very minutely and closely punctured; the antennæ inserted almost as near to each other as to the eyes, the scape about equal in length to the first two joints of the flagellum, the second joint of the flagellum more than half as long again as the first and a little longer than the third. The emargination of the eyes exceeding in depth the length of the first joint of the flagellum; the eyes at the base of the clypeus nearly half as far again from each other as on the vertex. Posterior ocelli nearer to each other than to the anterior ocellus, but nearer to the eyes than to each other. Pronotum not more than two-thirds of the breadth of the head, very short, the posterior margin straight. Median segment as long as the mesonotum, narrowed strongly and abruptly truncate posteriorly, with a median carina lying in a narrow depression not quite reaching the base of the truncation, delicately obliquely striated, punctured between the striæ; the surface of the truncation with a deep depression at the base, finely punctured at the sides, finely transversely striated near the apex. Abdomen shining, very minutely punctured, the first segment slender at the base, as long as the second, and at the apex about two-thirds of the breadth of the second; the second segment transversely depressed at the base and longer than the third.

Entirely black, with a little sparse silvery pubescence on the orbits of the eyes and the sides of the median segment and abdomen; a little fulvous pubescence on the sides of the two apical segments; the silvery pubescence very short and fine, the fulvous coarser. Wings hyaline, iridescent, faintly clouded at the extreme apex; nervures black.

The second cubital cell is very short on the radial nervure, but half as long as the first on the cubital nervure, receiving the second recurrent nervure before the middle. The first cubital cell receives the first recurrent nervure at about one-sixth from the apex.

Length 7 mm., exp. 11 mm.

*Hab.* Kuranda near Cairns, Queensland (*Turner*); February.

Pison (Parapison) aberrans, sp. n.

♂. Antennæ no longer than the head, moderately thickened to the apex, about the same distance from each other at the base as from the eyes; the second joint of the flagellum scarcely longer than the first, the scape longer than the first three joints of the flagellum combined. Clypeus nearly three times as broad at the apex as long, the apical margin almost straight, clothed with shining silvery pubescence. Head and thorax opaque; an obscure, impressed, longitudinal line on the front below the anterior ocellus; the front round the base of the antennæ and the inner orbits of the eyes below the emargination clothed with silvery pubescence. Eyes narrowly and rather shallowly emarginate, the emargination hardly equalling in depth the length of the first joint of the flagellum; the distance between the eyes at the base of the clypeus exceeding by more than one-third the distance between them on the vertex; the posterior ocelli nearly twice as far from each other as from the eyes. Pronotum strongly depressed anteriorly, the posterior margin very broadly arched. Scutellum smooth and shining, broadly truncate at the apex. Median segment longer than broad, finely obliquely striated, longitudinally depressed in the middle, with a carina in the depression, truncate posteriorly; the surface of the truncation transversely striated, with a median sulcus. Abdomen shining, microscopically punctured, the segments feebly but broadly depressed on the apical margin; the second segment transversely depressed at the base, broader but hardly longer than the first and third.

Black; the mandibles and the tarsi ferruginous brown. Wings hyaline, iridescent; nervures black.

The first recurrent nervure is received by the first cubital cell a little before two-thirds from the base, the second at the extreme base of the second cubital cell. The second cubital cell is extremely small, almost pointed on the radial nervure, and not more than one-sixth of the length of the first cubital cell on the cubital nervure. On one side of the type specimen the second transverse cubital nervure is absent, leaving the cell open.

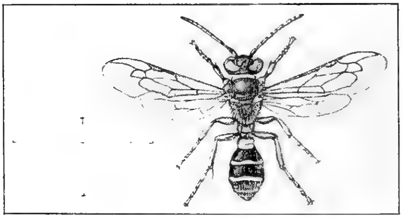
Length 4 mm.

*Hab.* Mackay, Queensland (*Turner*); January.

Pison (Aulacophilus) difficile, sp. n.

♀. Clypeus slightly produced and pointed in the middle of the apical margin, nearly twice as broad at the apex as long, thinly clothed with pale fulvous pubescence. Antennæ inserted just above the base of the clypeus, a little further from each other than from the eyes, as long as the thorax and median segment combined; the apical joints not at all thickened; the second joint of the flagellum longer than the third joint or than the scape. Eyes rather deeply emarginate, convergent towards the vertex, where they are separated by a distance equal to the length of the second joint of the flagellum; the posterior ocelli nearer to

Text-fig. 110.



*Pison (Aulacophilus) difficile.*

the eyes than to each other. Head opaque, about equal in breadth to the mesonotum, the front thinly clothed with short, pale, golden pubescence. Pronotum short, strongly depressed and clothed with pale golden pubescence. Thorax and median segment very delicately punctured. The median segment longer than the mesonotum, strongly narrowed and depressed to the apex, with a deep sulcus from the apex nearly reaching the middle, the sides with thin greyish pubescence. Abdomen petiolate, pubescent; the first segment twice as broad at the apex as at the base, half as long again as the second segment, the third segment a little broader than the second; the apical margin of segments 1–4 with a band of pale golden pubescence interrupted in the middle.

Black; the mandibles at the base, the antennæ (except the two apical joints), the tegulæ, the base and apex of the first abdominal segment broadly, the apical margin of the remaining segments, the tarsi, tibiæ, and the apex of the femora rufo-testaceous. Wings hyaline, nervures dull rufo-testaceous.

The first cubital cell very long, receiving the first recurrent nervure very near the apex; the second cubital cell very short on the radial nervure, receiving the second recurrent nervure near the base, less than three times as long on the cubital as on the radial nervure.

Length 11 mm., exp. 19 mm.

*Hab.* Mackay, Queensland (*Turner*).

This species resembles the following one *P. icarioides* in shape, but the antennæ are much longer and are not thickened at the apex, and the shape of the second cubital cell is very different. It does not approach so nearly to *Aulacophilus*, forming a connecting link with true *Pison*.

PISON (AULACOPHILUS) ICARIOIDES, sp. n. (Plate XXVI. fig. 13.)

♀. Clypeus broadly rounded at the apex, more than twice as broad as long, clothed with rather long, shining, very pale golden pubescence. Front round the base of the antennæ, and the inner orbits of the eyes as high as the emargination, clothed with short silvery pubescence; a short, obscure, median carina above and between the base of the antennæ; the vertex opaque. Eyes rather shallowly and broadly emarginate, the distance between them at the base of the mandibles about one-third greater than on the vertex; the posterior ocelli almost as far from each other as from the eyes. Antennæ inserted a little further from each other than from the eyes, scarcely longer than the head, much thickened to the apex; the second joint of the flagellum less than twice as long as the first and one-third longer than the third. Thorax, median segment, and abdomen opaque, very minutely and closely punctured; the pronotum nearly as broad as the head, very gradually depressed anteriorly; scutellum short and transverse. The median segment rather slender, longer than the mesonotum, much narrowed and rounded to the apex, not truncate, with a median sulcus from the base to the apex. First abdominal segment slender, nearly twice as long as it is broad at the apex, about three times as broad at the apex as at the base, with a deep sulcus from the base to beyond the middle, the apical margin strongly depressed; second segment very large, nearly three times as broad at the apex as the first, strongly convex; the apical margin of all the segments depressed.

Black; the mandibles (except at the apex), the antennæ at the base, the apex of the clypeus, the tegulæ, the first segment of the abdomen, the apical margins of the other segments, the tibiæ, tarsi, and the apex of the femora dull ferruginous. The pubescence on the posterior margin of the pronotum, the postscutellum, the apex of the median segment, the apical margin of all the abdominal segments, and the whole of the third golden yellow, short and dense. Wings very pale flavo-hyaline, slightly clouded on the costa and at the apex; nervures ferruginous.

The first recurrent nervure is received by the first cubital cell just beyond three-quarters from the base, the second by the second cubital cell close to the base. The second cubital cell is extremely short on the radial nervure, both transverse cubital nervures being strongly curved and convergent. As in *Parapison*, the true second cubital cell is obsolete.

Length 11 mm., exp. 18 mm.

*Hab.* Mackay, Queensland (*Turner*).

This species differs from *Aulacophilus vespoides* Sm. in the shape of the first abdominal segment, which is much shorter and broader, and also in the shape of the second cubital cell and the position of the recurrent nervures. I do not consider *Aulacophilus* of more than subgeneric value. The occurrence of species in Australia is another instance of the relationship of the Hymenopterous fauna of S. America and Australia. The present species shows most relationship to *Pison* in the *auratus* group.

TRYPOXYLON CONNEXUM, sp. n.

♀. Clypeus broadly rounded anteriorly, broad and short, densely clothed with short silvery pubescence. Antennæ inserted very near together, nearer to each other than to the eyes; the second joint of the flagellum nearly half as long again as the third, the apical joint conical, scarcely longer than the penultimate joint. Eyes separated on the vertex by a distance about one-third greater than that separating them at the base of the clypeus; the posterior ocelli nearly twice as far from each other as from the eyes, and further from the anterior ocellus than from each other. The inner orbits of the eyes are clothed with silvery pubescence as high as the deep and narrow emargination. The anterior ocellus is surmounted by an elevated semicircular carina, which is narrowly separated from the inner margin of the eyes and reaches as low as the emargination, whence it is continued as a **V**-shaped carina, much elevated at the apex and almost reaching the base of the antennæ; from the apex it is continued as a very high carina between the antennæ, terminating abruptly at the base of the clypeus; the space enclosed by the carinæ is concave and opaque; the vertex subopaque, with an obscure longitudinal carina between the posterior ocelli. Pronotum on a level with the mesonotum, short and broadly, but slightly, emarginate anteriorly, the anterior margin raised and thickened. Mesonotum opaque and finely, but not very closely punctured; the mesopleuræ with sparse silvery pubescence. Median segment slender, obliquely truncate posteriorly, transversely striated, the posterior surface with a deep median sulcus; the triangular space at the base slightly convex, transversely striated, and divided by a longitudinal sulcus. Abdomen shining, very minutely punctured and feebly pubescent; the first segment very slender, slightly thickened at the apex, longer than the second and third segments combined.

Black; the posterior margin of the pronotum pale testaceous; tegulæ and the spines of the tibiæ testaceous. Wings hyaline, nervures fusco-ferruginous.

♂. As in the female, but the apical joint of the antennæ is longer and slightly curved near the apex, fully twice as long as the second joint of the flagellum.

Length, ♀ 10–12 mm., ♂ 9 mm.

*Hab.* Mackay, Queensland (*Turner*); February and March.

Very near *T. pileatum* Sm. from India, but the frontal carinæ are much more strongly developed and the first abdominal segment longer; the sculpture of the median segment is also coarser.

TRYPOXYLON PLACIDUM Sm.

*Trypoxylon placidum* Sm. Proc. Linn. Soc., Zool. vii. p. 35. n. 1, 1863.

*Hab.* Mysole (*Smith*); Cairns, Queensland (*Turner*), April.

CRABRO (RHOPALUM) MILITARIS, sp. n.

♂. Clypeus small, subtriangular, without a carina, without spines on the anterior margin. Mandibles bidentate at the apex, the inner tooth the longest. Head and thorax shining, minutely punctured, the front smooth, the groove for the scape deep and very narrowly separated from the eyes. Eyes almost touching the base of the antennæ, where they are separated from each other by a distance equal to half the length of the scape. The second joint of the flagellum half as long again as the first. Pronotum not more than half as wide as the head, narrowed anteriorly, the angles obtuse. Mesonotum broadly and very shallowly depressed on the middle of the anterior half, with a very obscure longitudinal carina in the depression; the scutellum divided by an obscure longitudinal carina. Mesopleuræ shining, a little more strongly punctured than the mesonotum. Median segment steeply sloped posteriorly, smooth and shining; the longitudinal sulcus dividing the triangular space at the base very shallow and obscure, well-defined and deep on the posterior slope. Abdomen petiolate, longer than the head and thorax combined, and slender; the first segment very narrow and flat, swollen at the apex, longer than the second segment, which is long and gradually broadened to the apex, the fourth segment the broadest. Epipygium shining, very narrowly truncate at the apex.

Black; the scape of the antennæ, the anterior and intermediate tibiæ and tarsi, and the apex of the femora yellow; the apex of the first abdominal segment, the second and third (except on the apical margin), the posterior tibiæ and tarsi, and the apex of the femora ferruginous. Wings hyaline iridescent, nervures black.

The recurrent nervure is received by the cubital cell at two-thirds from the base. The posterior tibiæ are much swollen towards the apex.

Length 12 mm., exp. 17 mm.

*Hab.* Victoria (*French*); Tasmania.

The specimen from Tasmania has the wings fusco-hyaline.

Crabro (Rhopalum) tricolor Sm.

*Crabro tricolor* Sm. Cat. Hym. B. M. iv. p. 394. n. 14, 1855, ♂.

♀. Mandibles bidentate at the apex, the outer tooth very small. Clypeus convex in the middle and subcarinate, produced in the middle of the apical margin and emarginate, the angles of the emargination forming strong blunt teeth, a small tooth on each side; the whole clypeus clothed with shining silvery pubescence. Antennæ inserted close to the eyes, the distance between the eyes at their base about equal to the length of the second joint of the flagellum; the first joint of the flagellum about half as long as the third, and a little more than half as long as the second. The posterior ocelli nearer to each other than to the eyes and nearer to the anterior ocellus than to each other, with a feeble longitudinal carina between them. Head and thorax opaque, very closely and minutely punctured, the front smooth and shining, the groove for the scape occupying the entire breadth, the posterior margin of the head broadly emarginate. Pronotum short, strongly narrowed anteriorly; the mesopleuræ less opaque than the mesonotum. Median segment steeply sloped posteriorly and rounded, the space at the base opaque, very finely rugose, with a sulcus from the base to the apex and a few very short striæ from the base. Abdomen petiolate, opaque, very minutely punctured; the first segment long and slender, swollen at the apex, a little longer than the second, the second and third gradually widened, the fourth the broadest; the fifth dorsal segment clothed with short, close, fulvous pubescence. The epipygium is triangular, opaque, the sides slightly raised. The posterior tibiæ strongly swollen to the apex. The recurrent nervure is received by the cubital cell just before three-quarters from the base.

Black; the scape of the antennæ, the apex of the tegulæ, the tarsi, the anterior and intermediate tibiæ, and the apex of all the femora and of the posterior coxæ yellow; the base and apex of the second abdominal segment and the base of the third ferruginous; the tarsal ungues black. Wings hyaline, faintly tinged with fuscous; nervures fuscous.

♂. As in the female.

Length, ♀ 13 mm., ♂ 11 mm.

*Hab.* Woodford, Blue Mts, N. S. Wales (*G. A. Waterhouse*); Victoria (*French*); Tasmania (*Smith*).

Crabro (Rhopalum) tenuiventris, sp. n.

♀. Mandibles feebly bidentate at the apex. Clypeus clothed with shining white pubescence, truncate on the apical margin, convex at the base, with an oblique semicircular truncation at the apex, the truncation smooth and shining, without pubescence. Antennæ inserted close together, touching the eyes; the second joint of the flagellum longer than the first. Eyes just above the base of the antennæ separated by a distance about equal to the length of the second joint of the flagellum; the posterior ocelli a little further from the eyes than from each other and about the same distance from the posterior margin of the head as from each other. Head smooth and shining, the posterior margin broadly emarginate. Thorax smooth and shining, the pronotum narrowed anteriorly; the median segment rounded posteriorly, shining and very minutely punctured, with a median sulcus from the base. Abdomen elongate, shining and minutely punctured; the first segment very long and slender, of almost even thickness throughout, the second and third gradually broadened, the fourth the broadest. The recurrent nervure is received at the middle of the cubital cell, the transverse cubital at about one-third from the base of the radial cell.

Black; the mandibles and a mark on each side of the third abdominal segment rufo-testaceous; the scape of the antennæ, the apex of the tegulæ, the tubercles at the posterior angles of the prothorax, and the anterior and intermediate tibiæ and tarsi pale yellow; the four apical ventral segments testaceous. Wings hyaline, nervures black.

Length 4 mm.

*Hab.* Mackay, Queensland (*Turner*); May.

CRABRO (RHOPALUM) TRANSIENS, sp. n.

♂. Clypeus broadly rounded at the apex, without a carina, very feebly convex, and clothed with short silvery pubescence. Eyes separated from each other at the base of the antennæ by a distance nearly half as great again as the length of the scape; the first joint of the flagellum longer than the second, which is equal to the third. Posterior ocelli a little further from each other than from the eyes and as far from the eyes as from the posterior margin of the head. Head and thorax subopaque, microscopically punctured; the pronotum less than half as broad as the head and narrowed anteriorly, mesopleuræ minutely punctured, the groove rather shallow. Median segment smooth, rounded and steep posteriorly, with a transverse row of coarse punctures at the base and a short longitudinal sulcus at the extreme apex. Abdomen shining, microscopically punctured, petiolate; the first segment very narrow, swollen at the apex, a little longer than the second segment, the third and fourth segments the broadest. The recurrent nervure is received by the cubital cell at about three-fifths from the base.

Black; the scape of the antennæ and the posterior angles of the pronotum yellow; the first joint of the flagellum, the following four joints beneath, the mandibles, tegulæ, first joint of the abdomen, the base of the second joint, the tibiæ, tarsi, trochanters, and femora (except at the base) ferruginous. Wings hyaline, brilliantly iridescent; nervures fusco-ferruginous.

Length 5 mm.

*Hab.* Victoria (*French*).

CRABRO (RHOPALUM) FRENCHII, sp. n.

♀. Mandibles bidentate at the apex, the teeth short and feeble. Clypeus short, slightly convex, without a carina, and clothed with short silvery pubescence. Eyes separated from each other at the base of the antennæ by a distance equal to about three-quarters of the length of the scape; the first joint of the flagellum longer than the second. Posterior ocelli as far from the eyes as from each other and a little nearer to the posterior margin of the head. Head and thorax shining, microscopically punctured; the pronotum short and transverse, about two-thirds of the width of the head, the angles not prominent. Median segment shining, with a median sulcus from the base to the apex. Abdomen petiolate, as long as the head, thorax, and median segment combined, shining; the three basal segments smooth, the fourth and fifth very closely and minutely punctured; the first segment narrow, very slightly swollen at the apex, more than twice as long as broad, about one-third shorter than the second segment; the second gradually widened to the apex; the third and fourth segments the broadest. Pygidium elongate, triangular. The posterior tibiæ are swollen towards the apex. The recurrent nervure is received close to the middle of the cubital cell.

Black; the mandibles (except at the apex), the scape of the antennæ, the posterior angles of the pronotum, the trochanters, and the anterior and intermediate tibiæ and tarsi pale yellow; the tegulæ, pygidium, and the posterior tibiæ and tarsi fusco-ferruginous. Wings hyaline, iridescent; nervures fusco-ferruginous.

Length 5 mm.

*Hab.* Victoria (*French*); November.

CRABRO (RHOPALUM) CONATOR, sp. n.

♂. Mandibles bidentate at the apex, the teeth of about equal length. Clypeus clothed with silvery pubescence, broadly rounded anteriorly, with a delicate median carina. Eyes separated from each other at the base of the antennæ by about half the length of the scape, diverging very broadly towards the vertex. Second joint of the flagellum half as long again as the first and a little longer than the third. Posterior ocelli a little further from each other than from the eyes and more than half as far again from the posterior margin of the head as from each other. Head large, subquadrate, broadly emarginate posteriorly, finely rugulose behind the ocelli, rugose in front of the ocelli, with very thin erect pubescence. Pronotum short, broadly and shallowly emarginate anteriorly, the anterior angles slightly produced, narrower than the head. Mesonotum shallowly punctured; mesopleuræ opaque, almost smooth, the groove narrow and punctured. The enclosed space at the base of the median segment coarsely longitudinally rugose, the sides and apex of the segment obliquely striate-rugose. Abdomen opaque, petiolate; the first segment very slender, twice as long as the second, a little swollen at the apex, the second segment nearly as broad as the third.

Black; the scape of the antennæ, a spot on each side of the apex of the first abdominal segment, a broad band across each of the remaining segments and the whole of the seventh, the tibiæ, tarsi, and the apex of the femora ochraceous yellow. Wings hyaline, iridescent; nervures fusco-ferruginous.

The recurrent nervure is received by the cubital cell beyond two-thirds from the base.

Length 7 mm.

*Hab.* Cooktown, Queensland (*Turner*); November.

Crabro (Rhopalum) idoneus, sp. n.

♀. Head and thorax opaque, very delicately punctured-rugulose; mandibles bidentate at the apex, the teeth short, the inner tooth the longest; maxillary palpi five-jointed, labial palpi three-jointed. Clypeus transverse, slightly produced in the middle of the anterior margin. Front concave, the antennæ inserted nearer to the eyes than to each other. Pronotum transverse, rounded at the angles; mesonotum with a depression from the middle of the anterior margin to the centre; the scutellum half as long as broad. Median segment very short, rounded, and truncate posteriorly; the space at the base longitudinally striated at the base, almost smooth and opaque at the apex, with a median carina extending on to the surface of the truncation to the apex. Abdomen petiolate, very minutely punctured; the petiole about half as broad as long, of even length throughout, nearly as long as the second segment, which is slightly narrower than the third. Epipygium deeply punctured, lanceolate.

Black; the clypeus, cheeks, the truncation of the median segment, and the fourth and fifth abdominal segments clothed with pale golden pubescence; the mandibles fusco-ferruginous; the flagellum (except the basal joint), the tegulæ, the first abdominal segment, the pygidium, the apical margins of the other abdominal segments, the posterior tibiæ and tarsi, and the posterior femora above ferruginous; the scape of the antennæ, the basal joint of the flagellum, the pronotum very narrowly interrupted in the middle and on the sides, the scutellum (except the apical margin), a transverse line on the postscutellum, the anterior and intermediate legs, and the posterior tibiæ beneath yellow. Wings hyaline, iridescent, clouded in the radial cell; nervures ferruginous.

The recurrent nervure is received by the cubital cell at three-fifths from the base. The radial cell is very broadly truncate at the apex, the radial nervure indistinctly produced beyond the cell. The eyes are separated at the base of the antennæ by a distance equal to about three-quarters of the length of the scape; the first two joints of the flagellum are about equal in length. The posterior ocelli are a little further from the eyes than from each other and a little further from the posterior margin of the head than from the eyes.

♂. As in the female, but more slender; the head and thorax shining, almost smooth; the second abdominal segment narrow, about one-third longer than the first, very little more than half as wide at the apex as the third segment; the fourth segment the widest; the posterior tibiæ more dilated than in the female; the scutellum wholly black, the second abdominal segment ferruginous with a large black spot in the middle. The eyes are only separated at the base of the antennæ by about half of the length of the scape and diverge towards the vertex less strongly than in the female.

Length, ♂ 6 mm., ♀ 7 mm.

*Hab.* Mackay, Queensland (*Turner*); May.

CRABRO (RHOPALUM) AGILIS Sm.

*Crabro* (*Rhopalum*) *agilis* Sm. Proc. Linn. Soc., Zool. iii. p. 18, 1858, ♀.

*Hab.* Celebes (*Wallace*); Mackay, Queensland (*Turner*).

CRABRO PROSOPOIDES, sp. n.

♀. Clypeus slightly produced, with a median carina from the base not reaching the apex, clothed with silvery pubescence. Eyes separated at the base of the antennæ by a distance scarcely exceeding one-quarter of the length of the scape; the first joint of the flagellum fully as long as the second. Mandibles bidentate at the apex, the teeth short; maxillary palpi six-jointed, labial palpi four-jointed. The posterior ocelli about one-third further from each other than from the eyes and about as far from the posterior margin of the head as from each other. Head very closely and finely punctured, the front smooth and concave. Pronotum transverse and linear, the angles not prominent; mesonotum finely and closely punctured, the groove on the mesopleuræ well marked. Median segment steeply, but not vertically, sloped posteriorly, the triangular space at the base smooth and shining, with a shallow median sulcus, and a transverse row of deep punctures at the extreme base; the posterior slope with a large, deep depression at the base, very delicately and closely transversely striated. Abdomen very finely and closely punctured, the first segment one-third longer than the second, very narrow at the base, the apex half as wide as that of the second segment, the second segment narrower than the third, the second and third segments moderately constricted at the base, the apical segment triangular. The recurrent nervure is received at the middle of the cubital cell.

Black; the scape of the antennæ, pronotum, tegulæ, scutellum, postscutellum, tibiæ, tarsi, and the apex of the femora yellow; the flagellum light ferruginous. Wings hyaline, nervures fuscous.

♂. As in the ♀. The apical segment of the abdomen is rounded.

Length, ♀ 8 mm., ♂ 6 mm.

*Hab.* Mackay, Queensland (*Turner*); March to May. Townsville, Queensland (*Dodd*).

CRABRO PERLUCIDUS, sp. n. (Plate XXVI. fig. 15.)

♀. Mandibles bidentate at the apex, the inner tooth a little the longest. Clypeus strongly convex at the base, clothed with silvery pubescence, with an obliquely depressed smooth truncation to the middle of the apical margin. Antennæ inserted nearly twice as far from each other as from the eyes, the first joint of the flagellum longer than the second; the eyes separated from each other at the base of the antennæ by a distance exceeding half the length of the scape. Posterior ocelli a little nearer to each other than to the eyes, half as far again from the posterior margin of the head as from each other. Head and thorax smooth and shining; the pronotum slightly depressed, rounded at the anterior angles; scutellum very finely punctured. Median segment very short, steeply sloped posteriorly, the enclosed space at the base irregularly obliquely striated, with a depressed, transverse, coarsely punctured sulcus at the base; a median sulcus from the base to the apex. Abdomen shining, very minutely punctured, nearly as long as the head and thorax united; the first segment as long as the second, twice as broad at the apex as at the base and half as broad as the apex of the second segment. Pygidium elongate triangular.

Black; the scape of the antennæ and the anterior and intermediate legs yellow, the intermediate legs stained with ferruginous; the flagellum, posterior legs, and abdomen bright ferruginous; the tegulæ testaceous. Wings hyaline, nervures black.

The cubital cell receives the recurrent nervure at two-thirds from the base; the radial cell receives the transverse cubital nervure before the middle.

Length 7 mm., exp. 10 mm.

*Hab.* Mackay, Queensland (*Turner*); May.

CRABRO DODDII, sp. n.

♀. Clypeus a little produced and truncate at the apex, with a median carina, clothed with silvery pubescence. Antennæ inserted twice as far from each other as from the eyes; the second joint of the flagellum small, shorter than the first. Eyes separated from each other at the base of the antennæ by a distance equal to two-thirds of the length of the scape, strongly divergent towards the vertex. Posterior ocelli a little further from each other than from the eyes, but nearer to each other than to the posterior margin of the head. Head finely punctured-rugose; the front opaque, with sparse silvery pubescence. Thorax rugose, the pronotum transverse, almost as broad as the head, the anterior angles prominent. Mesopleuræ without a groove for the femora. The enclosed space at the base of the median segment coarsely rugose with a deep median sulcus. Abdomen short, not petiolate; the first segment subtruncate at the base, depressed on the apical margin, the second segment the longest. All the segments opaque, very closely and finely punctured. The recurrent nervure is received near the apex of the cubital cell.

Black; the mandibles (except at the apex), the scape of the antennæ, the anterior and posterior angles of the pronotum, the postscutellum, the tibiæ, and the apex of the femora yellow; the flagellum, the tegulæ, the base of the femora, the tarsi, and the abdomen light ferruginous, the first abdominal segment with an obscure yellow band at the apex. Wings hyaline, nervures fusco-ferruginous.

♂. As in the female, but the pronotum is entirely yellow and the postscutellum black.

Length, ♀ 8 mm., ♂ 6 mm.

*Hab.* Townsville, Queensland (*Dodd*); February.

CRABRO HEBETESCENS, sp. n.

♀. Mandibles tridentate at the apex, the inner tooth the shortest, a strong acute tooth just before the middle of the inner margin. Maxillary palpi six-jointed, labial palpi four-jointed. Clypeus clothed with shining white pubescence, with a carina from the base to the apex, truncate at the apex, with two short teeth on each side. Head large, finely and closely punctured, the cheeks clothed with silvery pubescence. Antennæ inserted very close to the eyes, the second joint of the flagellum about half as long again as the first or third. Eyes at the base of the antennæ separated by a distance about equal to the length of the two basal joints of the flagellum; front very narrow, the groove for the scape reaching the eyes; the facets of the eyes larger near the base of the antennæ than elsewhere. Posterior ocelli very far apart, as far from the eyes as from each other, but nearer to each other than to the posterior margin of the head, which is straight. Pronotum more than two-thirds of the breadth of the head, very short and transverse, the anterior margin raised. Thorax punctured, the mesopleuræ strongly grooved for the anterior femora. Median segment short, subtruncate posteriorly, the enclosed space at the base very broadly rounded and rugose; the face of the truncation finely transversely striated, with a delicate longitudinal carina. Abdomen ovate, shining and finely punctured, the apical segment lanceolate.

Black; the mandibles at the base, the scape of the antennæ, the anterior margin of the pronotum, interrupted narrowly in the middle, the tubercles at the posterior angles of the pronotum, a small spot on each side at the base of the scutellum, a spot on each side of abdominal segments 1–5, the tibiæ above, and the basal joint of the tarsi creamy white. Wings hyaline, nervures black, the tegulæ fuscous. The recurrent nervure is received by the cubital cell at about three-quarters from the base, the cubital nervure is sharply bent at the point of junction, the apical portion appearing almost more like a part of the transverse cubital than of the cubital nervure.

Length 9 mm.

*Hab.* Mackay, Queensland (*Turner*); January.

CRABRO CINCTUS, sp. n. (Plate XXVI. fig. 14.)

♀. Head very large, almost square, slightly rounded at the posterior angles, extremely finely and closely punctured. Mandibles broad at the apex and tridentate, the inner tooth very short, the middle tooth the longest. Clypeus slightly porrected, almost vertically truncate at the extreme apex, the surface of the truncation semicircular and slightly concave. Cheeks depressed along the outer orbits of the eyes, the margins of the face and the depressions on the cheeks clothed with short silvery pubescence. A longitudinal sulcus below the anterior ocellus and a longitudinal carina above it, a shallow depression on each side of the carina behind the posterior ocelli, the front clothed with short golden pubescence, the inner orbits of the eyes slightly depressed. Thorax narrower than the head; the anterior and posterior margins of the pronotum raised and with the angles slightly prominent, a deep transverse sulcus interrupted in the middle separating the raised margins. Mesonotum and scutellum very finely and closely punctured, the disc of the mesonotum with a broad and shallow depression. Median segment short, truncate posteriorly, with a deep, longitudinal, median sulcus from the base to the apex; the enclosed space at the base closely punctured with a few very short striæ at the base, broadly rounded at the apex. Abdomen subpetiolate, coriaceous, pygidium narrow and lanceolate.

Black; the mandibles at the base testaceous yellow; the clypeus, the scape of the antennæ, the two basal joints of the flagellum, and a spot on each side at the anterior angles of the mesonotum yellow; the pronotum, a large mark on the scutellum, the post-scutellum, a spot on the mesopleuræ, a short longitudinal line on the middle of the basal abdominal segment, a broad transverse band at the base of the second segment, and the three apical segments above orange; the tegulæ and the apical ventral segment of the abdomen ferruginous brown. Legs yellow, stained with ferruginous brown. Wings hyaline, tinged with fuscous; nervures dark fuscous.

Length 12 mm.

*Hab.* Mackay, Queensland (*Turner*); April.

The posterior ocelli are two and a half times as far from the posterior margin of the head as from each other; further from each other than from the eyes. The antennæ are inserted close to the eyes, the second joint of the flagellum nearly twice as long as the first and as long as the third; the distance between the eyes at the base of the antennæ equal to half the length of the scape. The mesopleuræ are rugose, the depression for the femora not developed. The recurrent nervure is received by the cubital cell beyond three-quarters from the base; the radial nervure is not continued beyond the end of the radial cell.

CRABRO MACKAYENSIS, sp. n.

♀. Mandibles tridentate at the apex, the inner tooth much the shortest, the central tooth longer than the outer one. Clypeus slightly advanced, truncate at the apex, with a longitudinal carina from the base, clothed with short silvery pubescence. The pubescence on the cheeks pale golden. Head finely and very closely punctured; eyes very large, the front between them narrow and concave; a very shallowly depressed, longitudinal, and almost smooth mark on the inner margin of the eye near the summit; a short longitudinal sulcus below the anterior ocellus and another on the vertex almost reaching the anterior ocellus; the posterior ocelli as far from each other as from the eyes. Pronotum very short, transverse, raised and thickened, not prominent at the angles; mesonotum finely rugose. Median segment short, the space at the base enclosed by carinæ, longitudinally striated, with an obscure median carina, broadly rounded at the apex; the posterior truncation very obscurely transversely striated, with a median sulcus. Abdomen subovate, very minutely and closely punctured; the first segment narrow at the base, the apex about two-thirds of the breadth of the second segment, only a little longer than the second segment; the apex of the fifth segment clothed with pale golden pubescence; the apical segment lanceolate, smooth and recurved at the sides, with a tuft of long golden pubescence on each side.

Black; the mandibles (except at the apex), the scape of the antennæ, the pronotum (very narrowly interrupted in the middle and more broadly on the sides), a spot on each side near the base of the scutellum, a transverse line on the postscutellum, a spot near the middle of the enclosed space on the median segment, a broad transverse band near the apex of the first abdominal segment, a small spot on the sides of the second and fourth segments, and a transverse band narrowly interrupted in the middle on the fifth segment, yellow; the four basal joints of the flagellum, the tegulæ, the apical margins of the abdominal segments, the tibiæ, tarsi, and extreme apex of the femora and coxæ ferruginous brown. Wings pale flavo-hyaline, nervures pale ferruginous.

Length 10 mm., exp. 17 mm.

*Hab.* Mackay, Queensland (*Turner*); April.

The second joint of the flagellum is about one-third longer than either the first or third, and nearly equal in length to two-thirds of the distance between the eyes at the base of the antennæ.

CRABRO ORDINARIUS, sp. n.

♀. Mandibles bidentate at the apex, the teeth long and of about equal length. Clypeus densely clothed with silvery pubescence, with a carina from the base to beyond the centre, with a smooth and shining, oblique, triangular truncation at the apex. Head and thorax very closely and finely punctured, the front and cheeks clothed with pale golden pubescence; the posterior ocelli far apart, further from each other than from the eyes. The anterior margin of the pronotum raised, with a transverse groove behind it on the sides. A faint and broad depression from the anterior margin of the mesonotum to the middle; the scutellum faintly depressed in the middle. Median segment short, truncate posteriorly, the enclosed space at the base broadly rounded at the apex, obliquely striate rugose, with a very broad median sulcus in which lie several transverse striæ; the face of the truncation pubescent, very finely rugose, with a strong median sulcus. Abdomen very closely and minutely punctured, not petiolate, the apical segment lanceolate.

Black; a spot at the base of the mandibles, the scape of the antennæ, the first joint of the flagellum, the anterior margin of the pronotum narrowly interrupted, the posterior angles of the pronotum, a spot on each side at the basal angles of the scutellum, a transverse line on the postscutellum, a trilobed mark at the base of the first abdominal segment, a transverse band at the base of the third and fourth segments, a line on the anterior tibiæ, and a spot near the apex of the posterior tibiæ, yellow; the tegulæ and the legs (except the coxæ) ferruginous. Wings hyaline, nervures ferruginous.

♂. As in the female, but without the yellow mark on the first abdominal segment, and there is a dull yellow transverse band on each side of the fifth and sixth segments.

Length, ♀ 9–11 mm., ♂ 9 mm.; exp., ♂ 12 mm., ♀ 17 mm.

*Hab.* Mackay, Queensland (*Turner*); February–May.

The second joint of the flagellum is longer than the third in both sexes and more than twice as long as the first. The eyes are separated at the base of the antennæ by a distance rather exceeding one-third of the length of the scape in the female and by a little less in the male. The groove on the mesopleuræ is not well-developed.

Crabro conglobatus, sp. n.

♀. Mandibles broad and bidentate at the apex, the teeth of about equal length. Clypeus small, advanced in the middle, strongly emarginate at the sides, slightly convex, without a carina, and clothed with pale shining pubescence. Eyes separated at the base of the antennæ by a space equal to one-third of the length of the scape; the second joint of the flagellum about three times as long as the first and half as long again as the third. Posterior ocelli a little nearer to each other than to the eyes, and more than half as far again from the posterior margin of the head as from each other. Head and thorax very closely and finely punctured; the cheeks clothed with very pale golden pubescence. Pronotum narrower than the head, transverse, the angles not prominent; mesopleuræ smooth and shining, with a well-marked groove.

Mesonotum half as broad again as long, with a broad shallow depression from the anterior margin to the centre, in the depression is a very delicate longitudinal carina. Median segment very short, the posterior slope vertical, the space at the base coarsely obliquely striated, with a median sulcus; the posterior surface transversely rugose, with a deep median sulcus. Abdomen subovate, shining, very minutely punctured; the first segment about one-third longer than the second, very narrow at the base, rather more than half as wide at the apex as the apex of the second segment, the apical segment lanceolate. The radial nervure is received not far from the apex of the cubital cell.

Black; the scape of the antennæ, pronotum very narrowly interrupted in the middle, the scutellum (except at the base), a transverse line on the postscutellum and a transverse band on each side of abdominal segments 2–4, least broadly separated in the middle on the second segment, yellow; the tegulæ, legs, mandibles, and the apical margins of ventral segments 2–5 ferruginous. Wings fusco-hyaline, nervures black. A small spot on the mesopleuræ below the anterior wings yellow.

♂. As in the ♀, but the distance between the eyes at the base of the antennæ is equal to half the length of the scape, the median segment is more coarsely striated and the apical abdominal segment is rounded; the yellow spot on the mesopleuræ is absent.

Length, ♂ 9 mm., exp. 14 mm.; ♀ 10 mm., exp. 17 mm.

*Hab.* Mackay, Queensland (*Turner*); April and May.

Nearly allied to *C. palitans* Bingh. from India.

Crabro bivittatus, sp. n.

♀. Mandibles bidentate at the apex. Clypeus small, clothed with silvery pubescence, with a median carina, slightly porrect at the apex, with a minute tooth on the apical margin on each side of the carina. Head subquadrate, slightly emarginate posteriorly, very finely and closely punctured, the front smooth in the middle, clothed with silvery pubescence on the sides. The posterior ocelli further from each other than from the eyes and at least one-half further from the posterior margin of the head than from each other. Pronotum narrowed anteriorly, the anterior margin straight and a little raised with a slight groove behind it; the mesonotum slightly depressed in the middle anteriorly, minutely punctured. Median segment steeply sloped posteriorly; the space at the base divided by a very broad median sulcus in which are a few transverse striæ, with short longitudinal striæ at the base, the apex finely punctured; the posterior slope of the segment transversely and very finely striated, with a median sulcus. Abdomen very closely and minutely punctured. The recurrent nervure is received a little before the apex of the cubital cell.

Black; the scape of the antennæ yellow; the anterior margin of the pronotum narrowly interrupted, a broad transverse band at the base of the second and fourth abdominal segments and a narrow band on each side of the fifth segment, orange; the tibiæ, tarsi, and the apex of the femora dark ferruginous, the tegulæ rufo-testaceous. Wings hyaline, tinted with fuscous; nervures black.

Length 9 mm.

*Hab.* Victoria (*French*).

Type in British Museum.

The eyes are separated at the base of the antennæ by a distance equal to about one-third of the length of the scape, the second joint of the flagellum is nearly three times as long as the first and fully half as long again as the third. The first abdominal segment is narrowed to the base.

### EXPLANATION OF PLATE XXVI.

Fig.
1. *Harpactophilus arator*, sp. n., p. 461.
2. *Harpactophilus tricolor*, sp. n., p. 462.
3. *Ammophila aurifera*, sp. n., p. 464.
4. *Psenulus interstitialis* Cam., p. 463.
5. *Cerceris inexpectata*, sp. n., p. 469.
6. *Tachytes formosissimus*, sp. n., p. 482.
7. *Notogonia regina*, sp. n., p. 475.
8. *Zoyphium rufonigrum*, sp. n., p. 494.
9. *Nysson* (*Acanthostethus*) *punctatissimus*, sp. n., p. 505.
10. *Gorytes sanguinolentus*, sp. n., p. 497.
11. *Gorytes lucidulus*, sp. n., p. 498.
12. *Pison melanocephalum*, sp. n., p. 515.
13. *Pison* (*Aulacophilus*) *icarioides*, sp. n., p. 521.
14. *Crabro cinctus*, sp. n., p. 531.
15. *Crabro perlucidus*, sp. n., p. 529.

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May 26, 1908.

Prof. E. A. Minchin, M.A., Vice-President, in the Chair.

The following papers were read:—

## 1. The Rudd Exploration of S. Africa.—X. List of Mammals collected by Mr. Grant near Tette, Zambesia. By Oldfield Thomas, F.R.S., F.Z.S., and R. C. Wroughton, F.Z.S.

[Received April 14, 1908.]

We now come to the final collection of the Rudd Exploration, for after making it Mr. Grant had a severe attack of fever, and by arrangement with Mr. Rudd he has now come home, so that this magnificent exploration, which has been going on for the last five years, thus comes to an end.

Further details of the papers written on the different collections are appended to the present account, but we may here say that the results of Mr. Rudd's splendid generosity have far surpassed, in their great and permanent value, our most sanguine expectations—a fact for which the fullest credit must also be given to the collector, Mr. C. H. B. Grant, who has risen in the ablest manner to the great opportunity afforded him by Mr. Rudd.

The total results form the largest collection of Mammals ever received by the National Museum from any one source, the nearest approaches to it being the products of the Simons and Robert expeditions to S. America, and the Duke of Bedford's Exploration of Eastern Asia, the last-named being still in progress.

In all 1541 mammals, exclusive of duplicates, have been registered as presented to the National Museum by Mr. Rudd, while duplicates have been presented to the Royal Scottish Museum, Edinburgh, and the South African Museum, Cape Town.

A considerable and quite unexpected number of new species and subspecies have been discovered, and, what is quite as important, most of the old species, insufficiently or inexactly described on specimens now deteriorated, have been definitely identified by topotypes, and are represented by good modern material, which may be made the basis of further progress.

In this connection the Tette series, of which we give an account in the present paper, is of especial importance; for every worker on South African zoology has been hampered by the difficulty of making out with exactitude the species obtained during Dr. Peters's famous expedition to Zambesia, and described by him in his 'Reise nach Mossambique,' of which the 'Säugethiere' was published in 1852.

In order, therefore, to get a series of the species described by Peters, Mr. Grant went to Tette, Peters's chief collecting-place, and formed the series enumerated below.

While we were working out this series, the definite determination of Peters's species has enabled us to sort out a number of the groups, with the result that many forms hitherto assigned, in our papers and elsewhere, to Peters's species, now prove to need description.

Mr. Grant's notes on the Tette district are as follows:—

"It was the driest time of the year when I reached Tette, and, except in the main rivers, there was practically no water anywhere, and as, on the Zambesi near Tette, there were too many natives present for it to be possible to collect, I moved southwards and pitched my camp at the junction of the Luenya and Mazoe Rivers, which is some 20 miles due south of Tette.

"The country there is exactly similar to that along the Zambesi, being hilly, and in places somewhat mountainous; the soil is sandy and very stony, especially on the hill-sides, but there are no krantzes that would harbour dassies or red hares.

"All the vegetation, except along the rivers, was dried and dead and the trees leafless, the course of the rivers being plainly shown from a distance by the verdure of the trees on their banks.

"Everywhere the veldt is well bushed, amounting to thickets in most parts, with a fair amount of larger timber, mainly *mopani* and 'cream-of-tartar,' the latter being very plentiful and growing to an enormous size.

"Except in favourable situations, grass does not seem to grow freely, and the cereal crops of the natives are not nearly so good as in many districts to the southward, although tomatoes, onions, &c. are grown freely on the banks and in the beds of the rivers.

"The natives are mixed local tribes variously known as Nyungwis, Tongas, Barués, &c. When not too lazy they give much of their time to the capture of small buck, cats, squirrels, rats, &c., the majority of which they utilize for food.

"The climate cannot be considered healthy, even in the dry season, and the temperature is generally high during the day and makes good collecting difficult.

"In the five weeks I spent in the Mazoe camp the average temperature was 95°, 104° being the highest recorded; no rain fell."

1. CERCOPITHECUS PYGERYTHRUS RUFOVIRIDIS Is. Geoff.

♀. 2003.

This specimen, a young female, is undoubtedly the same form as those from Gorongoza mentioned in our last paper, and both are almost certainly *Cercopithecus flavidus* of Peters. We follow Mr. Pocock* in holding that that species is a synonym of *C. rufoviridis*, and accordingly adopt this name for the specimens from Gorongoza and Tette. Mr. Pocock has pointed out (*l. c.*) that the specimens obtained by Mr. Grant in the Knysna, Zululand, and E. Transvaal are all typical *C. pygerythrus* Cuv., and to these we may add the specimens received from Inhambane and Beira since the date of Mr. Pocock's paper. All former identifications in the present series of papers must be modified accordingly.

"Native name, 'Pusi.'

"Only two troops of this monkey were seen and they were exceedingly wild.

"Generally frequenting the trees along the river-banks and observed drinking in the middle of the afternoon."—C. H. B. G.

2. GALAGO MOSSAMBICUS Pet.

♂. 2042. ♀. 2028, 2029, 2030, 2031, 2043.

Topotypes of species.

These specimens, which represent "*Otolicnus mossambicus*," confirm what we have stated in describing *G. granti* in a former paper †, namely, that this latter species is readily recognizable on account of its long muzzle.

From *G. moholi* Sm., to which it is no doubt closely allied, *G. mossambicus* is separated by its smaller size (greatest length

* P. Z. S. 1907, p. 737.
† P. Z. S. 1907, p. 286.

of skull 38 mm., of upper tooth-row from front of canine to back of last molar 13·7 mm., against 41 and 15 mm. in *moholi*) and proportionally much longer tail.

3. EPOMOPHORUS CRYPTURUS Pet.

♀. 1999.

A young specimen. Topotype of species.

"Native name, 'Demanyundo.'

"Said to be common, but only the one specimen was seen, and that was put up and shot in the daytime in a thicket on the bank of the Mazoe."—C. H. B. G.

4. RHINOLOPHUS LOBATUS Pet.

♂. 2018. ♀. 2013, 2014, 2019, 2021, 2025.

These are practically topotypes of Peters's species, the technical type-locality being Sena.

"Native name, 'Nyagelingwelingwe'; it is the same for all insectivorous bats."—C. H. B. G.

5. RHINOLOPHUS HILDEBRANDTI Pet.

♀. 2009.

6. HIPPOSIDERUS CAFFER Sund.

♂. 2024. ♀. 2015, 2016, 2020, 2022, 2023.

"Both species of *Rhinolophus* (vide supra), these, and *Petalia* (vide infra) were all taken out of one tree."—C. H. B. G.

7. PETALIA* CAPENSIS Sm.

♂. 2011, 2012, 2017. ♀. 2010.

These specimens represent the *Nycteris fuliginosa* of Peters, the type-locality of which was Boror.

8. VESPERTILIO CAPENSIS Sm.

♂. 2004.

An exceptionally large individual, but not, we think, separable from *V. capensis*.

9. SCOTOPHILUS NIGRITA DINGANI Sm.

♂. 1994.

The various forms included by Dobson under *Scotophilus borbonicus* = *nigrita*, in his 'Catalogue of the Chiroptera,' may apparently be separated into two groups by their size—a larger, represented by *S. nigrita* Schreb., and a smaller, the oldest name for which is *S. viridis* Peters.

The present specimen is a topotype of Peters's *Nycticejus planirostris*, but we are unable to separate it from *S. dingani*.

* = *Nycteris* auctorum.

The forms of S. African *Scotophilus* (including those noticed below) may be arranged in a key as follows:—

| | |
|---|---|
| A. Size larger (forearm 52–57 mm.; skull length 20–21; maxillary tooth-row 7–7·5) .............. | *nigrita*-group. |
| *a.* A strong suffusion of yellow in the colouring, making upper surface olive-green, belly bright yellow .............................................. | *S. nigrita dingani* Sm. |
| *b.* No tinge of yellow in the coloration.............. | *S. nigrita herero* Thos. |
| B. Size smaller (forearm 45–51 mm.; skull length 17–18; maxillary tooth-row 6·3–6·8) ........... | *viridis*-group. |
| *a.* A strong suffusion of yellow in the colouring, making upper surface olive-green, belly bright yellow .............................................. | *S. viridis* Pet. |
| *b.* No tinge of yellow in the coloration ........... | *S. viridis damarensis* Thos. |

"Two species of this genus were secured, neither being common.

"They appear early in the evening and their flight is strong; they hawk the country in wide and regular circuits."—C. H. B. G.

10. Scotophilus viridis damarensis Thos.

♂. 1955, 1956, 2027, 2032.

Reference was made in the paper on the Inhambane Collection * to the presence in the series of *Scotophilus* of certain specimens smaller in size than the rest; as these smaller specimens possess all the essential characters attributed by Peters to his *Nycticejus viridis*, we accept them as representing that species, the type locality of which is the island of Mozambique.

The present specimens are indistinguishable from *S. damarensis* Thos., and as they also closely resemble the Inhambane specimens except in coloration we rank them as a western race of *S. viridis*.

11. Scoteinus schlieffeni australis, subsp. n.

♂. 1967, 1975, 1993, 2000, 2005, 2007. ♀. 1995, 2001.

On laying out all the specimens of this species in connection with the identification of the present series, it became evident that there are several well-marked geographical races separable on colour characters.

Typical *S. schlieffeni* was based by Peters on a specimen from Cairo. He described it as "supra rufescens, subtus ex albo rufescens." A second species, *S. minimus*, based on a ♀ from Tanganyika was described by Noack as "oben olivengelbbraun unten weissgelb. Seiten hell umbra . . . ." Unfortunately we have no undoubted specimen of either of these for comparison, but we consider that we are justified in describing three forms as certainly distinct from either typical *S. schlieffeni* or *S. minimus* (which latter is at most a local race of the former). These are: (1) a pale desert form from the Aden Hinterland; (2) a white-bellied desert form from Upper Egypt; and (3) the present series from S. Africa.

* P. Z. S. 1907, p. 285.

The following are descriptions of these three forms :—

Scoteinus schlieffeni bedouin, subsp. n.

Rather smaller in size than typical *S. schlieffeni*.

Colour above nearest to "wood-brown," but a much paler shade than that given by Ridgway ; below still paler, *i. e.*, the colour containing more white.

Dimensions of type :—

Head and body 41·8 mm. ; tail 28·8 ; forearm 30 ; ear 9·5.

Skull—greatest length 12·2 ; interorbital breadth 3·3 ; brain-case breadth 6·3 ; breadth across upper jaw at level of $m^2$ 5·6 ; post-canine tooth-row 3·5.

*Hab.* Lahej, near Aden.

*Type.* Adult. B.M. no. 95.6.1.53. Collected on the 12th March, 1895, and presented to the Museum by Col. J. W. Yerbury.

A second specimen taken at the same time only differs in being slightly smaller. The difference in coloration between these specimens and a series of four taken by Mr. W. Dodson, 18th Sept., 1899, at Sheik Othman, only 10 or 12 miles distant—nearer the coast—is most marked. These latter do not differ materially from specimens from the south coast of the Red Sea, which we provisionally refer to typical *schlieffeni*.

Scoteinus schlieffeni albiventer.

Size as in typical *S. schlieffeni*.

Colour above "ecru-drab," below pure white.

Dimensions of type :—

Head and body 50 mm. ; tail 30 ; forearm 32 ; ear 9.

Skull—greatest length 12·6 ; interorbital breadth 4 ; brain-case breadth 7·3 ; breadth across upper jaw at level of $m^2$ 5·9 ; post-canine tooth-row 3·8.

*Hab.* Naikhala, Upper Egypt.

*Type.* Adult male. B.M. no. 4.11.3.4. Original number 73. Collected 13 Feb. 1904, and presented to the Museum by the Hon. N. C. Rothschild.

Scoteinus schlieffeni australis.

Size about as in typical *S. schlieffeni*.

Colour above near "mummy brown," below the same colour but paler.

Dimensions of type :—

Head and body 50 mm. ; tail 28 ; forearm 31 ; ear 12.

Skull—greatest length 13 ; interorbital breadth 4 ; brain-case breadth 7 ; breadth across upper jaw at level of $m^2$ 6 ; post-canine tooth-row 3·8.

*Hab.* South Africa (type from Inhambane).

*Type.* Adult male. B.M. no. 6.11.8.19. Original number 1595. Collected 5 Aug. 1906, by Mr. C. H. B. Grant (Rudd Exploration).

Mr. Grant took two specimens at Inhambane and the present series of eight individuals at Tette. There is but little variation throughout the series, the greatest difference being in size, the forearms ranging from 28 to 31 mm. There is absolutely no sign of the green or olivaceous tinge implied by Noack's description of the colour of *S. minimus*, viz. "olivengelbbraun," and the underside of *S. schlieffeni australis* could by no possibility be characterised as "weissgelb."

It is worthy of record that in one specimen (2005) of the Tette series there is present a well-developed second incisor on the left side of the upper jaw, between the normal incisor and the canine.

12. Chœrephon limbatus Pet.

♂. 1957. ♀. 1958, 1959.

The type locality of Peters's *Dysopes limbatus* was the island of Mozambique, but he also records it from Sena.

13. Nasilio brachyrhynchus Sm.

♀. 1974.

"Native name, 'Nyumdundo.'

"According to native report, common, although I was unable to obtain more than the one specimen.

"Inhabiting the more stony parts of the veldt."—C. H. B. G.

It has been already suggested by Thomas * that Peters's *Macroscelides fuscus*, from Boror, was based on an abnormal melanistic example of this species.

14. Crocidura sp.

♀. 1960.

"Native name, 'Sutsutsu.'

"Apparently very scarce.

"Frequenting the vegetation and reeds on the river-banks."—C. H. B. G.

15. Felis serval Erxl.

♀. 2002.

"Native name, 'Njanjanji.'

"Said to be plentiful, and certainly the spoor was frequently seen.

"Nocturnal only, often visiting the kraals at night."—C. H. B. G.

16. Genetta rubiginosa Puch.

♂. 1968, 1982, 2035.

On collating all the S. African Genets in the Museum

* Ann. Mag. N. H. (6) xiii. p. 70, 1894.

Collection we find that they may be arranged in three well-marked groups, as follows:—

A. Fore feet black.
  *a.* Hairs of dorsal crest and tail long (at least 50 mm. near base of tail); dorsal spots relatively small with a distinct tendency to coalesce into longitudinal stripes; tail-tip white ........ *felina*-group.
  *b.* Hairs of dorsal crest and tail short (not more than 35 mm. near base of tail); dorsal spots large, always distinct; tail-tip black ........ *tigrina*-group.
B. Fore feet pale; hairs of dorsal crest and tail short (not more than 35 mm. near base of tail); dorsal spots of medium size, not coalescing; tail-tip black ........ *rubiginosa*-group.

*felina*-group.—In his 'Mammals of South Africa' (p. 52, 1900), Mr. Sclater records a species under the name of *Genetta senegalensis*, from Lake Ngami. The animal he described is probably the same as *Genetta ludia* Thos. & Schwann * and is certainly a member of our *felina*-group. The distribution of this group is thus the central plateau from Namaqualand to the Transvaal, north of 30° S. lat.; within this area, it is represented in the south by typical *G. felina*, and in the north by *G. ludia.*

*tigrina*-group.—Occupies the extreme south of Africa below 30° lat., scarcely varying at all, so far as we know, throughout its range.

*rubiginosa*-group.—*G. letabæ* Thos. & Schw., belongs to this group, and it now seems doubtful whether it can be distinguished specifically from typical *G. rubiginosa.*

In his unfinished monograph of the Genets † Prof. Matschie, when establishing *G. zambesiana*, gives the habitat of *G. rubiginosa* as "Caconda u. Küste von Deutsch Süd-West Afrika," but Pucheran distinctly states in the original description that it was from the Cape of Good Hope. We have compared representatives of this group from Natal, Inhambane, N. and E. Transvaal, Beira, Gorongoza, Tette, and Angoniland, and can find no essential variation, so that if Natal be taken as the type-locality, both *letabæ* and *zambesiana* may have to be considered as synonyms of Pucheran's species. The distribution of the group is therefore all South Africa north of 30° lat. and east of 28° long., extending at least to Angoniland, in 16° S. lat.

"Native names, 'Mpiswi' and 'Mwili.'

"Common, especially near kraals, where they cause considerable annoyance by stealing fowls.

"Strictly nocturnal, never observed in the daytime."—C. H. B. G.

17. Crossarchus fasciatus Schreb.

"Native name, 'Ndembo.'

"Not common; found in small troops.

"Inhabiting the thickest parts of the bush as at Gorongoza."—C. H. B. G.

* P. Z. S. 1906, p. 579.
† Verhandl. Internat. Zool. Congr. Berl. 1901, p. 1138, &c.

18. Mungos auratus, sp. n.

♀. 1976, 1996.

A brilliantly fulvous Mungoose about the size of *M. ratlamuchi*, but differing in having the hairs of the back annulated.

Size about as in *M. ratlamuchi*. General colour above "ochraceous buff," darker on the back and tail; below "ochraceous buff." Individual hairs of the rump and back, as far forward as the shoulders, basally "drab-grey," then "ochraceous," paling to "buff" at the tip, with a subterminal black ring; those of the crown and face ringed buff, black, buff and tawny; those of the nape, sides of the throat, shoulders, flanks, limbs, and belly "ochraceous buff" almost to their bases, which are "mouse-grey." Tail coloured like the back for two-thirds its length, then dark "tawny," with a black tip 60–70 mm. long.

Skull as in *M. ratlamuchi*.

Dimensions of type:—

Head and body 324 mm.; tail 290; hind foot 62; ear 26.

Skull—condylo-basal length 62; basilar length 57; zygomatic breadth 33; palate breadth across $p^4$ 21; length c–$m^1$ 21·5.

*Hab.* Tette, Portuguese Zambesia.

*Type.* Adult female. B.M. no. 8.4.3.46. Original number 1976. Collected August 26th, 1907.

A second specimen, a younger female, is quite like the type, and Mr. Grant assures us he saw several more.

This beautiful new Mungoose is an unexpected discovery, as Tette is the type-locality of Peters's *Herpestes ornatus*, which Mr. Grant supposed he had secured. But *ornatus*, as shown by Peters's figure and descriptions, is allied to and probably identical with the much darker coloured *M. cauui* Smith *, of which the Museum possesses specimens from both north and south of Tette.

"Native name, 'Runkoe.'

"Several of this species were observed, but were difficult to trap.

"Found everywhere, especially near kraals.

"Certainly diurnal, perhaps nocturnal also."—C. H. B. G.

19. Funisciurus cepapi sindi, subsp. n.

♂. 1961, 2006, 2026. ♀. 1941, 1969, 1985.

On laying out the available specimens of *F. cepapi* it becomes evident that there are two well-marked geographical races, a northern and a southern, separable on their coloration. The type-locality is given by Smith as "the banks of the Marikwa R.," *i. e.*, the upper basin of the Limpopo River, in the southern part of

* *Cf.* Wroughton, Ann. Mag. N. H. (7) xx. p. 120, 1907. It may be noted here that the subspecies from Zanzibar described by Wroughton in this paper as *Mungos melanurus lasti* is antedated by *Herpestes ornatus rufescens* Lorenz (Abh. Senck. nat. Ges. xxi. Heft iii. p. 462, 1898), a name of which no indication is given in the title to the article, and which has therefore been missed by all recorders and bibliographers since.

the combined range, and we therefore separate the present series as a northern subspecies under the name of *F. cepapi sindi.*

Size as in typical *F. cepapi.* Fur rather shorter (5–7 mm. on the back). Colour-pattern above as in true *F. cepapi*; below pure white all over instead of the white being limited to (at most) the chin, throat, and chest as is the case in *F. cepapi*, which has the belly washed with clay-colour. Back of thighs and midrib of tail beneath bright ochraceous. Individual hairs of tail ochraceous with two black rings, so that when the hairs are spread out at right angles to the midrib there are two black longitudinal bands running the whole length of the tail (as seen from below) parallel to the midrib; in typical *F. cepapi* the ground-colour of the tail-hairs is dull "clay-colour" with three black rings, and consequently the resultant black longitudinal stripes are three in number. Tail equal in length to head and body, proportionally somewhat shorter than in typical *F. cepapi.*

Skull slightly smaller, brain-case broader and fuller.

Dimensions of type:—

Head and body 170 mm.; tail 168; hind foot 39; ear 20.

Skull—greatest length 43; basilar length 33; interorbital breadth 12; length of upper molar tooth-row (exclusive of $p^3$) 7·6.

*Hab.* Lower Basin of Zambesi (type from Tette).

*Type.* Adult female. B.M. no. 8.4.3.51. Original number 1941. Collected 18th August, 1907.

The specimens from Gorongoza mentioned in our last paper on the Rudd Exploration (P. Z. S. 1908, p. 169) must be included in this subspecies, though they show the distinctive characters less markedly than the Tette series.

"Native name, 'Sindi.'

"Common, generally observed in pairs.

"Living on the berries, &c., of the trees and shrubs, for which they may often be seen hunting on the ground.

"When alarmed they quickly make for some large tree and disappear into a hole or cavity.

"Diurnal, active in the early morning and late afternoon, resting during the heat of the day."—C. H. B. G.

20. TATERA LOBENGULÆ de Wint.

♂. 1947, 1951, 1952, 1953. ♀. 1942, 1943, 1944, 1945, 1946, 1954.

Externally these specimens cannot be separated from those from Beira and the Limpopo Valley, *i. e.* from *T. lobengulæ bechuanæ*, but while having the same narrow skull as that subspecies they pproximate to *T. lobengulæ mashonæ* in having rather smaller bullæ than the Limpopo form.

"Native name, 'Mpynya.'

"Common and found everywhere, especially in clearings and native lands."—C. H. B. G.

Peters's "*Meriones leucogaster*" (type-locality Mesuril) is a member of the short-tailed group, of which most of the species are found north of the Zambesi.

21. ARVICANTHIS DORSALIS CALIDIOR, subsp. n.

♀. 1962.

Comparison of the series from the Zambesi Basin with those from the Transvaal and Zululand, which, as the type shows, represent the true *Arvicanthis dorsalis* of Smith, establishes the fact that individuals of the former are easily separable by their darker, warmer colouring, and we propose to separate them as a geographical race under the name of *Arvicanthis dorsalis calidior*.

Size and fur as in typical *A. dorsalis*.

Colour-pattern richer and darker than in the southern form. General colour "chestnut" above, individual hairs dark slate with "vinaceous cinnamon" band and black tip; in true *A. dorsalis* the general aspect is near "clay-colour" and the pale rings of the individual hairs are the palest buff.

Dimensions of the type:—

Head and body 135 mm.; tail 146; hind foot 27; ear 17.

Skull—greatest length 34; basilar length 27; zygomatic breadth 16; diastema 8·5; upper molar series 6.

*Hab.* Zambesi Basin (type from Tambarara, Gorongoza Mountains).

*Type.* Old male. B.M. no. 8.1.1.72. Original number 1817. Collected 13th March, 1907.

The present specimen from Tette, though immature, is identifiable as belonging to this subspecies, in which also should be included the specimens dealt with in our paper on the collection from Beira (P. Z. S. 1907, p. 779), a series in the Museum Collection from Mashonaland, collected by Mr. J. ff. Darling, others presented by Mr. C. F. M. Swynnerton from Chirinda, &c.

"Native name, 'Mhoni.'

"Rare in this district, the specimen sent being the only one taken or observed."—C. H. B. G.

22. MUS MICRODON Peters.

♂. 1964, 1965, 1966, 1972, 1973, 1983, 1984, 1987, 1988, 2008. ♀. 1979, 1981, 1990, 1991, 1992.

Topotypes of species.

The characters of these specimens prove that the group of South African multimammate mice is divisible into two species. The present one, with a tail equal in length to the head and body combined, extends, so far as we can judge from the specimens available, from Natal and Zululand northwards along the coast and throughout the Northern Transvaal and Rhodesia to the Zambesi. The second species, *Mus coucha*, recognisable by its proportionally much shorter tail, is represented in the Museum

Collection from the South-West Transvaal, Bechuanaland, Orange River Colony, Basutoland, and as far south as Deelfontein and King William's Town, in Cape Colony (*i. e.*, about 33° S. lat.). Mr. Sclater in his 'Mammals of South Africa' records it from the Cape and Namaqualand, but Mr. Grant failed to obtain it in either of these localities.

We are doubtful if *Mus coucha zuluensis* Thos. & Schw.* can be retained as a subspecies distinct from true *M. microdon*, with which its describers had not an opportunity of comparing it.

"Native name, 'Ntisha.'

"Abundant everywhere; habits similar to those of *M. coucha zuluensis*."—C. H. B. G.

23. Mus chrysophilus ineptus, subsp. n.

♂. 1949, 1950, 1963, 1971. ♀. 1978, 1989.

Like true *chrysophilus*, but with lower skull and narrower brain-case.

Size as in the typical form, but hind foot on the average shorter and tail proportionally longer. Colour also as in *chrysophilus* but paler, the slaty bases of the hairs markedly paler both above and below.

Skull about the same length as in the type form, but markedly narrower and flatter; the brain-case much smaller; the whole skull lower, height from alveolus of $m^2$ to crown 9 mm. against 10 in true *M. chrysophilus*.

Dimensions of type:—

Head and body 148 mm.; tail 182; hind foot 27; ear 21.

Skull—greatest length 37; basilar length 29; zygomatic breadth 17; brain-case breadth 13; nasals length 16; diastema 9·5; molars 5·7.

*Hab.* Tette, Portuguese East Africa.

*Type.* Old male. B.M. no. 8.4.3.73. Original number 1949. Collected 22nd August, 1907.

In the series of 7 specimens obtained by Mr. Grant several have broken tails, but in those which are complete, the head and body varying between 145 and 150 mm., the tail reaches 180, whereas in typical *M. chrysophilus* specimens of the same size have a tail-length of about 170. The greatest breadth and brain-case breadth in the type skull of the species are recorded by Mr. de Winton as 18 and 15 mm. respectively; a comparison with the similar measurements given for this local race shows how markedly narrow its skull is; moreover, in true *M. chrysophilus* the greatest breadth is at the posterior end of the zygomatic arch, while in *M. c. ineptus* it is across its anterior end. The type is distinctly older than the individual described by Mr. de Winton.

"Native name, 'Kwisikwisi.'

"Fairly common and inhabiting both the bush and the native lands."—C. H. B. G.

* P. Z. S. 1905, i. p. 268.

We take this opportunity of describing a second local race of *M. chrysophilus* :—

MUS CHRYSOPHILUS ACTICOLA, subsp. n.

A large coast form of *M. chrysophilus*, the hind foot always markedly longer than in that animal.

Size somewhat larger than in true *M. chrysophilus*.

General colour as in the type form, but the slaty bases of the hairs of the under surface markedly shorter and very much paler than in the true *chrysophilus*, in which the slaty bases of the hairs of the lower surface of the body do not differ materially in shade from those of the back.

Skull larger than in the typical subspecies, but the bullæ slightly smaller. Height at $m^2$ 10 mm.

Dimensions of the type :—

Head and body 155 mm.; tail 202; hind foot 34; ear 23.

Skull—greatest length (c.) 39; basilar length 30·5; zygomatic breadth 19; brain-case breadth 15; nasals length (c.) 15; diastema 10; molars 6·2.

*Hab.* Coast between Limpopo and Zambesi Rivers (type from Beira).

*Type.* Adult male. B.M. no. 7.6.2.59. Original number 1752. Collected 25th December, 1906, by C. H. B. Grant (Rudd Exploration).

The type of *M. c. acticola* is of about the same age as that of true *M. chrysophilus*. In a long series of adult specimens from Inhambane and Beira the hind foot is recorded as low as 30 mm. in only three specimens, whereas in a large number of typical *M. chrysophilus* it never exceeds 29. The tail would seem to be proportionally quite as long as, or even longer than, in *M. c. ineptus*.

24. MUS AVARILLUS, sp. n.

♀. 1980.

A mouse outwardly resembling *M. namaquensis*, but with the teeth of *M. chrysophilus*, of which it is probably a dwarf relative.

Size rather smaller than in *M. namaquensis*. Fur soft and silky, but rather short (8–9 mm. on the back, 5–6 on the belly). Colour as in *M. namaquensis*, but the shorter coat allowing the basal slaty portion of the hairs to show through gives the upper side a duller general colour and makes the belly greyish white instead of the apparently pure white of *namaquensis*.

Skull a copy in miniature of *M. chrysophilus*. Teeth as in that species.

Dimensions :—

Head and body 105 mm.; tail 143; hind foot 26; ear 21.

Skull—greatest length 31; basilar length 23; greatest breadth 14; brain-case breadth 12·5; interorbital breadth 4·9; nasals 11·6; diastema 7·6; upper molar series 6; bullæ 5·3.

*Hab.* Tette, Portuguese Zambesia.

*Type.* Adult female. B.M. no. 8.4.3.79. Original number 1980. Collected 27th August, 1907.

Outwardly this species has a most striking resemblance to *M. namaquensis*, but its skull and teeth characters separate it readily from any member of that group. The shape of the skull and large size of the teeth point conclusively to its close affinity to *M. chrysophilus*, of which it is no doubt a dwarf form.

[MUS ARBORARIUS Peters.

As this species was based on specimens from Tette we have given special attention to its identification. Peters in his description * mentions two specimens, but as he quotes the dimensions of the female in the diagnosis and figures its skull (that of the male being still in the stuffed specimen †) we adopt it as the type. He gives an excellent figure of the skull (*l. c.* pl. xxxv. fig. 7), and this agrees in all essential characters with that of a specimen from Salisbury, Rhodesia, belonging to a widely-spread species, of which we have been able to recognise at least four local races, as follows:—

1. MUS NAMAQUENSIS Sm. *Hab.* Namaqualand. (= "*Mus auricomis* de Wint.," Thos. & Schw. P. Z. S. 1904, p. 179.)
2. MUS NAMAQUENSIS CENTRALIS Schw. *Hab.* Deelfontein, C.C. (=*Mus auricomis centralis* Schw. P. Z. S. 1906, p. 107.)
3. MUS NAMAQUENSIS LEHOCLA Sm. *Hab.* Kuruman. (=*Mus lehocla* Sm. Type locality "Latakoo.")
4. MUS NAMAQUENSIS AURICOMIS de Wint. *Hab.* Mashonaland. (=*Mus auricomis* de Wint. P. Z. S. 1896, p. 802.)

We have unfortunately no material to enable us to judge whether *arborarius* is identical with the Mashonaland race or whether, as seems to us more probable, it forms a fifth geographical subspecies.

This identification altogether removes *arborarius* from the *Thamnomys* group, to which it has been usually referred, perhaps on the evidence of the stuffed male, which may possibly prove to be an example of the next species.

The skull of *Mus namaquensis* has, as Peters's figure of "*arborarius*" shows, evenly divergent supraorbital ridges, cut back anterior zygomatic plate, small bullæ, and comparatively broad parapterygoid fossæ, all these characters being in contrast with those shown by the Tette *Thamnomys* next to be described.

The definite determination of the old types of Smith's *Gerbillus namaquensis* and *Mus lehocla* is one of the many advantages gained from the study of the Rudd Collection.]

* Reis. Mossamb. p. 152, 1852.

† At least when Thomas examined it in Berlin in 1887.

25. THAMNOMYS RUDDI, sp. n.

♂. 1970. ♀. 2033, 2036.

A *Thamnomys*, belonging to the group in which the characteristic third inner cusps of the upper molars are reduced to a ridge, and with the mammary formula 1—2 = 6.

Size about as in *Mus namaquensis auricomis*. Fur soft and fairly long (12 mm. on the back). General colour above near "clay-colour"; below pure white. Individual hairs of the back basally slate-colour for two-thirds their length, then buff; a small proportion of black hairs scattered through the coat; belly-hairs white to their bases. Hands and feet white.

Skull with a marked interval (2 mm. or more) between the henselion and the commencement of the palatal foramina.

Dimensions of the type:—

Head and body 124 mm.; tail 160; hind foot 22; ear 20.

Skull—greatest length 32·5; basilar length 26; greatest breadth 15·5; brain-case breadth 13·2; interorbital breadth 5; nasals length 12; palatal foramina 7; diastema 8·5; upper molar series 5; bullæ 7.

*Hab.* Tette, Portuguese East Africa.

*Type.* Old female. B.M. no. 8.4.3.81. Original number 2033. Collected 14th Sept., 1907. Three specimens examined.

"Native name, 'Nsunto.'

"This species, although undoubtedly common, is difficult to secure owing to its arboreal habits.

"It inhabits the hollows of decayed and dead trees, in which it makes warm nests of leaves, &c., of no particular shape, merely filling up the cavities with débris.

"Strictly nocturnal; one specimen was shot at night whilst climbing among the branches of a small tree when I was sitting up for *Galago*."—C. H. B. G.

In working out this *Thamnomys* we have found that the two following forms also require description:—

THAMNOMYS COMETES, sp. n.

A *Thamnomys* belonging to the same group and about the same size as the last, but with a markedly longer tail.

Size as in *T. ruddi*, but tail one-third longer. Fur soft, shorter than in *T. ruddi* (9–10 mm. on the back). Colour almost exactly as in *T. ruddi*. Hands and feet white.

Skull with bullæ and teeth smaller, and palatal foramina produced more forward than in *T. ruddi*.

Dimensions of the type:—

Head and body 124 mm.; tail 195; hind foot 24; ear 20.

Skull—greatest length 33·2; basilar length 26; greatest breadth 15·8; brain-case breadth 13·6; interorbital breadth 5; nasals length 12·5; palatal foramina 8; diastema 8·5; upper molar series 4·5; bullæ 6.

*Hab.* Inhambane, Portuguese East Africa.

*Type.* Old female. B.M. no. 6.11.8.115. Original number 1644. Collected by Mr. C. H. B. Grant, 18th August, 1906 (Rudd Exploration).

Three specimens examined. The proportionally very long tail, the smaller teeth and bullæ, and the extension forward of the palatal foramina almost to the henselion serve to distinguish *cometes* at once from *ruddi*, which in colour it so closely resembles.

THAMNOMYS SURDASTER, sp. n.

A smaller *Thamnomys* belonging to the same group as the two described above, but with smaller skull, teeth, and bullæ, and colour-pattern as in the *rutilans*-group.

Size somewhat smaller than in *T. ruddi.* Fur soft, short (7–8 mm. on the back). General ground-colour above "clay-colour," with strong tawny suffusion on rump and lower back, often extending forward even to the crown; below pure white. Hands and feet buff, fingers and toes white.

Skull small, teeth and bullæ very small.

Dimensions:—

Head and body (c.) 110 mm.; tail 160; hind foot 22; ear 18.

Skull—greatest length 29; basilar length 22; greatest breadth 14; brain-case breadth 12; interorbital breadth 4·5; nasals length 10·6; palatal foramina 5·8; diastema 7·2; upper molar series 4; bullæ 5.

*Hab.* Nyasaland and North-East Rhodesia. (Type from Zomba.)

*Type.* Adult. B.M. no. 93.5.2.27. Collected by Mr. A. Whyte in October 1892 and presented by Sir H. H. Johnston.

Three specimens from Zomba examined. The Museum has an example from Angoniland and one from the East Loangwa District (collected by Mr. S. A. Neave), which also appear to belong to this species.

26. SACCOSTOMUS CAMPESTRIS Peters.

♂. 1948, 1977.

Topotypes of species*.

These specimens confirm our opinion that in South Africa there are two forms in this genus, the smaller ones represented by *S. campestris*, and a larger, for which the oldest name is *S. mashonæ* de Wint.

"Native name, 'Psuku.'

"Apparently rather scarce and usually taken in native cultivation along the banks of the rivers.

"The cheek-pouches of the specimens sent contained sweet potato."—C. H. B. G.

* Reis. Mossamb. 1852, p. 167, pl. xxxiv. fig. 3 & pl. xxxv. fig. 12.

27. STEATOMYS PRATENSIS Peters.

♂. 2038, 2040, 2041. ♀. 2039.

Topotypes of species.

"Native name, 'Nsana.'

"Not found nearer Tette than the southern side of the Luenya and Mazoe Rivers, and even there not plentifully.

"Lying dormant in small burrows throughout the winter. The specimens sent were dug out and were excessively fat and lazy."—C. H. B. G.

28. HIPPOPOTAMUS AMPHIBIUS L.

♂. Luenya River.

"Native name, 'Umvu.'"—C. H. B. G.

29. CEPHALOPHUS GRIMMI L.

♂. 1997.

"Native name, 'Mhemwi.'

"Fairly common, but as it generally inhabits the thickets it is not easy to shoot.

"Feeding in the early morning and late afternoon and probably throughout the night.

"Observed going to water just before sundown."—C. H. B. G.

30. RAPHICEROS SHARPEI COLONICUS Thos. & Schw.

♀. 2034 (juv.).

"Native names, 'Kesenyi' and 'Gagoro.'

"Several of this species were seen, but always in such thick country that it was impossible to get a shot.

"Inhabiting broken and hilly country, thickly bushed."—C. H. B. G.

31. NESOTRAGUS LIVINGSTONIANUS Kirk.

♂. 2037 (juv.).

"Native name, 'Mrumsa.'

"Decidedly scarce, owing principally to the natives driving and catching them in nets and also to there not being a great deal of country suitable to their habits.

"Only found in the thickest bush.

"The Livingstone Buck is found near Beira, but is not found in Gorongoza, where it is quite unknown to the natives."—C. H. B. G.

32. ÆPYCEROS MELAMPUS Licht.

♂. 1940.

"Native name, 'Impala.'

"Only seen in small herds, seldom exceeding six in number, they having been much shot out, and no old rams were seen.

"Out feeding on the short grass in the open glades in the early morning, where they can sometimes be approached within shot, retiring soon after sunset to the thickest and more inaccessible parts of the bush.

"The alarm-call is a loud snort."—C. H. B. G.

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The following is a list of the papers which have been published on the mammals presented by Mr. Rudd, and we have supplemented it by mentioning such other papers as have been published both here (also largely based on Mr. Rudd's specimens) and in S. Africa during the same period, thus making this a bibliography of S. African Mammalogy subsequent to the publication of Sclater's 'Mammals of S. Africa.'

The Rudd papers are arranged chronologically under the headings of the localities dealt with :—

I. British Namaqualand.
O. Thomas & H. Schwann, P. Z. S. 1904, i. pp. 171–183, pl. vi. (28 species.)

II. S.E. Transvaal—Wakkerstroom.
Iid. P. Z. S. 1905, i. pp. 129–138. (26 spp.)

III. Zululand.
Iid. P. Z. S. 1905, i. pp. 254–276, pl. xvi. (49 spp.)

IV. Knysna.
Iid. P. Z. S. 1906, i. pp. 159–168. (31 spp.)

V. N.E. Transvaal—Klein Letaba and Woodbush.
Iid. P. Z. S. 1906, pp. 575–591. (51 spp.)

VI. E. Transvaal—Legogot.
Iid. P. Z. S. 1906, pp. 779–782. (25 spp.)

VII. Inhambane—Coguno.
O. Thomas & R. C. Wroughton, P. Z. S. 1907, pp. 285–299. (39 spp.)

VIII. Beira.
Iid. P. Z. S. 1907, pp. 774–782. (29 spp.)

IX. Gorongoza Mts.
Iid. P. Z. S. 1907, pp. 164–173. (32 spp.)

X. Tette, Zambesia (as above).
Iid. P. Z. S. 1908, pp. 535–552. (32 spp.)

Other papers based wholly or in large part on Rudd material :—

Andersen, K. Five new *Rhinolophi* from Africa. Ann. Mag. N. H. (7) xiv. p. 378, 1904.

—— On *Hipposiderus caffer* Sund. and its closest allies. Ann. Mag. N. H. (7) xvii. p. 269, 1906.

Thomas, O. A new Mungoose (*Herpestes ruddi*) from Namaqualand. Ann. Mag. N. H. (7) xii. p. 465, 1903.

—— A new Golden Mole (*Amblysomus corriæ*) from Knysna. P. Z. S. 1905, ii. p. 57.

Wroughton, R. C. On the various forms of *Arvicanthis pumilio* Sparrm. Ann. Mag. N. H. (7) xvi. p. 629, 1905.

—— Notes on the Genus *Tatera*, with descriptions of new species. Ann. Mag. N. H. (7) xvii. p. 474, 1906.

—— Notes on the Genus *Otomys*. Ann. Mag. N. H. (7) xviii. p. 264, 1906.

—— On three new Mammals from S. Africa. Ann. Mag. N. H. (7) xx. p. 31, 1907.

—— On the African Mungooses usually referred to the *Herpestes gracilis* group. Ann. Mag. N. H. (7) xx. p. 110, 1907.

Other papers bearing on S. African mammalogy that have been published during the last few years are:—

Broom, R. On some new species of *Chrysochloris*. Ann. Mag. N. H. (7) xix. p. 262, 1907.

—— A Contribution to the Knowledge of the Cape Golden Moles. Trans. S. Afr. Phil. Soc. xviii. p. 283, 1907.

—— Further Observations on the Chrysochloridæ. Ann. Transvaal Mus. i. p. 14, 1908.

De Winton, W. E. On *Cynictis selousi* de Wint. P. Z. S. 1901, p. 2, pl. i.

Gough, L. H. On a new Species of *Rhinolophus* from Pondoland. Ann. Transvaal Mus. i. p. 71, 1908.

Jameson, H. L. On a new Hare from the Transvaal. Ann. Mag. N. H. (7) xx. p. 404, 1907.

Matschie, P. Ueber die Abänderungen der Ginsterkatzen (*Genetta*). Verh. V. Internat. Zool. Congress, Berlin, p. 1128, 1902.

Schwann, H. List of Mammals obtained by Messrs. R. B. Woosnam and R. E. Dent in Bechuanaland. P. Z. S. 1906, i. p. 101. (25 spp.)

—— On *Felis ocreata*, better known as *Felis caligata*, and its subspecies. Ann. Mag. N. H. (7) xiii. p. 421, 1904.

Thomas, O. On two new Hares allied to *Oryctolagus crassicaudatus*. Ann. Mag. N. H. (7) x. p. 244, 1902.

—— On some new forms of *Otomys*. Ann. Mag. N. H. (7) x. p. 311, 1902.

—— The common Hare of Central Cape Colony. Ann. Mag. N. H. (7) xii. p. 343, 1903.

—— On a remarkable new Hare (*Lepus monticularis*) from Cape Colony. Ann. Mag. N. H. (7) xi. p. 78, 1903.

# 2. Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Isopoda terrestria. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S.*

[Received April 23, 1908.]

(Plate XXVII.†)

The small collection of African Land-Isopoda which Dr. Cunnington has asked me to examine includes only four species. Two of these are already known. The other two appear to require the institution of a new genus. Whether the species for which it is instituted are themselves new may be more open to question. It is with much reluctance that I accept the responsibility of offering a decision. In the balance of uncertainties one has at last to make up one's mind. At present there are a bewildering number of species in the genus *Philoscia*, many of them very incompletely described, and few, if any of them, completely illustrated. A remedy for this state of affairs will not be easily found. The creatures themselves put difficulties in the way of the student. Their readiness to wander about the world undermines any systematic structure built on geographical distribution. Their variability seems to separate forms which are specifically identical. On the other hand, general resemblance seems to unite forms which, on closer examination, are found to be distinct. Among the appendages the antennæ and uropods afford especially useful characters, and these appendages are particularly liable to be detached or broken. The structure of the pleopods, especially those of the male, is more and more acquiring systematic importance, but male specimens are not always available. Fortunately there are naturalists to whom difficulties are not discouragements so much as incentives to action. This paper will serve at least some useful purpose if it should induce any such investigator to deal effectively with the genus *Philoscia* and its immediate allies.

## Fam. Oniscidæ.

### Gen. Metoponorthus Budde-Lund.

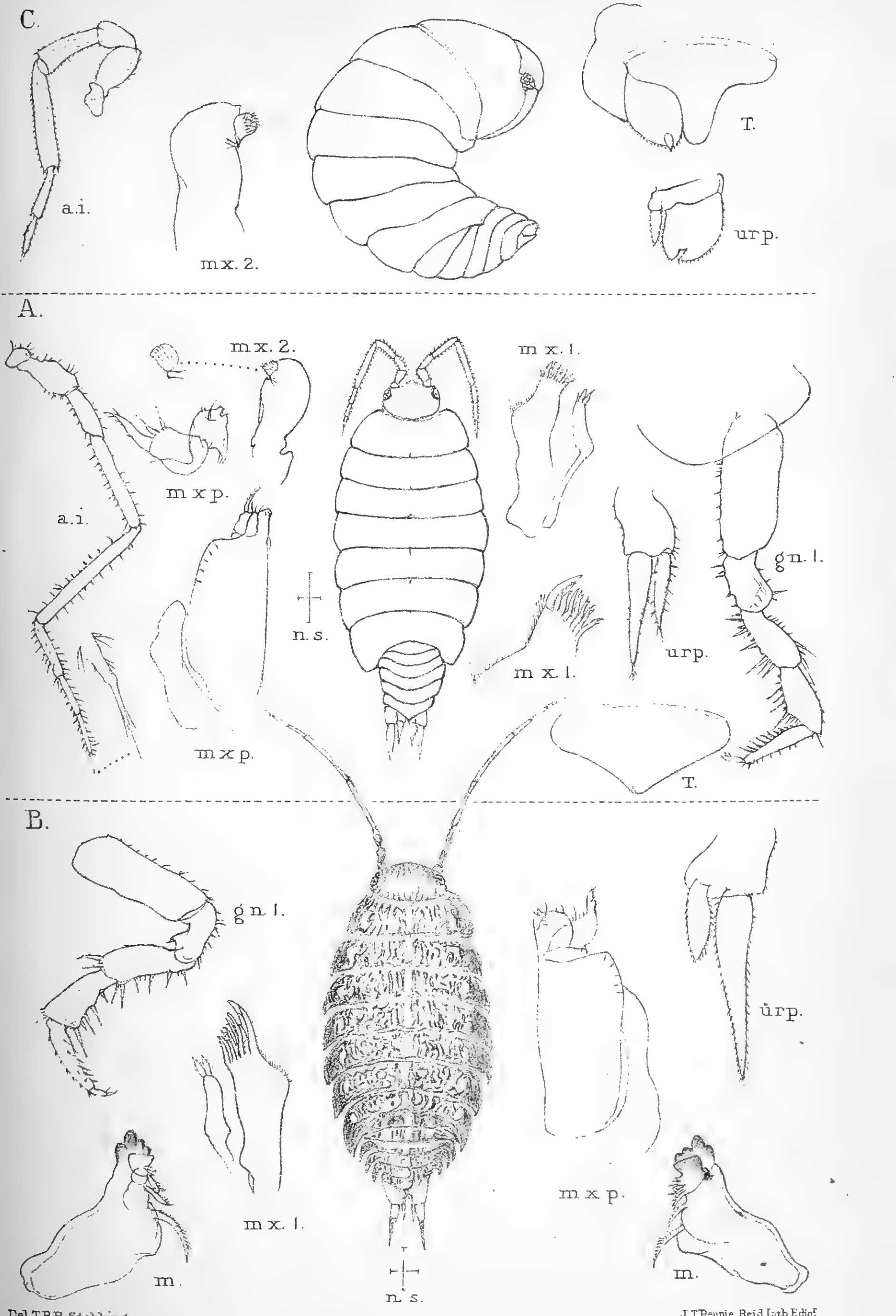
1885. *Metoponorthus* Budde-Lund, Isopoda terrestria, p. 161.

Metoponorthus pruinosus (Brandt).

1833. *Porcellio pruinosus* Brandt, Conspectus Crust. Oniscod. pp. 19, 26 (Budde-Lund).

* [The complete account of the new genus diagnosed in this communication appears here, but since the name and the preliminary diagnosis were published in the 'Abstract,' the genus is distinguished by being underlined.—Editor.]

† For explanation of the Plate, see p. 560.




Del. T.R.R. Stebbing.

J. T. Rennie Reid, Lith. Edin.

A. ANCHIPHILOSCIA KARONGAE, n. sp. B. A. CUNNINGTONI, n. sp.
C. PERISCYPHIS CONVEXUS (Budde-Lund).

1879. *Metoponorthus pruinosus* Budde-Lund, Prospectus Crust. Isop. terrest. 4.

1885. *Metoponorthus pruinosus* Budde-Lund, Isopoda terrestria, p. 169.

Of this well-known and widely distributed species there is a single specimen in the collection, found under stones on beach, Island Camp, Birket el Qurun.

ANCHIPHILOSCIA Stebbing.

Abstr. P. Z. S. 1908, p. 28 (May 26).

Mandibles with setulose lobe adjoining the inner cutting-plate, and with two to three plumose setæ between this lobe and the unjointed plumose lash which represents the molar. First maxillæ with eight spines at the apex, and the strongly sinuous distal part of the outer margin fringed with fine setules, which are much longer proximally and a little longer distally than those in the middle of the series. Second maxillæ with a small, clearly defined, finely setulose inner plate, not longer than broad; the outer part of the maxilla much broader, pellucid, almost unarmed, without apical cleft. Maxillipeds with terminal joint of palp distinguishable from the second. Telsonic segment triangular.

The genus *Philoscia* was established by Latreille in 1804. Both in French and Latin the name is on that occasion printed *Philoscie*, but it has always been presumed that the Latin form was due to a printer's error. *Oniscus sylvestris* Fabricius, which is the same as the earlier *O. muscorum* Scopoli, is the only species mentioned in connection with the genus at its institution. In any re-arrangement, therefore, of the very numerous forms which are at present united under Latreille's generic name, it is clear that Scopoli's species must be the standard for those to be retained under *Philoscia*.

The new genus characterised above agrees in general with the definition of *Philoscia* given by Budde-Lund in 1885 (Isopoda terrestria, p. 207), A. Dollfus in 1897 (Feuille des Jeunes Naturalistes, No. 317, p. 1), and Sars in 1898 (Crustacea of Norway, vol. ii. p. 172). Thus, it has the body oval or elongate, scarcely contractile. The lateral lobes of the head are sharply deflexed. The first segment of the peræon has the hind margin regularly curved. The pleon is more or less abruptly narrower than the peræon. The second antennæ are slender, with three-jointed flagellum. The rami of the uropods extend beyond the telsonic segment, and the inner ramus is articulated to the peduncle not far in front of the outer.

On the other hand, in the mandibles, where *P. muscorum* has only one penicil or plumose seta, the new genus has three penicils on the left and two on the right mandible. In this respect it agrees with the minutely described and carefully illustrated *Anaphiloscia simoni* Racovitza (Arch. zool. expérimentale, vol. vii.

p. 185, 1907), but it has the setulose lobe with which in Racovitza's genus the mandible is not equipped. The first maxillæ have eight spines on the outer plate, whereas in *Paraphiloscia stenosoma* Stebbing (Willey's Zoological Results, part v. p. 648, 1900) they have only three apical spines on that plate. The outer margin of that plate is more strongly sinuous and less uniformly fringed than in *P. muscorum*. The second maxillæ have the inner setulose lobe distinctly defined and the much broader outer lobe undivided; while in *P. muscorum* the outer lobe is longitudinally cleft and the setulose lobe has no distinct lower margin, nor is this margin mentioned by Racovitza, in whose species the second maxilla otherwise resembles that of *Anchiphiloscia*. In the maxillipeds the articulation between the second and third joints of the palp is in this genus discernible under high magnification. Racovitza declares this palp to be clearly only two-jointed in *A. simoni*. In the latter species the telson is almost semicircular, in the species referred to the present genus it is triangular. The two species in question are in many respects in close agreement, but one of them has the pleon abruptly narrower than the peræon, with the lateral apices of the pleon segments inconspicuous from above, while in the other the narrowing of the pleon is far less abrupt, and the apices of the third, fourth, and fifth segments as seen from above are well separated and conspicuously displayed.

The generic name is compounded of ἄγχι, near, and *Philoscia*.

Anchiphiloscia karongæ, sp. n. (Plate XXVII., A.)

This species shows a close resemblance to *Philoscia suarezi* Dollfus, from Diego Suarez in North Madagascar (Mém. Soc. Zool. de France, vol. viii. p. 185, fig. 7 in text, 1895), of which, however, the mouth-organs are not described. Independently of these, other features seem to make the identification inadmissible. These affect the second antennæ, the uropods, and the telson.

The body is rather narrowly oval, the head not broad, the last peræon segment strongly arched over the pleon and then turning obliquely outwards on either side, not forming acute apices. The pleon is brusquely narrower than the peræon, and the adpressed lateral angles of the third, fourth, and fifth segments are not discernible from above. The telsonic segment is broader than long, with the sides straight, but the point not blunted as in *P. suarezi*.

The sides of the head curve in towards the front, with the eyes situated at the angles so formed. The small first antennæ have the second joint intermediate in thickness between the stout first and tapering third, the latter being scarcely longer than the second, and a little shorter than the first. The second antennæ are longer than half the body, the second joint a little longer than the third but much shorter than the fourth, the fifth nearly as long as the third and fourth combined and as long as the flagellum; in this the first joint is longer than the second, but scarcely longer than the third (without reckoning the brush-like setiform apical process), therefore not as in *P. suarezi* nearly equalling in length the two together. In the example figured, however, the third joint is a little shorter than the second.

The upper lip has its distal margin evenly rounded. The cutting-edge of the mandible is divided into four horny-looking blunt teeth. The secondary plate on the left mandible has the same horny appearance, but that on the right is pellucid. The other features have been already discussed. The first maxillæ have the two plumose setæ seated on the inner part of the apex; of the spines on the outer plate the outermost is, as usual, the strongest; of the three following the intermediate is short; to these simple spines succeed four, each with a subapical tooth. The second maxillæ have been already discussed. The maxillipeds have the plate of the large and long second joint extending to the apex of the palp's second joint, notched at the inner distal angle, where it has one minute spine-tooth, a little behind which a regular spine rises from a little surface-lobe, and at the outer distal angle the apical margin has two more spine-teeth, also of very small size. The second joint of the palp is furnished with one or two setiform spines, and the slender, faintly separated third joint has setules on the outer margin and apex.

The first gnathopods have the third, fourth, and fifth joints much broader than the sixth; the fourth and fifth subequal in length, strongly spined on the hind margin, the fourth with a row of tiny denticles on the proximal part of its front margin, the fifth with oblique rows of spinules on the inner surface, the distal series projecting beyond the obliquely truncate distal margin; the sixth joint has the hind margin proximally furred with spinules.

The fifth peræopods are, as usual in the allied forms, the longest of the limbs. They have the fourth joint shorter than the third or fifth, and the fifth shorter than the sixth. In the young, taken from the mother's pouch, with eyes and other parts well developed, no trace of these limbs could be discerned.

Uropods with inner ramus attached on a level with the outer, compared with which it is not exceptionally narrow as in *P. suarezi*, and it is more than half as long. Each ramus is tipped with a tuft of setæ. Telson in young rounded.

Dimensions about 6 mm. in length by 2·75 mm. in breadth.

*Locality*. On damp decaying wood close to swamp, Kambwe, near Karonga.

For the colouring comment will conveniently be made in comparison with the next species.

ANCHIPHILOSCIA CUNNINGTONI, sp. n. (Plate XXVII., B.)

This species is in striking agreement with the preceding in regard to the antennæ and all the minute details of the mouth-organs, but the head is wider and the hinder segments of the peræon have their postero-lateral angles more acute, the hind margin of the seventh segment being uniformly arcuate and strongly produced over the pleon; the third, fourth, and fifth pleon segments are not adpressed, but have their postero-lateral angles well displayed; the convergent sides of the telson are slightly incurved. The first gnathopods have the sixth joint a little less widened distally than in the other species, but the difference is slight. The uropods have the inner ramus attached slightly in advance of the outer, which is fully double its length, therefore relatively much longer than in *P. annulicornis* Budde-Lund, as shown in the figure by Dollfus (Mém. Soc. Zool. de France, vol. viii. p. 184, 1895), from Diego Suarez.

In the general colouring of brown, variegated with lighter markings, on the back, this species agrees with *Philoscia muscorum* and several allied species. It has a thin light stripe extending from the back of the head nearly to the tip of the telson. In the peræon this is flanked on either side by a broad piece of variegated pattern, while the side-plates are dark, each with one conspicuous light patch, but not, as in *P. annulicornis*, having the postero-lateral angles pellucid. In the pleon the first two segments and the telsonic segment have each three light patches—one belonging to the medio-dorsal stripe, the others separated from it by dark patches. The second antennæ have the long fifth joint proximally dark and distally light. The uropods have the peduncles generally light and also the proximal part of the outer ramus; but this is variable, as one specimen shows one of these rami light to the apex, though the other is dark except close to the base.

In *A. karongæ* the colour is similar, but rather more dusky, the medio-dorsal stripe being also less continuous, and in one specimen the hinder segments of the peræon have their apices clear instead of dark.

Dollfus (*loc. cit.*) remarks of *P. annulicornis*: "This species is variable; the specimens of the type (coming from Mount Ambre) are all of great size (12 mm. by 6·5 mm.). Generally, above all in the plain, the length does not exceed 7 to 8 mm.; sometimes the joints of the flagellum of the second antennæ are subequal; but above all there are varieties *ex colore*: the clear spaces at the angles of the peræon may be lost, or instead of them there may be marblings or patches [such as those] situated in the median region; the antennæ are often either entirely light or entirely dark." The original says, "les taches claires des angles du pereion peuvent s'effacer, ou être remplacées par des marbrures ou taches situées dans la région médiane," where a word or two seems to be missing from the second clause.

Specimens of *A. cunningtoni* measured 7 mm. by 3·5 mm., or 6 mm. by 3 mm., the antennæ and uropods in each case not included.

*Locality.* Under stones, near Niamkolo Bay, Lake Tanganyika.

### Fam. ARMADILLIDIIDÆ.

### Gen. PERISCYPHIS Gerstaecker.

1873. *Periscyphis* Gerstaecker, Die Gliederthier-Fauna des Sansibar-Gebietes, van der Decken Exp., p. 526 (Budde-Lund).
1885. *Cercocytonus* Budde-Lund, Isopoda terrestria, p. 42.
1885. *Peryscyphis* Budde-Lund, Isopoda terrestria, p. 293.
1898. *Periscyphis* Budde-Lund, Die Land-Isopoden Ost-Afrikas, iv. 3.
1908. *Periscyphis* Budde-Lund, Swedish Zool. Exp. in Egypt, No. 26 A, p. 10.

In his latest work Budde-Lund gives a new description of this genus, having recognised that several of the species from German East Africa which he allotted to it in 1898 require a different systematic position. He gives some valuable illustrations of details in his own two species, *P. convexus* and *P. albescens*, but the typical species, *P. trivialis* Gerstaecker, remains unfigured. It is obvious that under the new definition those species which have the apex of the telsonic segment quadrate are excluded.

PERISCYPHIS CONVEXUS Budde-Lund. (Plate XXVII., C.)

1885. *Cercocytonus convexus* Budde-Lund, Isopoda terrestria, p. 44.
1885. *Peryscyphis convexus* Budde-Lund, Isopoda terrestria, p. 293.
1908. *Periscyphis convexus* Budde-Lund, Swedish Zool. Exp. in Egypt, No. 26 A, pp. 2, 9, pl. 1. figs. 20–25.

Head with frontal line evanescent in the middle. The side-plates or raised lateral borders of the first peræon segment broadest where flanking the eyes, narrowing downwards without quite reaching the hind margin of the segment; the second and third segments narrowly rounded at the lower corners, the following segments more squared, the seventh having the hind margin very concave in the middle but rather flattened at either side. The pleon short, with the segments in position successively shorter in the middle till the telsonic segment, which has a linguiform termination.

The eyes in our specimens do not appear to have more than 20 ocelli. Budde-Lund gives the genus about 25 to 30.

In the second antennæ the joints of the peduncle in order of length are the 1st, 3rd, 2nd, 4th, 5th, the last decidedly the largest, and longer than the flagellum, of which the first joint is longer than the second.

The mandibles have a trifid cutting-edge.

The lobes of the lower lip appear to be almost circular.

The first maxillæ agree closely with Budde-Lund's figures, the inner plate having 2 setæ or penicils, of which the inner is longer and stronger than the outer. Of the 9 spines on the outer plate, the two outermost are the stoutest, and then the next but one. I do not find any of them bifid at the tip. The subapical incurvation of the outer margin is finely setulose, as shown by Budde-Lund.

The second maxillæ have the inner plate very small, as broad as long, and strongly furred with very little setules; the outer plate membranaceous, broadly rounded, almost unarmed.

The maxillipeds seem to agree well with Budde-Lund's figure. The epipod, which he does not show, is large, reaching to the distal end of the principal joint, or nearly so.

That which appears to be the most characteristic feature of the species (unless it be shared with *P. trivialis*) is found in the uropods. Here the peduncle is large and quadrate, obliquely rounded off at the distal outer angle, but having its minute outer ramus inserted in and not protruding beyond a little notch near the distal inner angle. The inner ramus depending from an upper arm of the peduncle does not reach its extremity or the apex of the telson.

The length about 7 mm.

*Locality.* Under stones on beach, Birket el Qurun.

## EXPLANATION OF PLATE XXVII.

A. *Anchiphiloscia karongæ*, n. g. et sp.

*n.s.* Lines indicating natural size of specimen figured in dorsal view.
*a.i.* Second antenna, with further enlargement of setiform terminal portion and its armature.
*mx.* 1, *mx.* 2, *mxp.* First and second maxillæ and maxilliped, with further enlargement of terminal portions.
*gn.* 1. First gnathopod.
*urp.*, *T.* Uropod, and telsonic segment.

B. *Anchiphiloscia cunningtoni*, n. g. et sp.

*n.s.* Lines indicating natural size of specimen figured in dorsal view.
*m.m.*, *mx.* 1, *mxp.* Mandibles, first maxilla, and maxilliped.
*gn.* 1. First gnathopod.
*urp.* Uropod.

C. *Periscyphis convexus* (Budde-Lund).

Specimen in the centre figured in three-quarter dorsal view, without appendages.

*a.i.* Second antenna.
*mx.* 2. Second maxilla.
*urp.* Uropod.
*T.* Telsonic segment, with left uropod and part of fifth pleon segment.

The mouth-organs throughout are figured on a higher scale than the other appendages.

# 3. On the Anatomy of *Antechinomys* and some other Marsupials, with special reference to the Intestinal Tract and Mesenteries of these and other Mammals. By Frank E. Beddard, M.A., F.R.S., F.Z.S.

[Received April 28, 1908.]

(Text-figures 111–124.)

Contents.



## I. *On some Points in the Anatomy of* Antechinomys laniger.

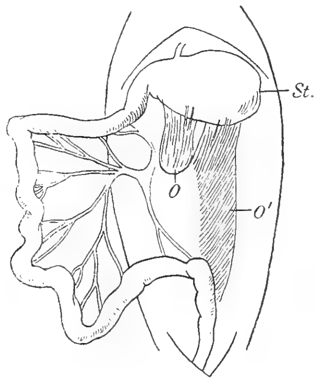
An example of this rare Marsupial was kindly placed in my hands some time since by Mr. Beck of this Society, with the request that I would examine its anatomy. The specimen consisted of the carcase after the skin had been removed, and was therefore incomplete as regards many of the muscles. But the viscera were intact, and I am able therefore to contribute something towards a fuller knowledge of this small Polyprotodont Marsupial. The only memoir known to me which deals with its anatomy is one by the late Mr. Alston in the 'Proceedings'* of this Society, written nearly thirty years ago. In this paper a number of facts is given relating to the internal organs of the body and there is also an account of its osteology. The viscera are somewhat summarily described by Mr. Alston; and there is thus some scope for a fuller account of certain organs in the light of later work upon the anatomy of mammals.

The *stomach* of this Marsupial has been figured by Alston, who has compared it with that of *Antechinus*†. He has, moreover, divided other related genera by the more globular or more transversely elongate form of that organ. I submit herewith (text-fig. 111) a drawing of the stomach of the specimen of *Antechinomys* which I have myself dissected and which I hope is accurate. It will be seen that it agrees more nearly with *Antechinus* as represented by Mr. Alston than with *Antechinomys* as figured by that naturalist. In particular I would call attention to the considerable calibre of the duodenum where it leaves the stomach, and to the fact that the cardiac half of that organ is considerably prolonged beyond and to the left of the entrance of the œsophagus. I am led, therefore, to doubt the value of the

* P. Z. S. 1880, p. 454.
† Now referred to *Phascologale* (Thomas, Cat. Marsupials Brit. Mus. 1885).

characters of that organ in discriminating between these allied genera.

Text-fig. 111.




Alimentary tract of *Antechinomys laniger*.

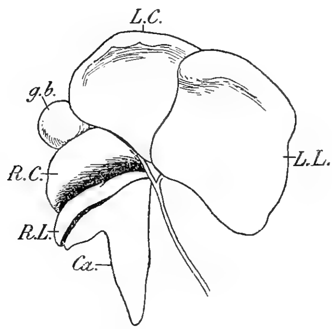
*O*. Omentum. *O'*. Splenic omentum. *St*. Stomach.

The *intestine* presents a number of features of interest. It is in the first place very short, as Mr. Alston has pointed out. Furthermore, there is no external differentiation into sections. The tube has the same bore throughout, and the absence of any trace of a cæcum renders it impossible to fix the delimitation between ileum and colon. The alimentary tract is not only short but, comparatively speaking, rather wide. There is no duodenal loop to be distinguished from the rest of the tube. The interesting fact about the intestine is that the whole tube is suspended from the middle line of the dorsal parietes by a single continuous mesentery. This is absolutely uncomplicated by any secondary attachments of any sections of the gut to each other, or to the parietes. In other mammals there is at least (in the majority of cases at any rate) one folding of the gut upon itself. That is, in the region of the stomach the transverse colon lies above the duodenum just after it issues from the stomach, and there is in this region a more or less direct mesenteric secondary connection between the duodenum and the colon or mesocolon. There is nothing of the kind in *Antechinomys*.

Another point of importance to be noted in relation to the intestine is that the loops into which it is thrown are not fixed. The whole intestine can be straightened, or rather of course thrown into a continuous curve, and thus differs markedly from many forms where the foldings of the intestine are permanent foldings and cannot be straightened out without tearing the supporting mesentery. Indeed, it is not too much to say that the alimentary tract of this mammal is as simple as that of any Lizard.

Mr. Alston's figure of the *liver* of *Antechinomys* does not agree entirely with the appearances which I have observed, and the description which he gives is very brief. I find (text-fig. 112) no Spigelian lobe, but the caudate lobe is deeply bifid and largely covers the right kidney. The gall-bladder, which Alston has correctly stated to be present, appears to me to occupy an unusual position. Instead of lying in a cleft in the middle of the right central lobe, as is at any rate often the case among mammals, it lies, as in some other Marsupials*, to the median side of the right central lobe almost between it and the left central. I did not find the right lateral lobe quite so large as Alston has figured it. It is closely fitted to the caudate. The liver "formula" of this Marsupial seems to me to be fairly accurately expressible as follows:—viz., $LL\frac{1}{2} > LC = RC > RL = Ca$.

Text-fig. 112.




Liver of *Antechinomys laniger*, abdominal aspect.

*Ca.* Caudate lobe. *g.b.* Gall-bladder. *L.C.* Left central lobe. *L.L.* Left lateral lobe. *R.C.* Right central lobe. *R.L.* Right lateral lobe.

The *spleen* is of large size and shows no indication of a triradiate form; it is wider at the duodenal end and narrower at the opposite extremity. The wide extremity of the spleen is marked by two parallel longitudinal furrows which divide up this extremity into several finger-shaped lobes not detached from each other.

The *pancreas* is very diffuse and scattered, consisting of numerous small lobules; it forms a more or less continuous mass which lies partly in the mesoduodenum and partly in the splenic omentum. It reaches also to the other side of the stomach and a piece of it lies to the left of the cystic duct between that duct and the duodenal end of the stomach.

The *omentum* (text-fig. 111, *O*) is very short and ends in pulled out ragged edges as is shown in the drawing. It is

* E. g. *Dendrolagus* and *Petrogale*, Beddard, P. Z. S. 1895, p. 131.

nowhere attached to the alimentary canal. The splenic omentum (text-fig. 111, *O'*) extends a little beyond the left kidney in its insertion on to the median dorsal line.

The left *kidney* is well below the right, and in fact its anterior end is only just a trifle above the level of the posterior end of the right kidney. The kidneys are rather large, about 10 mm. long.

The *organs of reproduction* are not widely different from those of other Marsupials. The example of *Antechinomys* dissected by myself was a female and apparently fully formed in the organs of sex. I am able to fill up a lacuna in our knowledge of those organs in the Marsupialia. The uterus of each side was swollen into an almost spherical dilatation near to the origin of the Fallopian tube into which it abruptly contracted. At the other extremity this dilatation lessened more gradually, though at the same time with some abruptness, into the rest of the uterus. At the junction of the two uteri in the middle line the common chamber thus formed is of greater calibre than is either of the uteri just before the junction. There seemed to be a rudiment of a median cul-de-sac. The two vaginæ are about the same calibre as the thinner part of each uterus and are not specially dilated anywhere. The funnel forms the usual fimbriated expansion which is attached to the ovary for a very short space. It and the Fallopian tube are supported by the anterior ligament of the uteri which is attached to the parietes in front of the ovary, and thus forms a pocket into which the ovary can be pushed.

## II. *On some Points in the Anatomy of* Phascologale macdonellensis.

I also owe to the kindness of Mr. Beck a complete example of this recently described species of *Phascologale*, which presents several features of interest in its anatomy. The genus itself is not well known anatomically. So far as I have been able to ascertain, there are only two recent memoirs extant which deal with the visceral structures of species of *Phascologale*. The first of these is in a paper upon *Antechinomys laniger* by the late Mr. Alston to which reference has already been made, and in which the stomach of *Antechinus* (= *Phascologale*) *swainsoni* and *Phascologale penicillata* are described, and in the case of the former figured, as well as some other viscera. In the second paper—Dr. D. J. Cunningham's Report upon the Marsupials collected during the voyage of H.M.S. 'Challenger,' * some notes are given upon the thoracic viscera (*not* the abdominal) of *Phascologale calura* and concerning the azygos vein.

The example which I dissected was a fully adult female with no signs of immaturity The teats (3 on each side) were large,

* Vol. v. of the Reports.

indeed so large as to suggest that the animal had recently borne young. Neither were there any signs of immaturity about the organs of reproduction. Nevertheless, there was a large persistent urachus or umbilical cord. There is no question here of mere traces or of a minute rudiment of this structure. It was large and conspicuous, as is plainly shown in the accompanying figure (text-fig. 113). Whether this umbilical cord does or does not contain any functional blood-vessels I cannot say. All vestiges of blood-vessels were invisible on dissection. Moreover, although I have used the term "cord" to express this structure, it is by no means an exactly descriptive word. When the animal was dissected under water the membrane forming the umbilical cord floated out loosely, being merely gathered together at the point where it perforates the rectus abdominis muscle to be attached to the skin.

Text-fig. 113.


"Umbilical cord" and adjacent viscera of *Phascologale macdonellensis*.

*int.* Intestine. *O.* Omentum. *R.* Rectus muscle perforated by umbilical cord. *St.* Stomach.

The attachment of this membrane to the intestine fixes that tube, as is natural, in a definite position; if it were not for this persistent umbilical cord the intestine could be, as I imagine, laid out in a continuous curve as in *Antechinomys*. The point where the umbilical membrane is attached to the gut represents, I presume, the position of Meckel's diverticulum. In this case the greater part of the intestine will be referable to the small intestine and the colon will be short. The umbilical membrane, however, is not limited to that portion of it which is attached to the intestine. In spreads out and is continuous with the omenta both great and small; there is absolute continuity between the umbilical membrane and the stomach and spleen. It would appear therefore, that *Phascologale macdonellensis*, like the majority of Marsupials, has an umbilical placenta. In relation to this I may say that there was no connection whatever between this umbilical cord and the bladder. The umbilicus itself lies rather in front of the last rib, and is situated 10 mm. from the end of the sternum; it is, on the other hand, 28 mm. from the anus.

One cannot but think that the case described here is exceptional, and that the genus or species generally is not characterised by this persistent umbilical cord. It will be, however, interesting to enquire how far the omentum is really connected with the membranes of the fœtus in development.

The *intestine*, as already mentioned, is held in position by the ligament derived from the persistent umbilical vesicle. It has a simple course like that of many Lizards, and forms only one loop upon itself as is shown in the drawing (text-fig. 113). It is not without interest to notice that this single loop is rather like the single loop thrown over the duodenal region during the development of the human alimentary canal.

The *liver* of this Marsupial differs in a few points from that of *Antechinomys*. There is in the first place a considerable Spigelian lobe; the caudate is not so extensively prolonged over the right kidney as it is in *Antechinomys*. Otherwise the liver does not differ much. An examination of an example of the larger species *Phascolomys penicillata* (for which I am also indebted to Mr. Beck) shows the same characters. The liver of *Sminthopsis* (of the species *S. crassicaudata* and *S. larapinta*) agrees more with that of *Phascologale* than of *Antechinomys*. In the former at any rate the Spigelian lobe was obvious.

The *spleen* of *Phascologale* is unlike that of *Antechinomys* in that the Marsupial triradiate form was obvious, particularly in *P. penicillata*. In the smaller species described here the bifurcate end of the spleen, that turned towards the left side of the body, was rather in the form of a triangular expansion of the end of the spleen, the base of the triangle lying towards the right. In *Sminthopsis* the spleen is more like that of *Antechinomys*, the right expansion being little marked.

As in *Antechinomys* the right kidney is much above the left, and the same asymmetry is seen in *Sminthopsis*. I examined the female generative organs of *P. penicillata* as well as of the species which forms the subject of the present notes. The same very strong dilatation of the distal end of each uterus that I have described in *Antechinomys* was to be seen in both of these species. It was very marked indeed in both. In the larger

*Phascologale penicillata* there was also a considerable dilatation at about the middle of each vagina. The two vaginæ and the bladder open into the common external canal at about the same level. I did not notice any trace of a median cul-de-sac of the uteri in the larger species, whose genitalia appeared to be rather more mature and were in any case larger than those of *P. macdonellensis*.

## III. *On the Intestinal Tract in some Marsupials, compared with that of other Mammals.*

Some of the general features of the intestinal tract in many Marsupials are already well known. It is well known through the investigations of many (*e. g.*, Owen *, Forbes †, Beddard ‡, Parsons §, Lönnberg ||, Klaatsch ¶, Mitchell **, &c.) that the large intestine of the Diprotodont Marsupials is as a rule †† very long relatively, even—it may be—much longer than the small intestine. In those Polyprotodontia in which a cæcum is present to mark the junction of the two regions of the gut, it is plain that the large intestine is relatively shorter, but not so short as in the Carnivora. These facts are shown graphically for six species of Marsupials by Dr. Mitchell. Though doubtless it is not asserted that the figures referred to exhibit with absolute accuracy the relative lengths of the large and small gut, it is clear that they make a very fair approximation to accuracy.

Furthermore, it is at least highly probable that more accurate figures could not have been compiled. For it is well known that the relative lengths of the two sections of the gut are apt to vary. For example it has been asserted by Brants (quoted by Tullberg ‡‡) that in 30 examples of *Mus decumanus* the relative lengths of the small and large intestine fluctuated between a small intestine ten times the length of the large, and a large intestine which was only one third of the length of the small intestine. Tullberg himself, in a series of very careful measurements of eight examples of the common rat, made upon specimens prepared in exactly the same fashion, found not so great but yet a considerable fluctuation. The extremes in two rats of equal size were in one example a small intestine of 808 mm. and a large intestine 201 mm., in the other the small intestine 835 mm. and the large intestine 186 mm. It is therefore

* *Dendrolagus inustus*, P. Z. S. 1852, p. 103.

† *Phascolarctos cinereus*, P. Z. S. 1881, p. 180.

‡ *Dendrolagus bennetti*, P. Z. S. 1895, p. 131.

§ P. Z. S. 1896, p. 683.

|| Several species, P. Z. S. 1902, i. p. 12.

¶ Morph. JB. 1892.

** Several species, Tr. Z. S. 1905, vol. xvii. p. 437.

†† To which at any rate *Petaurus breviceps*, an insect-eating Diprotodont, is an exception. See Lönnberg, *loc. cit.* p. 14.

‡‡ "Ueber das System der Nagethiere," Nova Acta Reg. Soc. Upsala, ser. ii. 1899.

impossible, as it would appear, to suggest any improvement in the figures of Dr. Mitchell from this side of the question.

| | Small Int. | Large Int. | Cæcum. |
|---|---|---|---|
| *Dendrolagus inustus* ♀ ........ | 117 | 73 | 4 |
| *Trichosurus vulpecula* ♂ ...... | $70\frac{3}{4}$ | 81 | $15\frac{1}{4}$ |
| *Macropus melanops* ♂ ........ | 156 | 162 | 18 |
| ,, *giganteus* ♀ ........ | 172 | 54 | 7 |
| ,, *brachyurus* ♀ ...... | 52 | 21 | $2\frac{1}{2}$ |
| ,, *billardieri* ........... | 146 | 30 | $2\frac{1}{2}$ |
| *Hypsiprymnus cuniculus* ♀ ... | 24 | 10 | $1\frac{1}{2}$ |
| ,, *gaimardi* ♂ ... | 40 | 28 | 2 |

Apart from the relative lengths of the small and large intestines and the form of the cæcum, or its absence, upon which I have no new facts of my own to record in the present paper, but concerning which I take the opportunity of utilising a series of measurements recorded by my predecessor Mr. W. A. Forbes (see list above), the intestinal tract of mammals exhibits a series of modifications in different groups and in members of those groups, which may be considered under the following headings, viz.:—

(1) The relationship of the various coils of the intestine to each other. (2) The fixity or freedom of the loops of the small intestine. (3) The permanent loops of the colon.

Under all of these headings I have a few new facts to record with respect to the Marsupials and to certain other mammals.

(1) *The relations of the coils of the intestine to each other.*—It is clear from the descriptions given by Owen *, that as a rule at any rate † the intestinal tract in the Marsupials is a freely movable tract throughout, having no mesenteric connections between the colon and other regions. As Sir Richard Owen was particular to describe such folds and connections when they occur in other mammals (as for example Rodents), the absence of any such statements in his papers upon Marsupials leads to the inference that such do not exist in those mammals; a statement which I am able to confirm from my own dissections. Other observers have noted a similar series of facts. Prof. Grant in describing the anatomy of *Perameles nasuta* ‡ has noted the dimensions of the several tracts of the intestine but has made no comment upon any folds of the gut, which would certainly have been mentioned (one assumes) had they been present, since the same observer almost at the same time § carefully described such folds in the Paca. Vrolik, in describing the anatomy ‖ of *Dasyurus ursinus*, does not appear to have said anything about

* On *Dasyurus macrourus* (=*D. maculatus*), P. Z. S. 1835, p. 7; on *Macropus parryi*, ibid. 1834, p. 152; on *Dendrolagus inustus*, ibid. 1852, p. 103.

† This does not, however, seem to apply to the Wombat (see Owen, P. Z. S. 1836, p. 49) which requires re-examination from this point of view.

‡ Mem. Wernerian Soc. vi. 1832, p. 184.

§ *Loc. cit.* & *t. cit.* p. 133.

‖ Tijdschr. wis- en natuurk. Wetensch. 1851, p. 153; briefly abstracted in Ann. Mag. Nat. Hist. ix. 1852, p. 245.

the presence of any folds in the gut, but gives measurements of the lengths of the several parts of the gut.

The late Sir William Flower * by implication makes the same statement; for he remarks of the alimentary tract of the Opossum (*Didelphys virginiana*) that "the colon forms a single arch and then passes directly down to the pelvis; but being very loosely attached by mesentery it is very movable."

None of these writers, however †, with the exception of Sir Richard Owen, refers to the fact that among the Marsupialia there are two grades in the complication of the alimentary tract to be met with. That author says of *Dasyurus maculatus*—"The mesentery was one continuous duplicature of the peritoneum extending from the pylorus to the end of the colon as in the Reptilia."

It appears to me that by this phraseology is indicated an intestine like that of *Antechinomys* described in the present paper ‡, comparable to an early stage in the development of the alimentary tract of man before the hinder part of the gut has been folded over the anterior part. In his Treatise on Comparative Anatomy the "reptilian" condition of the gut in certain Marsupials is more plainly stated.

These two stages in the development of the intestine are figured in Flower's Lectures on the organs of digestion in the Mammalia already referred to and in any textbook of human anatomy. It is obvious that the conditions obtaining in *Antechinomys* represent the first stage persistently retained. There are not many positive facts which lead to the supposition that any other Marsupial shows the same. The only figures of the entire alimentary tract of a series of Marsupials known to me are those of Mitchell already referred to, and of Klaatsch §. But there is no indication here of differentiation between the lower and higher types in the direction referred to. Klaatsch, indeed, figures *Dasyurus viverrinus* as *not* possessing the "reptilian" form of gut, since it possesses the cavo-duodenal ligament. I can quite confirm him from an examination of *D. maugæi*.

That this simple form of gut is not due merely to its shortness and to the mechanical difficulty implied by a folding over, is proved by the occurrence of the same type in animals belonging to other orders of mammals. In *Centetes ecaudatus*, for example, among the Insectivora, there is precisely the same type. The continuous mesentery of the gut is nowhere folded over, and the whole intestine is arranged exactly on the plan of that of *Antechinomys*, though it is much longer. Dr. Mitchell's figure of *Centetes* might at first sight appear to bear out my statement. But if this figure be compared, *e. g.*, with that of *Phalangista*

* In his Lectures on the Alimentary System of Mammals reported in Med. Times and Gazette, 1872.

† Nor is the fact adverted to by Cunningham in his description of the gut of the Thylacine, &c., Rep. Zool. Challenger, vol. v.

‡ *Supra*, p. 562.

§ Morph. Jahrb. xviii. 1892, p. 622, fig. 2, p. 664, fig. 10, pl. xxii. fig. 7.

*vulpina*, no difference in this particular between the two forms is there discernible. Now in *Phalangista* there is the typical folding over of the hinder part of the alimentary tube upon the anterior. The two figures, therefore, which have been referred to, only hide the essential differences between the two types, informing us merely of the existence in one and the absence in the other of a cæcum—a fact already well known. It is interesting to note that *Centetes* has not always this simple arrangement of the gut. I found it in one example but not in another, where there was one folding over, but no further specialisation. This is also interesting not merely from the point of view of fixity of characters, but because in the Hedgehog the gut is folded over upon itself as in most mammals, and is not a simple coil on a continuous mesentery *.

I am not quite clear from his description and interpretation of Zoerner's † results, whether Klaatsch places the Edentate *Myrmecophaga* in the same category as *Antechinomys*. But I imagine not, since *Tarsius* is described as showing "die einfachsten Mesenterialverhältnisse" among the Mammalia. In any case, I can assert that some of the American Edentata also show a very simple gut, comparable to that of *Tarsius* and *Antechinomys*. In *Myrmecophaga jubata* and *Tamandua tetradactyla* the gut can be laid out without removal from the body in a continuous loop, precisely like the figure given of the same by Mitchell ‡. In this feature the genera mentioned are to be contrasted with *Dasypus* and other Armadillos. There is, however, no indication of the differences in the figures of Mitchell excepting, indeed, that the mesocolon is drawn on one side of the colon in one form, and on the other in the other types. This cannot, however, imply any such difference as is here recorded, since, as already referred to, the different conditions obtaining in *Centetes* and *Phalangista* are indicated by a diagram which would imply complete similarity, while *Phalangista* and *Macropus* are

* It is possible, however, that Dr. Mitchell (Tr. Z. S. 1905, vol. xvii. p. 532) may have forestalled me and have met with the same variation in this rather important feature which I have noted above. In his "Summary of Systematic Inferences" he writes that "in most .... Insectivora .... the intestinal tract .... (is) suspended by a continuous mesentery." This would seem to imply the condition which I have described above. On the other hand, he does *not* in the same section say the same of the American Anteaters, which in this respect resemble *Centetes*, so far as one of the specimens of the latter which I dissected is concerned. And again in the special section dealing with mammals individually, Dr. Mitchell makes no mention of a continuous mesentery, but remarks that *Erinaceus* is practically identical with *Centetes*. It may well be that the recollection of more than one example led to these two not precisely contradictory, but not altogether concordant statements. I may recall the fact that some years ago I described (Novit. Zool. vol. viii. 1901, p. 91) a continuous mesentery in two other examples of *Centetes ecaudatus*, and did not meet with the important variation recorded here.

† "Bau und Entwickelung des Peritoneum &c. von einiger Edentaten," Inaug.-Diss. Halle, 1881. Not seen by me.

‡ It is important to settle this matter definitely, for Flower is not conclusive in his statements. On an early page of the "Lectures," already quoted, he remarks that the reptilian character of the gut is "only found among Mammals in some Insectivora and insectivorous Marsupials." Later, however, he refers to it as also existing in Whales and in *Myrmecophaga*.

represented as different. I am disposed to believe from its shortness that the gut of *Bradypus* will be found also to conform to this plan *. The simple colon of all these forms of *moderate* length, neither excessively long nor excessively reduced, is, as I think, in agreement with Dr. Mitchell, a mark of low position in the series, especially since no modification traceable to different feeding-habits is recognisable.

On a superficial inspection the intestinal tract of many Carnivora appears to be constituted on the same simple plan as that of *Antechinomys*, *Myrmecophaga*, *Centetes*, &c. That is to say, the gut can be laid out in one continuous coil without removing it from the body or cutting any mesentery. There are, however, variations in the degree of freedom of the gut. In *Cercoleptes caudivolvulus* for example, the gut can be readily laid out either to the left or to the right, and then forms a continuous coil apparently with a continuous mesentery throughout. It would seem in fact to have retained the primitive arrangement altogether. In *Ictonyx capensis*, on the other hand, this spreading out into a continuous fold is only possible on the left side; the gut cannot be thus spread out on the right side. So too with *Nandinia binotata*. In *Ursus syriacus* the gut can be readily laid out on the left side; but I have unfortunately no note as to whether it can be also spread out to the right so as to present the appearance of a continuous mesentery like that of the simplest mammals. In *Genetta rubiginosa*, however, the gut can, as in *Cercoleptes*, be laid out on either side of the middle line without tearing or unduly stretching any mesenteries. The disposition of the gut, however, in these animals, though superficially as has been said that of the simplest forms in the order, is in reality different. It will be seen that where the end of the duodenal loop comes near to the middle dorsal line, it is actually fastened to the mesocolon by a short mesentery, as is shown in the accompanying figure (text-fig. 120 B on p. 591). The comparative freedom which the whole intestinal tract enjoys is clearly due to the partial disappearance of this particular mesentery, the ligamentum cavo-duodenale. If more extensive, the arrangement of the intestine in a continuous coiled line from stomach to rectum would be impossible. If, on the other hand, the mesentery disappeared altogether, there would be actually a continuous mesentery from end to end of the gut. I am inclined, therefore, to believe that the intestine has in these forms undergone a simplification approximating to the primitive state of the gut with its mesentery. And indeed it may well be that even the apparently simple forms like *Antechinomys* are in reality the terminal stage in such a reduction, and not evidence of the persistence of a primitive state of affairs. I believe, however, that the coincidence of this apparently primitive state in such widely removed types as *Centetes* and *Tamandua* is evidence in

* As to *Cholœpus*, however, Klaatsch observes that "das Lig. hepatocavoduodenale ist schwach entwickelt."

the contrary direction. The conditions obtaining in the Carnivora, and as it would appear in the whole of that group, cannot be looked upon as a reduction due to small size. For it will have been noted that the large Bear is quite on a level with the small *Cercoleptes* or *Ictonyx*. It is not only the Carnivora which show this simplification of the gut. For I have already remarked that the same state of the intestine and its mesentery is to be seen alternatively in *Centetes*. Even among the Primates it exists; for in *Chrysothrix sciureus*, as I point out later (p. 577), the intestine can equally well be laid out along a comparatively straight mesentery to either right or left side. It must be noted, however, that in this animal and in the Carnivora the colon is very short. It is, in the specimen which I dissected, only 6½ inches in length, a measurement which agrees exactly with that of Martin *.

Although the above facts concerning the Carnivora are I believe correct, and indeed quite bear out Klaatsch's figure † of the intestinal tract of the Cat, where the mesentery attached to the duodenum and to the middle line is figured and termed "ligamentum cavoduodenale," and his statements concerning other genera. Max Weber has, however, described and figured a different state of affairs in the Bear ‡. The species examined was *Ursus arctos*, and the gut is figured as turned over to right and left without a trace of this ligament, and described in the following words:—"Der ganze übrige Darm an einer einfachen Mesenterialplatte (Mesenterium commune) die mit einfacher radix mesenterii an der Wirbelsaüle wurzelt aufgehängt ist." There may of course be this difference between the two species of *Ursus*, or the case may be analogous to that which I have described above in *Centetes ecaudatus*. In any case it is clear that the majority of the Carnivora (whether Arctoid or Æluroid) do not bear out the statement of Max Weber with reference to *Ursus arctos*.

In more differentiated forms a furthei complexity is introduced in the existence of a special ligament joining the commencing duodenum with the proximal end of the colon. For this Klaatsch adopts Krause's term *ligamentum colicoduodenale*. It is figured by Klaatsch in several forms, in *Myoxus*, *Stenops*, and human embryo. Nor has Tullberg neglected this connection between the small and large intestine in his figures of certain Rodents. This structure is so persistent in the Rodents that it even occurs in the case of the small *Arvicanthis*, where the colic coils are reduced to a minimum; as indeed they are according to Klaatsch's figures in *Myoxus*. It is very important to note that even the Marsupials with their little specialised gut show traces of the same; in *Trichosurus vulpecula* and *Pseudochirus peregrinus*

* P. Z. S. 1833, p. 89.
† "Zur Morphologie der Mesenterialbildungen, &c. ii Theil," Morph. Jahrb. xvii. 1892, p. 646, fig. 4.
‡ Die Säugethiere, p. 212.

I found this membrane, and I may take this opportunity of remarking that the omentum also is attached, though for a very short space, to the colon as in the genus *Macropus*. Neither of the facts is represented in Klaatsch's figure of the gut of *Trichosurus vulpecula* *. There remains, however, a substantial difference between *Trichosurus* and *Pseudochirus* on the one hand and *Macropus* on the other, in that in the latter the connection between omentum and colon is extensive, as is duly figured by Klaatsch for *Macropus bennettii*. I cannot agree with Dr. Mitchell in finding no connection of this kind between the duodenum and colon in *Hyrax*. In examples of this "Subungulate" which I dissected some time since, the duodenum near to its exit from the stomach was adherent to the colon in the neighbourhood of (distal to) the paired cæca by a ligament of some length. Moreover, there was also a fixation of the omentum upon the same region of the colon. I take this opportunity of remarking that *Hyrax* shows a particular point of likeness to the Perissodactyle Ungulates as I venture to think. In the latter group without exception, as has been shown by many anatomists, the cæcum is immediately followed by a single simple loop of the colon. The same occurs in *Hyrax*, though it is in that animal not quite so well-marked. The colon immediately after leaving the single cæcum, which I regard as the equivalent of the Perissodactyle cæcum, is folded back along the cæcum and connected with it by a ligament; the distal limb of this loop is not quite so well established as in the Perissodactyle, however. I discuss these facts more in detail on a subsequent page †.

The attachment of the great omentum to the colon is well-known as an anatomical fact. Klaatsch has figured this in several forms. Later in this communication I direct attention to the same attachments in various Rodents and Lemurs.

I have found no such attachment in Carnivora ‡, nor in American Edentates (in which I am in accord with Klaatsch). In *Orycteropus*, however,—and this emphasises the distinctness of that type from its alleged relatives in the New World—there is a fixation of the omentum along two separated lines. The most anterior is on to the cæcum and the very commencement of the colon. Then follows a considerable area of colon unattached to the omentum which is again attached to it further along. This state of affairs reminds us of the transitory condition in the human fœtus figured by Klaatsch (*cf. loc. cit.* p. 694, fig. 16), which is, however, permanent in *Cebus* as he has pointed out. For other facts relating to the attachment of the omentum and of other ligaments reference may be made to subsequent pages, where they are described in several animals.

* *Loc. cit.* pl. xxii. fig. 7.

† See below, p. 579.

‡ Except in one or two cases where it appeared to me to be distinctly pathological. The non-attachment of the omentum in Carnivora is not, of course, put forward as a new fact. I confirm it by fresh instances.

It is possible that the secondary attachment of the omentum to the colon bears some relation to the formation of the permanent loops of the colon. For this attachment at least offers a fixed and more or less immovable area or length, which would permit of unequal growth in this as compared with neighbouring tracts of intestine. Further contractions of the omentum during its growth would obviously tend to emphasise such loops and would act in the direction of rendering them more permanent. In any case it is important to notice that where there are no fixed ansæ coli, there is at least frequently no secondary attachment of the omentum to the colon. This is the case for example with Carnivora, and with Carnivorous Marsupials, with Armadillos, and Insectivora *. This rule, however, is not universal in its application; for among the Apes, where there are no definite ansæ coli, there is an attachment of the omentum to the colon. On the other hand, where there are well-defined ansæ the omentum is as a rule found to be inserted upon one of the ansæ. The more exact relations in a number of Mammals are as follows:—Among the Lemurs where there is one colic fold, whether simple or forming a spiral, the omentum is invariably attached to the distal limb of the loop or spiral †. Among Rodents I found that in *Lagostomus* the omentum was attached along the colon from the beginning of the distal limb of the *ansa paracæcalis* to the end of the proximal limb of the *ansa coli dextra*. In *Hystrix cristata* the omentum is attached along one half of the distal limb of the *ansa coli dextra*, the *ansa coli sinistra* having no such connection. In *Sciurus maximus*, however, where the same two ansæ are present, there is no such insertion of the omentum. These facts do not appear to have been dealt with by Tullberg in the Rodents.

The lesser omentum of human anatomists is called by Klaatsch ligamentum hepatogastro-duodenale. It is the ventral membrane of the gut. This is universally represented among Mammals. The posterior continuation of this, however, the ligamentum hepato-cavoduodenale, is not universal. The cavo-duodenal part of this has already been referred to in various mammals. The ventral portion of the membrane, the hepatoduodenale, now requires some consideration. This is described by Klaatsch in *Echidna*, and sought for without finding it in certain Marsupials. On the other hand, it is stated to be present in various Carnivora, Rodents, and Lemurs. I found this as a distinct membrane very plainly to be seen in *Ursus syriacus*. It is to be noted that in this Carnivore the caudate lobe of the liver is prolonged down to the level of the duodenal loop. And thus there was a possibility, so to speak, of finding the membrane, which indeed was slight though unmistakable and connected the extremity

* I do not, of course, put forward this non-attachment of the omentum as an entirely new fact.

† Klaatsch, *loc. cit.* p. 667, fig. 11, would regard the omentum as occupying the interspace of the loop also. I am not convinced of this.

of the liver-lobe with the ligamentum cavoduodenale. The two mesenteries were quite continuous. In *Echidna* also and other types in which this membrane exists, the liver descended to the level of the recurrent duodenal loop, where it was attached by the ligamentum cavoduodenale. In *Hyrax*, however, the extreme end of the liver is distant from the end of the duodenal loop by a space of fully three inches. There is thus an impossibility of finding a state of affairs like that described above in *Ursus*. In *Hyrax* the duodenum in the ascending limb courses over the right kidney, to which it is firmly attached by membrane; the same kidney is equally attached to the liver by an hepato-renal ligament. Thus we have a series of membranes connecting the liver with the ligamentum cavoduodenale. Klaatsch has regarded this as the equivalent of the entire ligamentum hepato-cavoduodenale, the arrangement of which with respect to its several elements will evidently depend upon the relative positions of the several viscera concerned.

(2) *The Permanent Loops of the Colon*.—As a rule, with but few exceptions, the Marsupials possess none of those permanent loops of the colon which have been termed by Tullberg "ansæ coli," and by Klaatsch "flexuræ coli." This is evident from the figures given by Klaatsch and Mitchell and from the descriptions of others, to some of which I have referred above. Nevertheless, the group is not absolutely to be characterised thus. I have found in one example of *Didelphys virginiana* a distinct permanent loop which was rather wide and lay at a considerable distance behind the cæcum. The specimen in which this occurred was a male, and in a female of the same species there was no such loop. I do not connect the variation with sex, but note its presence as indicative of the commencing formation of these special loops in the Marsupialia. I also observed something of the same kind in an individual of *Trichosurus vulpecula*. Furthermore, in several species of *Macropus** (i. e. *M. woodwardi*, *M. melanops*, and *M. hagenbecki*) the colon shortly after it issues from the cæcum and just below the stomach is slightly flexed, and permanently so, into a wavy outline of one or two undulations. This again is perhaps to be looked upon as a commencement of the ansæ coli of more highly differentiated forms.

The permanent loops of the colon have been described in a great many mammals and by many zoologists. I have, however, in the course of the past year accumulated a considerable number of facts in this department of anatomy which partly confirm the results obtained by others, are partly new (so far as I am aware), and in some cases enable me to distinguish between already published descriptions that do not happen to be in entire harmony. As to the latter section it must be borne in mind

* Quite possibly in others; but I have no notes on the point except of the species mentioned above.

that there is apt to be some variation in these loops, as I point out more particularly in the case of the Vizcacha (*Lagostomus trichodactylus*) and the Cape Hyrax (*Hyrax capensis*). Of the latter species I have examined an unusually large number of examples, a fact which naturally gives me some confidence in detailing the characteristics of the alimentary canal and mesenteries of this interesting form. My notes refer to the Anthropoidea, the Lemuroidea, the Hyracoidea, and the Rodentia, which I consider in the order named.

## Anthropoidea.

Of the Primates I only report upon two or three species, which happen to be remarkable in various ways. In the Gelada Baboon (*Theropithecus gelada*, sometimes called *Gelada rueppelli*) the intestinal tract as well as other details in its anatomy have been described by the late Mr. A. H. Garrod *. In a male and female dissected by him, the proportions between the small and large intestines differed greatly. In the male the colon was $\frac{2}{3}$ of the length of the small intestine, in the female the proportion was much less, *i.e.*, $\frac{5}{13}$ nearer to $\frac{1}{3}$. The example dissected by myself was also a female; but the proportions in length of the two sections of the gut were much nearer equality, though I have, I regret to say, no exact measurements. The ascending colon from its very beginning (*i. e.*, opposite to the entrance of the ileum) and a large portion of the transverse colon were attached to the great omentum. Moreover, the greater part of the ascending colon was bound down by a mesentery to the dorsal parietes. The colon had of course no fixed loops, which indeed do not occur among the Anthropoidea.

In *Semnopithecus melalophus* (a species of which the Society has possessed no previous examples) the small intestine was thrown into few wide and more or less fixed coils owing to the shortening of the mesentery. The colon was long, about double the length relatively of a *Cynocephalus porcarius* examined for purposes of comparison on the same day. Its arrangement was remarkable. The ascending colon and a portion of the transverse colon were sacculated in the usual way along three bands; and the greater portion of the descending colon was similar in its sacculation. Between the two, and corresponding to the greater part of the transverse colon, was a tract of uniform and small calibre entirely without sacculations. The omentum was attached to the mesocolon of the anterior sacculated region of the colon, but at a considerable distance from the colon.

The cessation followed after an interval by the resumption of a sacculation in the course of the colon, recalls a quite similar state of affairs in the colic loop of the *Rhinoceros sondaicus*, figured some years ago by Sir Frederick Treves and myself in that animal †. Although the colon has not, as in *Theropithecus*,

* P. Z. S. 1879, p. 451.
† Trans. Z. S. vol. xii. pl. xxxiv. figs. 1, 2.

a special mesentery not to be confused with the mesocolon, and attaching it to the parietes of the right side of the body, there is something of the same kind present. For the cæcum of this *Semnopithecus*, which is quite blunt at the apex, is fixed by a membrane to the parietes in the inguinal region on the right side. This had not the look of a former pathological adherence, which would, I think, have presented a more irregular appearance. There were of course no fixed loops in the colon. This special attachment of the cæcum is also found in some other Monkeys. The general anatomy of the Squirrel Monkey, *Chrysothrix sciureus*, has been described by Martin*, who pointed out the existence of an extremely short colon, which he found to be only 6½ inches in length. I can confirm this and add some details which bear upon the subject of the present investigation. The colon, rectum, and short cæcum presented almost exactly the appearance of those viscera in a Viverrid, the large intestine being slightly curved to the right, and thus showing as in many Viverrids a rudimentary transverse colon. It is an exaggeration of the condition observable in *Ateles melanochir*, where the whole of the colon is disposed in one bold curve rather more than semicircular and precisely like that of Armadillos. In *Ateles*, in fact, there is a well developed transverse colon, but hardly an ascending colon. The whole gut appears at first sight to be suspended on a continuous mesentery, for it can be laid out in a continuous curve either on the right or left side without removing it from the body, just as in such types. A closer inspection, however, shows the presence of a *ligamentum cavo-duodenale*, so that the conditions obtaining in this Monkey are just like those which have been described above in the Carnivora. This simplification can hardly be due to reduction in size. For in the smaller *Hapale penicillata* the gut cannot be turned over freely to right or left, and has the normal syphon shape.

### Lemuroidea.

The *ansa coli* of the Lemurs offers some particularly interesting modifications.

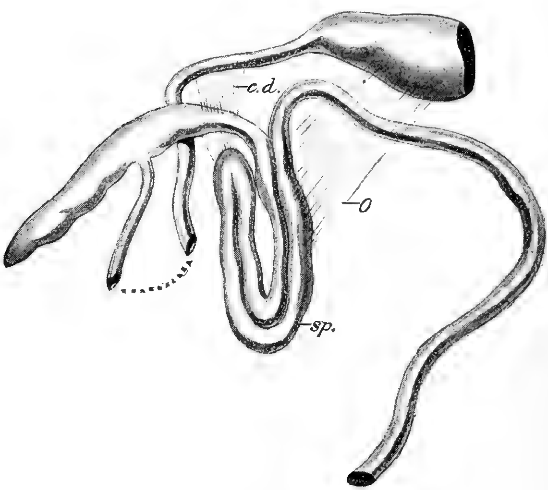
The simplest form of colon of those which I have examined is shown in *Microcebus smithii*. Of this Lemur the general anatomy has been described by Martin †. The colon shows no special *ansa* or *ansæ*, but is comparatively short and reaches the terminal straight portion by a boldly curved tract in which there are no permanent folds. This arrangement was identical in two examples of the Lemur which I dissected. This is very similar to the conditions figured in *Cheirogaleus coquereli* by Dr. Mitchell, though I am not quite certain from his description and figure taken together, whether there is or is not a well defined colic loop such as occurs in the genus *Lemur*. Dr. Mitchell speaks of "a colic loop . . . . relatively much shorter in *Cheiro-*

* P. Z. S. 1833, p. 88. † P. Z. S. 1835, p. 125.

*galeus*," but figures a state of affairs like, for instance, *Dasypus* where there is no defined colic loop. It would be, as I think, convenient to restrict the term colic loop to such a defined loop as occurs in the genus *Lemur*, to which I shall now refer.

Sir W. Flower has figured the single ansa coli in the genus *Lemur* (in *L. flavifrons*) and Dr. Klaatsch has figured an identical loop in *Hapalemur*, and Dr. Mitchell (without referring to Flower's figure or to that of Klaatsch) has figured an identical loop in *L. mongoz*, var. *nigrifrons*. They are indeed obviously identical. I can confirm from my own dissections the existence of this loop in *L. mongoz*, which seems to me to correspond to the *ansa coli dextra* of Tullberg, but of which the constituent limbs were closer together than is figured by Mitchell, agreeing therefore more closely with the figure of Flower. In *L. macaco*

Text-fig. 114.




Cæcum, colic spiral, &c. of *Galago garnetti*.

*c.d.* Ligamentum colico-duodenale, which lies opposite to a ligament binding extremity of colic spiral to commencement of colon. *O.* Omentum. *sp.* Colic spiral. The cut ends of the small intestine are joined by dotted lines.

was the same ansa coli. In *L. albifrons* again the same; but the two limbs were a little further apart in both of two examples. *Lemur sclateri* was the same. The genus *Galago* shows an interesting further development of this simple *ansa* of *Lemur*. I have ascertained that this loop has been figured previously in *Galago crassicaudata* by Flower; but I cannot accept the figure given by Dr. Mitchell as representing the facts in even an approximate fashion. I have lately examined two examples of *Galago garnetti* (the species described by Dr. Mitchell), and some years ago a single specimen of *G. maholi*. In all of these the *ansa coli dextra* (if I am right in so identifying the loop) is coiled as is shown in the accompanying figure (text-fig. 114) into a short spiral exactly like that of certain Rodents and most if not all Artiodactyles, though much simpler than the spiral of the vast majority of the latter. This characteristic spiral arrangement is entirely lost in the figure given by Dr. Mitchell *, to which I here refer, though accurately represented by Flower. The matter is of special interest because the same spiral arrangement of the *ansa coli dextra* is to be seen in the genus *Nycticebus* of the subfamily Lorisinæ, as is abundantly shown in the figures and descriptions of Vrolik † and Schröder van der Kolk ‡, which I am able to confirm by the dissection of two examples of *Nycticebus tardigradus*. The resemblance to *Galago* is exact. I am disposed to think that Dr. Mitchell's figure of the Potto requires revision, in which animal he represents two adjacent ansæ coli disposed like those of many Rodents. Dr. Mitchell has not referred to the papers cited below.

The dissection of an example of *Indris* enables me to confirm the figures of Milne-Edwards § as to the existence of a colic spiral in the Indrisinæ which is more elaborate than in the other types just dealt with. I may be permitted to point out another relation between these Lemurs with a spirally twisted *ansa coli* || which has not been insisted upon. In the genera where this occurs, *i. e.*, in *Galago*, *Loris*, *Nycticebus*, *Indris*, and, I imagine, *Perodicticus*, the characteristic carpal vibrissæ are absent; they are present in the remaining Lemurs with no *ansa coli* or only a simple one. Specialisation of structure has occurred concurrently in two features of their organisation. It is important to notice that in these Lemurs with a simple or a spirally twisted *ansa coli*, the omentum is attached to the loop or spiral. Furthermore, the opposite side of the spiral is attached to the cæcum, or to the colon just where it leaves the cæcum, by a ligament, and the duodenum is attached to the colon just opposite to this latter ligament by a colico-duodenal ligament.

## HYRACOIDEA ¶

I have examined several examples of *Hyrax capensis* and have more particularly studied two specimens of which one was specially favourable for study. This example was not more

* *Loc. cit.* fig. 41, p. 506.

† N. Verhandel. Nederlandsche Inst. Amsterdam, vol. x. 1844, p. 75.

‡ Tijdschr. Natuurk. Gesch. Leiden, viii. 1841, p. 277, pl. v. figs. vi., vii.; and a joint paper by these two anatomists in Bijdragen tot de Dierk. i. 1848–1854, p. 29. Gegenbaur also (Vergl. Anat. Wirbelth. ii. 1901, p. 178) figures the spiral in *Loris gracilis*. So also does Klaatsch, though not, as I think, quite accurately in *Nycticebus*.

§ Hist. Nat. Phys. et Polit. de Madagascar.

|| I cannot understand Klaatsch's statement that "die rechte Colonflexar ist . . bei *Lemur* relativ noch mächtiger entfaltet als bei *Stenops*."

than half grown, measuring not more than a foot in extreme length. The alimentary tract of this animal has been described at considerable length by Dr. Mitchell, but I find myself in grave disagreement with him, the disagreement extending to matters of fact as well as to interpretations of the value of certain structures. I furthermore deal with certain points which are not dealt with by Dr. Mitchell.

When the body-wall is cut and the halves reflected, the intestinal tract is seen to be represented by the large cæcum which occupies the greater portion of the left moiety, and by the paired cæca and the immediately preceding and succeeding sections of the colon which occupy the right moiety of the superficial part of the abdominal cavity thus disclosed. Above, a few coils of the small intestine are visible, but very few. As Dr. Mitchell has correctly stated, the duodenal loop is longer than he has represented in his figure *. It extends in the very general fashion down to about the middle of the lumbar region below the kidneys, and is there attached by the usual ligamentum cavoduodenale. This loop of the duodenum shows on the opposite side another remarkable mesenteric fold. When the single cæcum is turned forwards, it is seen that a mesentery with a free edge directed forwards runs over the duodenal loop, being attached on the left to the colon where it emerges from the single cæcum, and on the right to the colon where it passes towards the paired cæca. As this fold has a free edge, a pocket is formed which appears to be imperforate at the bottom. I have no facts to offer for the purposes of a comparison of this mesenteric recess with possibly similar structures in other mammals. The coils of the small intestine, with the exception of the duodenal loop, are, as usual, temporary coils, and the intestine can be straightened bit by bit as it is passed through the fingers. The ileum opens into the single cæcum, the resemblance of which to the cæcum of the Perissodactyles is apparent from the descriptions of others and from an inspection of this portion of the gut which has been somewhat confused by Dr. Mitchell's figure. He represents it as a bilobed dilatation on the course of "Meckel's Intestine." It is, in fact, almost a facsimile of the cæcum of a Rhinoceros, the chief difference being that it has a much blunter termination than in the Perissodactyle. It is moreover sacculated, and the relations to it of the small and large intestines respectively are exactly as in the Rhinoceros' cæcum. Moreover, the large intestine which emerges from it is of greater calibre than the small intestine which enters it. Finally Dr. Mitchell has taken no account of certain mesenteries related to this cæcum which unquestionably suggest its homology with the usual unpaired cæcum of mammals. That the paired appendages of the gut which arise further down may be the equivalents of the Edentate paired cæcum is quite possible. But if so, it is only in my opinion further evidence that the latter are not the equivalents of the usual unpaired cæcum of other

* Trans. Z. S. 1905, xvii. p. 461, fig. 14.

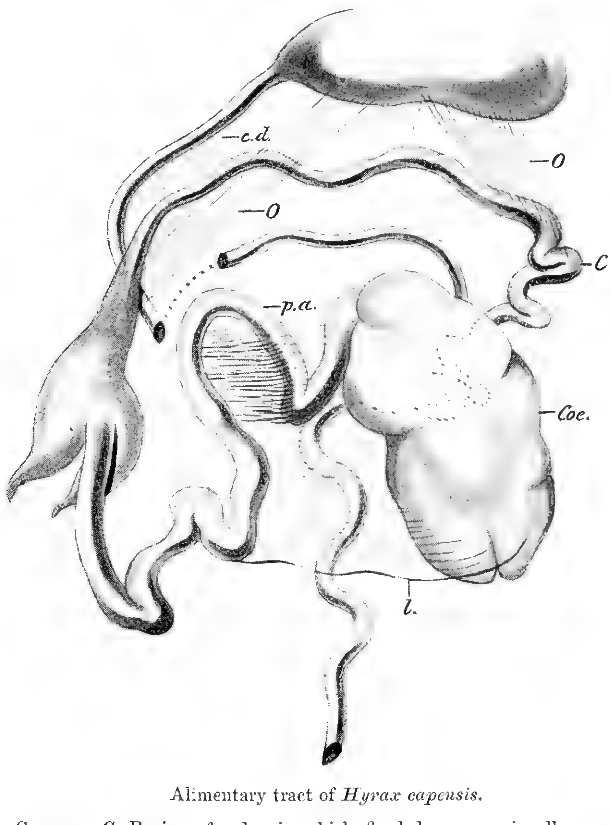
mammals. The paired cæca of *Hyrax* have no mesenteries of any kind attached to them. They hang perfectly free of peritoneum folds into the body-cavity. I do not think that any true unpaired cæcum, even the small one of the Carnivora, is thus free of mesentery.

The only other Mammals known to me in which the cæcum or cæca are thus entirely free of peritoneal folds, are the American Edentates. On the other hand, the unpaired cæcum of *Hyrax* has peritoneal folds connected with it. These are not mentioned by Dr. Mitchell, and they have a very important bearing upon the nature of the unpaired cæcum of *Hyrax*. It will be seen from the accompanying figure (text-fig. 115, p. 582), which may be compared with that given by Dr. Mitchell to which reference has already been made, that the colon where it leaves the cæcum is bent sharply upon itself, and then forms a more or less L-shaped curve. The whole of this part of the colon is attached to the cæcum by a mesentery which runs to the very tip of the cæcum. When the cæcum is examined more closely, the cæco-colic ligament is seen to arise from the cæcum along a straight line distant from, but continuing the line of, the ileum where it enters the cæcum. This fixed loop of the colon is surely to be compared to the single colic loop of the Perissodactyles, where indeed, as I myself * and others have pointed out, the same ligament occurs but is much shorter. The slightly twisted commencement of this ansa paracæcalis, as I interpret it, is reminiscent of that of many Artiodactyles and Rodents (e. g. *Arvicanthis*: for which see below, p. 589), but the length of the entire ansa is obviously more like that of the Perissodactyles. This marked loop is not figured by Dr. Mitchell, who only represents an alteration in the direction of the "small intestine" (as he regards it) where it leaves the unpaired cæcum. There is no mention in the text of any such ansa coli; the author to whom I am referring contenting himself with remarking that "the hind gut is subdivided into a distinct colic loop (C.L.) and a long straight rectum." The "loop" in question is not comparable to the ansa coli described by myself in this paper, and by others. It is merely the wavy transverse colon in which there are as a rule no ansæ at all. It is regrettable that Dr. Mitchell has used indifferently the same term ("colic loop") for the fixed ansæ coli which are permanent structures, and for alterations in the direction of the gut. The colon of *Hyrax* in fact, after leaving the ansa paracæcalis referred to, has no further ansæ coli. It has an irregularly looped course owing to its great length, and passes upwards giving off the paired cæca in an ascending colon, then runs across the body-cavity as the transverse colon, and descends in a series of wavy convolutions as the descending colon into the rectum. As is the case in all of the more specialised Mammalia, the omentum is attached to the transverse colon. And the mode of its attachment is

* "The Anatomy of the American Tapir," P. Z. S. 1889, p. 254.

very interesting. The colon where it leaves the region of the two paired cæca is attached to the stomach by a fold of the omentum. After this follows a section of the colon to which there is no such omental attachment, and again at the commencement of the descending colon the omentum is for a second time inserted upon it. This arrangement of the omental

Text-fig. 115.




Alimentary tract of *Hyrax capensis*.

*Cœ.* Cæcum. *C.* Region of colon in which fixed loops occasionally occur. *c.d.* Ligamentum colico-duodenale. *l.* Ligament uniting cæcum and commencement of colon. *O.* Omentum. *p.a.* Ansa paracæcalis.

attachments is precisely like that of *Orycteropus* as I have described on p. 573. And, as I point out in describing this feature in *Orycteropus*, there is a likeness with the fœtal condition in man. There is furthermore, as the figure cited shows, a well-marked colico-duodenal ligament attaching the duodenum immediately after it has left the stomach to the colon opposite to the attachment of the first part of the omentum. It may be that the attachments respectively to the colon immediately after it has left the paired cæca, is an argument in favour of regarding those cæca as the equivalents of the unpaired cæca in other forms. For in Rodents the attachments of the membranes in question are sometimes to the colon immediately after it has emerged from the cæcum in those animals, and the same relations are to be found in Lemurs. But against this resemblance may be placed the facts of the attachment of the membranes in question in *Dasyprocta*. In that Rodent, as I point out, the omentum and the duodenum are inserted upon the ansa coli, which lies at a considerable distance from the point of emergence of the colon from the cæcum. The evidence therefore cannot be regarded as very strong. Whereas the evidence already dealt with against the identification is very strong.

It will be clear from the foregoing that Dr. Mitchell's statement that "the hind gut divided into a simple colon and rectum merely conforms to the fundamental mammalian plan" is not correct. Nor can I agree with him in the further observation that "the general pattern of the intestinal tract in *Hyrax*, however, suggests no affinity with the patterns exhibited by Rodents and Ungulates." It appears to me to resemble both. But this is of course a matter of opinion. It is not without importance to observe that *Hyrax* shows some variation in certain of the features described above. Since writing the account which I have just given of this Ungulate I have dissected three other specimens, all of small size like that from which the above account has been practically entirely drawn. In one of them, the colon at the end of the transverse section at the further attachment of the omentum is fixed into a short ansa coli which is not very narrow, *i. e.*, the two limbs are not closely approximated. This corresponds in position to the splenic flexure of human anatomy, and is very like the ansa coli sinistra of *Tamias striata* described under my account of the ansæ coli of Rodents. The two other specimens did not show this specialised loop. Furthermore, the mesocolon undergoes some variations in its region of attachment to the dorsal parietes. I did not observe the exact arrangement in the first example dissected. But in the three now under consideration there were three different modes of attachment, thus clearly showing a great variation. In the individual just referred to, this mesentery was attached altogether outside of the left kidney. In a second individual, the left kidney lay for the greater part to the left of, *i. e.* outside of, the mesocolon, but the attachment of the latter was in part to the kidney and cut off an angle of that viscus anteriorly and to the right. In the third example, the line of attachment of the mesocolon divided the kidney into two longitudinal areas, of which the inner lay within the mesocolon area and the outer lay outside of the mesocolon. The pocket of peritoneum referred to was present in at least two of the subsequently dissected examples of *Hyrax capensis*, but the actual excavation to form a pocket was hardly at all marked. I may further remark that the cavoduodenal ligament ended some little way in front of the posterior angle of the duodenum *. In all the other points treated of in the above description of the intestinal tract of *Hyrax*, I found these three examples precisely like those originally dissected. It will be observed that my account substantially bears out that of George †, though adding some details.

## Rodentia.

As I have dissected a considerable number of Rodents with a view to the accurate mapping of their intestinal resemblances and differences, I may be permitted the following remarks, which, however, contain observations that are partly in accord with those stated at first hand, or as a result of agreement with others, by Tullberg.

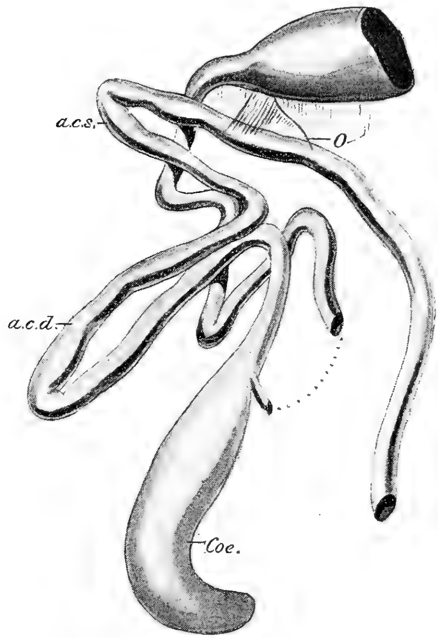
Among the Sciuroidea I have examined the following species, viz.: *Cynomys ludovicianus*, *Tamias striatus*, *Sciurus maximus*, *Sciurus macrurus*, and *Sciurus cinereus* (text-fig. 116), of which the second has been also examined by Tullberg as well as the Common Squirrel and some genera which I have not seen. Tullberg has not described or figured the ansæ coli of *Cynomys*. They are typically like those of other Squirrels. That is, there are two permanent loops, of which the first is very much the longer. In *Tamias striata* I find conditions rather different from those described and figured by Tullberg. He describes "nur ein rechte parallelschlinge," but figures two such loops of which the first, *i. e.* that nearest to the cæcum, is the shorter, though both are not so marked as in his figure of *Sciurus vulgaris*. I find in an example of this species two loops, the usual arrangement in Squirrels. Of these the first, that nearest to the cæcum, is of considerable length; and the second is much shorter and also much wider, its constituent tracts of colon being further away from each other than is the case with the anterior ansa coli. Apart from the shortness of both ansæ, especially the second, the colic loops of this Squirrel are like those of *Sciurus maximus*, where there are two; the longer of these next to the cæcum is actually six inches in length, with the two lengths of intestine closely approximated; the second loop is very much shorter but much wider; thereafter the rectum is nearly straight. In *Sciurus macrurus* the arrangement is nearly identical, but the shorter loop is composed of more closely approximated limbs; so too with *Sciurus tennanti* (W. A. Forbes MS.). In *Sciurus*

* This state of affairs would seem to be impossible until it is recollected that the ascending limb is tightly fastened down to the right kidney as it passes over the viscus. (See above, p. 580.)

† Ann. Sci. Nat. (6) i. 1874.

*vulgaris* Tullberg shows a somewhat different state of affairs; there are two well developed and narrow loops close together which are, however, of nearly the same length. This agrees with a figure given by Mitchell of *Xerus capensis*, and by Gegenbaur of *Cynomys ludovicianus* *, and W. A. Forbes (MS.) of *Arctomys marmotta*.

Text-fig. 116.




Part of alimentary tract of *Sciurus cinereus*.

*a.c.d.* Ansa coli dextra. *a.c.s.* Ansa coli sinistra. *Cœ.* Cæcum. *O.* Omentum.

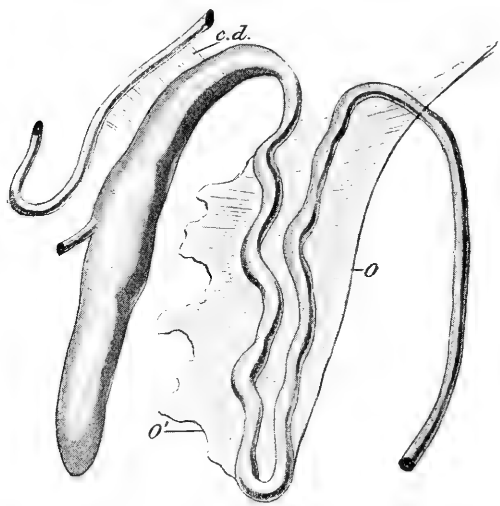
One of the Hystricomorph Rodents not figured by Tullberg is the Vizcacha, *Lagostomus trichodactylus*. It is stated, however, to resemble *Chinchilla* in possessing an *ansa coli dextra* and an *ansa paracæcalis*, which however is more free from the cæcum than in *Chinchilla*.

In the two examples which I have dissected there are differences from each other, but I am not clear how far—if at all—either of them differs from the example described by Tullberg. In the one, a female, the *ansa paracæcalis* was a very short, but rather wide loop, totally unlike that figured by Tullberg for *Chinchilla*. The *ansa coli dextra* was long and

* Vergl. Anat. d. Wirbelthiere.

narrow, and beyond the colon and rectum lay in loosely coiled folds which could of course be straightened out. In the other example, a male, the *ansa paracæcalis* was very large and wide and commenced immediately after the cæcum, ending only with the commencement of the *ansa coli dextra*; the latter was long and narrow as usual, and the rest of the colon, instead of being gathered into temporary folds in a comparatively limited space, ranged, so to speak, throughout the entire colon in a series of broad loops.

Text-fig. 117.




Part of alimentary tract of *Aulacodus*.

*c.d.* Ligamentum colico-duodenale. *O, O'*. Omentum.

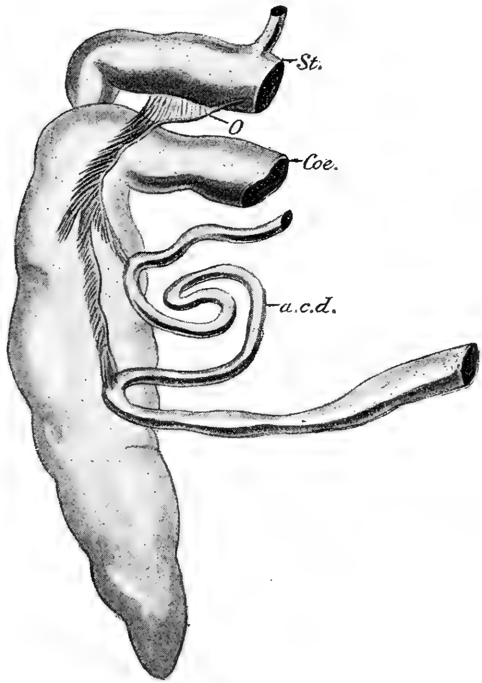
*Aulacodus swinderianus* is one of the types of Hystricomorphs not dealt with by Tullberg as regards the points under discussion. I may therefore record the results of a dissection of two examples of this Rodent. Immediately after the cæcum there is a single enormous loop measuring quite a foot long, which is followed by a nearly straight colon and rectum. I am uncertain whether this fold is to be looked upon as the paracæcalis or one of the ansæ coli, dextra or sinistra. Garrod does not seem to have mentioned it in his account of the viscera of this animal*.

I figure this loop of *Aulacodus* (text-fig. 117) since it differs in various details from that of any other Rodent known to me. It will be observed that the two limbs of the loop running parallel to each other and at no great distance are fringed on

* P. Z. S. 1873, p. 786.

both sides by a membrane with a free edge. On the one side, the membrane has a clearly marked perfectly straight edge, and traced up to the beginning of the loop this is seen to be continuous with the great omentum. The omentum is thus attached to the whole of the ansa coli. On the other side is an equally free fold of membrane, but here the membrane has not a clear cut edge. It ends raggedly and unequally as is shown in the figure. I should say that the figure is made without any cutting of the membranes, which preserve the condition they showed while the gut lay undisturbed within the abdominal cavity. I take it that the ragged edge is really the actual free edge of the omentum, which does not therefore actually end upon the ansa coli but is continued beyond it.

Text-fig. 118.




Part of alimentary tract of *Hydrochœrus capybara*.

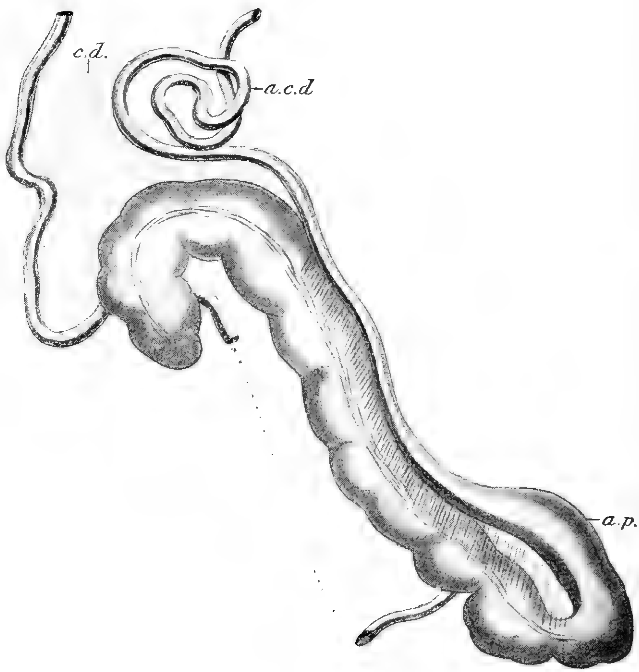
*a.c.d.* Ansi coli dextra. *Cœ.* Cæcum, cut through at about the middle of its course. *O.* Omentum. *St.* Stomach.

Although Grant * and Martin † as well as Tullberg have described the gut of the Paca, *Cœlogenys paca*, I think it worth

* Trans. Wern. Soc. *loc. cit.* † P. Z. S. 1838, p. 54.

while to record my own notes as a contribution towards possible variations in the nature of the spirally coiled ansa paracæcalis. The example which I dissected was coiled in a rather complicated fashion. There are altogether eight limbs in the spiral, and the figure given by Tullberg appears to me to represent rather fewer. That is to say, the loop originally a straight loop has been folded upon itself five times as will be seen from the number of "limbs."

Text-fig. 119.




Part of alimentary canal of *Dasyprocta punctata*.

*a.p.* Ansa paracæcalis. *a.c.d.* Ansa coli dextra. *c.d.* Colico-duodenal ligament.

With reference to this characteristic Hystricomorph spiral, I may mention that in *Hydrochœrus* it is apparently a late growth. I have dissected two examples of about half the full size to which the animal attains, and in both of them there was no complete spiral but merely a loop with a slight twist upon itself at the distal extremity (see text-fig. 118, p. 587).

*Dasyprocta aguti* possesses, according to Tullberg, a limited spiral. I found the same state of affairs in a newly born specimen, where the spiral was only twisted upon itself once, the condition being therefore much as in the half-grown *Hydrochœrus* just referred to.

Tullberg's figure of the Agouti is not quite so satisfactory as are the majority of his figures. It is so small that various details are left out. I therefore venture to supplement him by another figure of an allied species *Dasyprocta punctata* (text-fig. 119). In this specimen the colic loop is, as shown, rather larger than in *D. aguti*. It is precisely as in the Lemurs *Galago* and *Nycticebus* (see p. 578). The first part of the colon, as correctly shown by Tullberg, runs parallel with and very close to the cæcum, to which it is attached by a mesentery. There is a kind of attempt—so to speak—at its origin of an ansa paracæcalis like that of the Murines. The duodenum is attached both to the colic spiral and to the commencement of the cæcum, which bends back upon itself at its free end as shown in the figure. The great omentum is attached to the colon where it emerges from the spiral and also to the contiguous part of the spiral itself. It is not, however, attached to the whole left border of the spiral as in the Lemurs mentioned. I should mention that the cæco-colic ligament is attached along one of the two muscular bands upon the cæcum, the other being on the opposite side.

The small Barbary Mouse, *Arvicanthis pumilio*, has the simplest colon of any Rodent which I have had the opportunity of examining *, and the conditions characterising this genus have not been dealt with by Tullberg. The colon itself is relatively short and thrown into no temporary folds. The cæcum lies on the right side of the body rather low down, and the colon ascends, shows a transverse region, and then forms the descending colon. There is only one ansa coli present, and that is just where the colon emerges from the cæcum. It is there twisted into a short spiral. This ansa paracæcalis is in principle like that of other Rodents such as *Cricetus*. But it is the only loop present in *Arvicanthis*. It is noticeable that it has the characteristically Murine form. I could find no trace, at the angles formed by the bending of the colon, between the transverse and descending regions, of even so rudimentary a persistent loop as there is in *Cricetus*.

Tullberg has described various points in the anatomy of the two species of *Otomys*, viz. *O. unisulcatus* and *O. bisulcatus*, but has not dealt with the gut except to give the proportions of the several regions in the latter of those two species. Having had the opportunity of dissecting *O. irroratus*, I am able to fill in that lacuna in our knowledge of the Rodentia. In this Rodent we find almost exactly the same characters as in *Mus*. That is, there is only one colic loop and that is situated just at the commencement of the colon where it emerges from the cæcum. This ansa coli is doubled upon itself once, and this forms an "N" which is bound down to the cæcum. There are no other ansæ along the course of the colon. The great omentum seems to be not present

* *Mus rattus* is equally simple, and like *M. decumanus* figured by Mitchell—with perhaps even a less marked ansa coli.

at all as a free fold or as attached to the colon. This is an exaggeration of the characters to which Klaatsch has called attention in *Mus* and *Myoxus*. The splenic omentum (ligamentum recto-lienale) is attached to the colon direct as in *Mus*, and not to the mesorectum as is often the case in Mammals.

Although the loops of the colon in the Beaver have been figured by Tullberg, I do not find myself entirely in agreement with that figure. My own observations refer to the parts of the intestine to be dealt with as seen from the ventral surface—the surface exposed on dissection. I gather that the same view has been taken by Dr. Tullberg, since he represents the rectum as lying dorsally to those folds. If this be the case, the Beaver is another example of a Rodent showing some variation from specimen to specimen as is shown in the Vizcacha. The colon where it leaves the cæcum bends to the left and runs forward in close proximity to itself, being bound here by a mesentery. It then curves round and passes back again parallel to the beginning of the cæcum and large intestine, but on the opposite, *i. e.* the right, side, being here also attached closely to the gut in question by mesentery. The tube then bends upon itself and runs again parallel to itself for a little distance, being still attached by mesentery. The colon diverges to the right and forms the first of two ansæ coli like those of *Sciurus* &c. The first of these is attached by its left-hand limb to the ascending portion of the colon. This loop is slightly twisted to the left, and is indeed a rudimentary spiral like that of the Capybara &c. Immediately after the end of this loop the colon is modified into a similar loop of about equal length. Thereafter the colon runs in a broad curve to the rectum. It will be observed that the direction of the colon according to my observations is at first in the opposite direction as described by Tullberg.

The duodenum has varied attachments to the neighbouring regions of the colon and to the parietes, the latter of which I am not able to describe accurately. It is, however, important to note that the duodenum follows the curve of the first ansa coli and is attached to it by mesentery; there is also the usual ligamentum cavoduodenale.

(3) *Coils of Small Intestine.*—As a general rule the festooned coils of the small intestine are not at all permanent coils; the intestine can be passed through the fingers in a perfectly straight line without tearing or in any way distorting the mesenteron. At the same time of course the entire gut cannot be laid out in a circle or a portion of a circle owing to the shortness of its supporting mesentery. One portion can thus be freed from the rest, which in correspondence become closer and denser elsewhere. There are, however, exceptions to this general rule which I have observed among the Marsupials. In a specimen of *Pseudochirus peregrinus* it was impossible to straighten out the coils of the small intestine which were quite fixed. This characteristic,

however, appears to be individual and not to pertain to the species or genus; for in another example the small intestine was "normal." In another Marsupial, *Æpyprymnus rufescens*, the small intestine, considerably shorter than that of *Pseudochirus*, was also thrown into permanent coils. Here, however, I can only report upon a single individual.

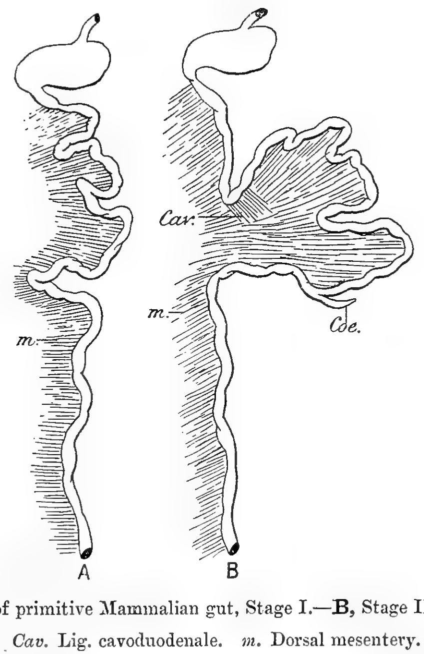
Among a considerable number of lower Mammals whose alimentary tracts I have recently studied, only *Dasypus vellerosus* (of which I have dissected a single example only) shows the same fixation of the numerous coils of the small intestine.

It is evident that this phenomenon is not a common one among the Mammalia, and it is at present doubtful how far it is characteristic, in the rare cases where it does occur, of a given species or genus.

*General Considerations.*

From the foregoing considerations it is clear that we can trace a number of stages of evolution of the intestinal part of the alimentary tract in the various groups of Mammalia which are not shown in their complete entirety in any one group.

Text-fig. 120.




**A,** Diagram of primitive Mammalian gut, Stage I.—**B,** Stage II.

*Cœ.* Cæcum. *Cav.* Lig. cavoduodenale. *m.* Dorsal mesentery.

In *Stage I.* the intestine is suspended upon a continuous mesentery and is not rotated upon itself to form the primary loop.

This is met with as an exception in the Marsupialia (e. g. *Antechinomys*); in the two Edentate American Anteaters, *Myrmecophaga jubata* and *Tamandua tetradactyla*; in *Centetes* (occasionally), at any rate, as representing the Insectivora; in the Elephant, so far as can be gathered from Flower's description *, as representative of the Ungulates. In the Odontoceti (*vide* Max Weber †) this arrangement of the intestine would appear to be the rule; but not in other Whales. *Tarsius* is the only Lemurine Mammal known to form an intestine slung upon a continuous mesentery ‡.

In *Stage II.* we have an intestine showing only the single rotation upon itself without any further specialisation, so far as concerns the gut. The suspensory mesentery, however, has

Text-fig. 121.

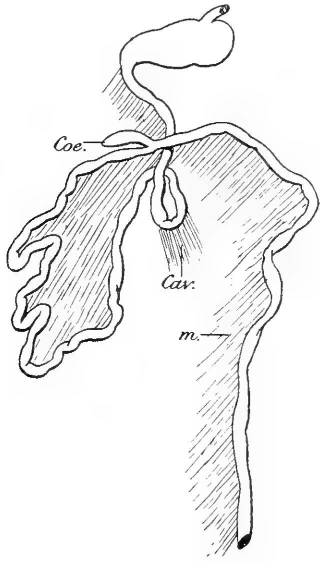



Diagram of Mammalian gut, Stage II.

Lettering as in text-fig. 120.

naturally divided into two, the additional one being what Klaatsch terms the "*ligamentum cavo-*(or *recto-*)*duodenale.*" We find this state of affairs in Marsupials (e. g. *Didelphys*, *Macropus*), in Edentates (e. g. *Dasypus*, *Orycteropus*), in Carnivora (? without exception), in Lemurs (e. g. *Microcebus*), in Primates (? without

* Med. Times & Gazette, *loc. cit.*

† Die Säugethiere. See for a particular instance (Porpoise) Hepburn & Waterston, Trans. R. Soc. Ed. xl. pt. ii. 1902.

‡ Klaatsch, *loc. cit.*

exception *). A slight modification of this stage is seen in many Carnivora and in the Primate *Chrysothrix*, where the intestine can be laid out flat without tearing the mesenteries; this is achieved by the reduction of the ligamentum cavoduodenale, and it is possible that the entire disappearance of this mesentery may account for such cases as *Centetes*, which therefore show an unreal primitiveness due to a reversion by degeneration.

This stage may be subdivided into two; of which one, Stage II. A, will include those forms in which the intestine is merely folded over once without further specialisation, and will include some Marsupials (e. g. *Didelphys*, *Hypsiprymnus*), Edentates (e. g. *Dasypus*), Carnivora (? all genera), Lemurs (e. g. *Microcebus*); and Stage II. B, which will be characterised by the further specialisation caused by the attachment to the colon of the omentum: this second group will contain many Marsupials (e. g. *Macropus*), Edentata (*Orycteropus*), Primates (division of Anthropoidea without exception).

Text-fig. 122.

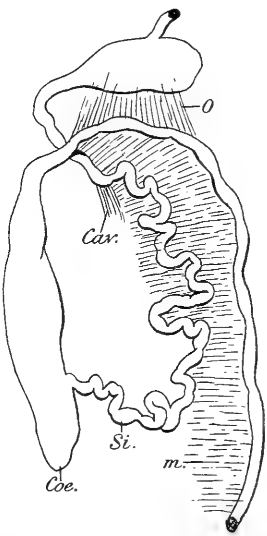



Diagram of Mammalian gut, Stage II. A.

*O.* Omentum. *Si.* Small intestine. Other letters as in text-fig. 120.

In *Stage III.* the essential difference from the two earlier stages is the formation of fixed permanent loops of the colon, termed *ansæ coli*. Combined with this is always an intestine

* Klaatsch's figure (*loc. cit.* fig. 12, p. 671) of the young *Hapale* with an ansa coli absent in the adult (fig. 13, p. 672) suggests the possibility of the Primate simplicity being due to reversion.

with the usual rotation of Stage II., and there is also invariably a connection of the omentum with the colon, and furthermore, always a secondary connection of the duodenum with the colon at its commencement. This stage is represented by Lemurs (the majority), all of the Hyracoidea, Perissodactyla * and Artiodactyla †, and, finally, Rodents.

Text-fig. 123.

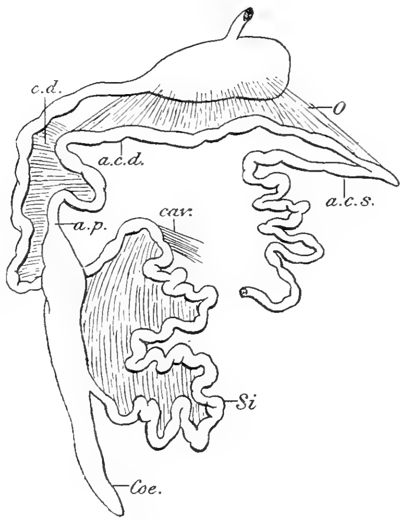



Diagram of Mammalian intestine, Stage III.

*a.c.d.* Ansa coli dextra. *a.c.s.* Ansa coli sinistra. *a.p.* Ansa paracæcalis. *c.d.* Colico-duodenal ligament. Other letters as in text-fig. 120.

This Stage is hardly divisible into different grades. There are, it is true, simpler forms and more complexly convoluted colons. It might perhaps be permissible to place at the base of the series the Perissodactyla and Hyracoidea where there is but one ansa coli, and that apparently the ansa paracæcalis of other types. If Klaatsch be right in regarding the coil of Ruminants and Swine as an ansa paracæcalis, this group would be added. In this case we arrive at the interesting conclusion that the colic spiral is not strictly homologous through those groups which show it. For in the Lemurs it cannot be doubted that the spiral is the ansa coli dextra. It is only the Rodentia which show the maximum of coiling of the colon, and in the more differentiated genera of that order (e. g. *Castor*) there are three ansæ coli, though not more.

* I have not dealt above in detail with the single simple *ansa coli* of Horses, Tapir, and Rhinoceroses, since it has been so often described.

† See especially Lönnberg, Acta Ac. Upsala, 1903, K. Vet.-Ak. Handl. 1901, and some other memoirs.

But other genera, e. g. *Mus* and *Arvicanthis*, with one ansa paracæcalis, and *Sciurus* with two ansæ, dextra and sinistra, and *Aulacodus* with only the ansa coli dextra, render it impossible to make hard and fast lines of division.

It will be noticed from the above account of the several stages seen in the Mammalian gut, that the Lemurs are the only group in which every stage but one is to be seen in a well-marked fashion. This fact of itself is enough to negative any accurate classificatory results to be deduced from the series of facts brought together in the present communication, though I offer later (p. 596) some observations upon the affinities of different groups as judged by the varied modifications of the intestinal canal.

Furthermore, it will be gathered from what has been brought forward in the present communication that the Marsupials, although their intestinal tract shows in a well-developed fashion only two stages, show indications as it were of the third stage. Occasionally an ansa coli exists, while secondary connections between the duodenum and commencement of the colon are found in *Trichosurus*. Arising, as is now believed, from some early Eutherian type, the Marsupials seem to have retained the potentialities of intestinal development exhibited in the later Eutheria.

It is important moreover to note that the attachment of the omentum to the colon in *Trichosurus* is to the extreme right of the latter; for it is on this side that the attachment commences in Man (Johannes Müller quoted by Klaatsch).

Simplification of structure does not always imply an archaic position with reference to allied forms which show a less simple anatomy. It has been again and again pointed out that size is an element which is not to be left out of consideration in weighing such apparently archaic structural conditions. For example, the smooth brain of many small mammals is not to be interpreted as evidence of the lowly position in the series of such smooth-brained types. On the other hand, the simple organisation of a Naiid Oligochæte as compared with that of a large earthworm, may be at least partly interpreted as simplicity not altogether due to reduced size. It is important therefore to note that the simple intestine of *Antechinomys* slung upon a single continuous mesentery is not a feature confined only to such small mammals. In comparing this form with *Arvicanthis*, which is even smaller, we find in the latter the usual rotated intestine with even a fixed colic loop. And other examples will be apparent from the foregoing pages as well as from previous writings on the subject. At the same time it is not to be forgotten that other instances may be due to simplification, and to belong therefore to a different category though apparently quite similar.

Although it is true that the specialised loops of the colon are often associated with a colon of great length, there is as it would appear no necessary connection between length and complexity, or even occurrence, of these special loops. The existence of such coils is in fact a character of given orders of mammals. Among those orders where they occur, that is to say the Rodentia, Perissodactyla, Artiodactyla, Hyracoidea, and Lemurs, there is no relation between complexity of coils and length of gut. The small Rodent *Arvicanthis* has a short colon not longer than that of many mammals of other groups without any trace of coils. And yet it possesses one ansa, the postcæcalis. The existence of three ansæ in the Beaver does not argue a longer colon than in the Agouti, where there is only one ansa, the ansa coli dextra. The complex spiral of *Indris* is not associated with a markedly longer colon than that which bears the one loop of the genus *Hyrax*. It is therefore clear that we must seek for the origin of these fixed loops of the colon in some other way than need for packing away a large tract of gut in a limited space. And it has been already suggested that this may be found in the attachment of the omentum.

### *Value of Intestinal modifications in Classification.*

Apart from certain facts given by Weber and others as distinctive of various groups of Mammals, Dr. Mitchell seems to be the only person who has attempted to discuss in detail the classificatory results to be obtained from a consideration of the varying characters of the intestinal tract. In a preliminary criticism of resemblances—an attempt to differentiate those upon which weight should be laid from those which cannot be admitted as of classificatory importance, this author has committed himself to a statement that will not receive the agreement of zoologists. "Likenesses" he writes (on p. 528) "which are due to the common possession of primitive features cannot be regarded as evidence of near relationship; that certain members of a group have retained what was once the property of all the members of that group can be no reason for placing such creatures close together in a system if that system is to be based on blood-relationship." It is, I imagine, by absolutely universal consent that *Echidna* and *Ornithorhynchus* are placed together in one order, Monotremata, and mainly by virtue of the facts that in both there is a large coracoid and a generally "primitive" shoulder-girdle: that in both the egg is large-yolked and meroblastic with a follicle of at most two layers of cells: that in both the anterior abdominal vein is either present or indicated by a large ventral mesentery: that in both the heart valve of the right auriculoventricular ostium has retained the partly muscular structure of that of lower types; and by other features all of which are primitive.

One can of course accede to Dr. Mitchell's assertion that the loss of a particular character in two groups is no reason for placing them in proximity, and that a new structural acquisition is evidence of relationship in proportion to the anatomical complexity of that structure; this latter is a perfectly correct restatement of Sir E. Ray Lankester's use of the Molluscan Odontophore as a test for the inclusion of a particular type in that phylum. Dr. Mitchell's sketch of the "archecentric" condition of the mammalian gut agrees absolutely with the figures given in any text-book of Human Anatomy * of the early human gut, and any mammalian gut.

There is in fact no doubt whatever that the primitive Mammalian gut was in all essentials a gut like that of the Reptilia, *i. e.*, a tube of no great length, and therefore with but few convolutions suspended by a continuous mesentery and with no permanent folds of any part. I leave undecided whether a cæcum or cæca are necessary adjuncts of this archetypal intestine, or whether they or it should lie about halfway down the intestinal tube.

Greater or less length is clearly of no importance inasmuch as that feature has been shown to vary in individuals (see above p. 585). Viewing the matter from this point of vantage, we ought to regard as most primitive in position any groups or group in which the alimentary tract has retained this Reptilian character throughout; which in fact are so far not one generation removed from the entire group of Lacertilia (including *Hatteria*), where no other conditions are, so far as anatomical investigation has gone, to be found.

So far as I can say from my own knowledge and from reliable statements published upon the matter, the only groups in which this primitive gut exists obviously are the Polyprotodontia (excluding the American forms), the Xenarthra (excluding Armadillos), the Proboscidea, the Odontoceti, and the Insectivora. But with regard to the latter the case of *Centetes* described above rather suggests a reversion. The Lemurs can hardly be added, since *Tarsius* is the only form which shows this straight mesentery unfolded anywhere; and as that genus is so minute in size the feature may be the result of degeneration.

Why Dr. Mitchell should remove from such an assemblage † the Insectivora, Proboscidea, and Odontoceti, and add to it the Tubulidentata and Diprotodont Marsupials, is not altogether easy to understand. His arrangement appears to me to be so far purely capricious, and to be based upon no facts. Moreover, I would point out that very nearly all zoologists would agree in regarding the groups which I have thus placed in juxtaposition as being ancient groups.

Dr. Mitchell, however, appears to me to be perfectly right in asserting that the Carnivora have not moved far from the common centre; though why this statement should be qualified by the suggestion that the reduction of the hind gut is a specialisation is not so apparent. As Dr. Lönnberg has well pointed out in the case of certain Marsupials ‡ (and others have pointed out in other

* *Cf. e. g.* D. J. Cunningham's Text-book.

† According to him the "ancestral group" contains Marsupialia, Xenarthra, Tubulidentata, and Galeopithecidæ. *All* Marsupials, I presume, are included.

‡ P. Z. S. 1902, vol. i. p. 12.

groups), there is a close association between the relative lengths of the regions of the gut and the food, a relation which is by no means ignored by Mitchell, though he does not quote any previous memoirs in discussing this matter.

Surely the American monkey *Chrysothrix* (see above p. 577), with a very short straight intestine, cannot be considered to differ importantly by this character from e. g. *Hapale* with the usual three-sided Primate large intestinal loop. On the contrary, I should be disposed to assert that the short colon of the Carnivora, persisting as it does through the whole order, differing as they do widely in their food, is rather evidence of an ancient state of affairs.

Moreover, a glance at the earliest Mammalia known would seem to suggest that a carnivorous, insectivorous, or at most omnivorous way of life was the primitive mammalian mode of life, a view which is strengthened by reflections upon the origin of the group, whether from Reptilian or Amphibian like forms. Otherwise it might be pointed out that on the whole the simple form of gut was associated with a shortness of gut associated in its turn with a carnivorous habit. The Elephant however (if I rightly interpret the investigations and statements of others) seems to possess a simple gut supported upon a continuous mesentery.

This, however, is by no means saying the same thing as to assert that the five groups mentioned are to be combined into a superorder and contrasted with the remaining Mammalia which stand in various relations to them. On the contrary, it appears to be totally impossible to classify the mammals by the form of their intestine, the chief reason for this being that so many grades are seen in the same group. On the other hand, it may be confidently said that the Ungulates and Rodents are some way removed from the base of the mammalian series; for in none of them are primitive conditions to be seen. These have, it would appear, become entirely lost.

It is particularly noteworthy that the Anthropoidea (understanding by this term the "apes" and "monkeys"), as contrasted with the Lemuroidea, exhibit primitive characters *, though not so primitive as the five groups with which we commenced this survey. There are no fixed loops to the colon, and there are the same fluctuations in the relative lengths of the small and large intestine that we find in *e. g.* the Marsupials. But special mesenteric connections render complex the coils of the gut, though not so numerous as we meet with in Rodents. On the other hand, the Lemurs present us with no particular likeness to the other Primates. The path pursued by these animals is really much the same as that pursued by the Rodents and the Ungulates. But this does not in my opinion imply affinity; it means no more than that there is a definite line of increasing complexity of the gut which is followed in all.

In fact, on the whole a study of the intestinal coils of Mammalia

* *Cf.* however Klaatsch, p. 671, fig. 12 for "lemurine" stage in young *Hapale*.

| Stage III. ......... | Stage II. *b* ......... | Stage II. *a* ......... | Stage I. ............ | |
|---|---|---|---|---|
| | — | — | — | MARSUPIALIA. |
| | | — | — | XENARTHRA. |
| | | | — | PROBOSCIDEA. |
| | | — | — | CETACEA. |
| — | — | — | — | LEMUROIDEA. |
| | | — | — | INSECTIVORA. |
| | | — | | MONOTREMATA. |
| | | — | | CARNIVORA. |
| | — | | | TUBULIDENTATA. |
| | — | | | ANTHROPOIDEA. |
| — | | | | HYRACOIDEA. |
| — | | | | RODENTIA. |
| — | | | | UNGULATA. |

I omit those groups concerning which I can find no certain information, viz., Sirenia, Chiroptera, Galeopithecidæ, Pholidota.

seems to lend support to the view that existing mammals have radiated out separately in many directions from a common stem, and that no two groups are very markedly nearer to each other than any others.

This view is in accord with certain opinions expressed by Prof. Osborn. The relative positions of the various groups (excluding those of which I have not sufficient knowledge derived from memoirs or from my own observations) can be expressed in some such diagram (p. 599) as that which accompanies these remarks. The stages referred to are described on a previous page.

## IV. *Note on the Existence of a Suprarenal Portal System in Marsupials.*

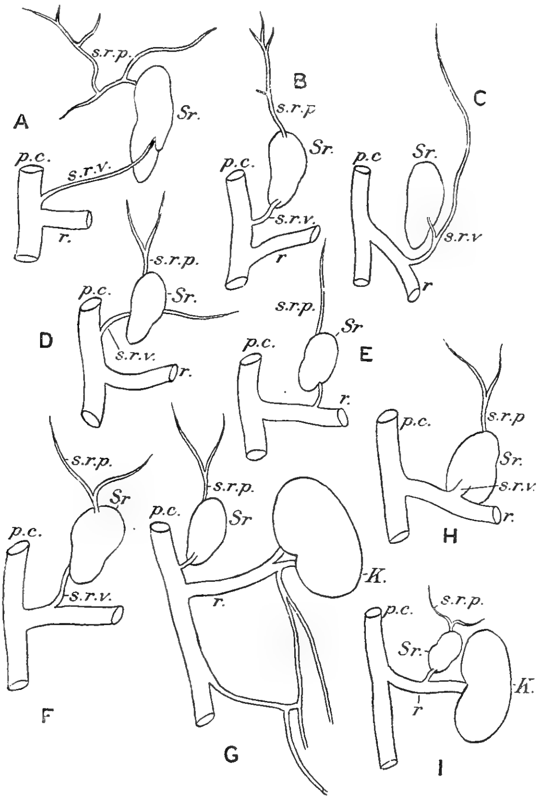
Although it is possibly true that physiologically there is no renal portal or suprarenal portal system *, it is plain that among Reptiles, as contrasted with Mammals, there are veins entering the kidneys and the suprarenal bodies from the parietes and hind limbs forming afferent veins to those glands, and thus contrasting with efferent veins which convey the blood from the glands in question directly to the postcaval system. Whether the capillaries intervening between the afferent and efferent veins are real capillaries or sinusoids does not affect the anatomical facts just stated, though naturally of great embryological and physiological importance. Neither does my own suggestion † that the suprarenal portal system is really due to the disappearance of that section of the postcardinal vein which runs over or near to that organ on each side and the consequent opening of its (the postcardinal vein's) affluents into the substance of the gland. It is still a fact that among Reptiles the suprarenal organs send a vein or veins to the postcaval and receive a vein or veins from the adjacent parietes. And this feature, whatever may be its physiological importance or want of importance, is an anatomical feature in which the lower Vertebrata differ from the Mammalia.

This being the case, attention is directed to the accompanying drawing (text-fig. 124, B) which represents the veins in the immediate neighbourhood of the kidneys of an example of the Marsupial *Dasyurus maugæi*. It will be seen that the suprarenal body of the left side of the body lies anteriorly to the left renal vein and not in contact with it. The vein from this body opens directly into the postcaval vein between the points of entrance thereinto of the two renal veins, but nearest to the left renal vein. In addition, however, to this vein connected with the suprarenal body, another vein is depicted in the figure which arises by more than one veinlet from the adjacent muscles. This vein runs in a direction parallel to that of the postcaval and ends in the suprarenal body, which it enters at the end remote from that whence the suprarenal affluent of the postcaval emerges from the

* *Cf.* Woodland, P. Z. S. 1906, p. 886. † P. Z. S. 1906, p. 24.

gland. *Dasyurus viverrinus* was exactly the same. In an example of *Macropus agilis* the same vein is present, but there are slight differences from the conditions observed and just described in *Dasyurus maugæi.* In the *Macropus* the suprarenal vein enters the left renal, and the suprarenal portal, as I venture to term the

Text-fig. 124.




Suprarenal veins in various Mammals.

**A.** *Thylacinus.* **B.** *Dasyurus maugæi.* **C.** *Nasua rufa.*
**D.** *Peragale lagotis.* **E.** *Trichosurus vulpecula.* **F.** *Macropus dorsalis.*
**G.** *Dasyurus viverrinus.* **H.** *Bettongia ogilbyi.* **I.** *Phascologale penicillata.*

*p.c.* Postcaval vein. *K.* Kidney. *r.* Renal vein. *Sr.* Suprarenal body.
*s.r.p.* Suprarenal portal. *s.r.v.* Suprarenal vein.

vein to which attention is directed in the present paper, enters as in *Dasyurus* at the opposite end of the suprarenal body. The suprarenal vein differs from that of *D. maugæi* in that it receives a tributary from the parietes. The left suprarenal veins of

*Macropus ualabatus* were much the same, but I did not observe the parietal branch of the suprarenal vein.

This state of affairs may now be compared with that observable in the higher Mammalia. In an example of *Nasua rufa* the veins in question had the disposition shown in text-figure 124, C. There is, as in the Marsupials already dealt with, a vein arising from the parietal musculature anteriorly. It arises by two main branches. But the vein formed by the junction of these passes ultimately to the left side of the suprarenal body, and receiving from it the suprarenal vein opens into the left renal vein. The parietal vein in fact does not touch the suprarenal body; it is merely an affluent of the suprarenal vein. It may be, however, the homologue of the vein in the Dasyure which enters the suprarenal body. On the right side of the body there was much the same disposition of veins observable. But the suprarenal vein poured its contents into the parietal vein which passes over the suprarenal body and was directed outwards to the right at right angles to the longitudinal axis of the body. These details were worth recording inasmuch as in a second example of *Nasua rufa*, and of the opposite sex, the same arrangements were met with and were alike in every detail.

Reverting to the Marsupials, an example of *Peragale lagotis* showed essentially the same disposition of the vein running into or from the suprarenal body that has been described in *Dasyurus*. In this Marsupial the suprarenal vein entered the postcaval independently of and anterior to the renal vein on the left side of the body. The suprarenal body received two affluents from the parietes. The first of these was a vein formed by the union of two branches which entered the gland anteriorly, and evidently is to be compared to the vein described above in *Dasyurus maugæi*. The second vein passes by the anterior end of the left kidney and enters the suprarenal body at about the middle of its length on the left side. In the Common Phalanger (*Trichosurus vulpecula*) the same evidence of a suprarenal portal system was obvious. In this case also the anterior suprarenal portal vein was present, and no other. The suprarenal vein entered the left kidney vein. *Macropus dorsalis* had but one suprarenal portal, the anterior vein, which is apparently so constant among the Marsupials and which arose from two affluents. In the features described in the present communication, *Petrogale penicillata* is exactly like *Trichosurus vulpecula*. *Phascologale penicillata* is slightly different from any of the Marsupials as yet described. The suprarenal vein opens, as is so frequently the case, into the renal vein on the left side of the body. Exactly opposite to it the suprarenal portal opens into the suprarenal body. But this vein before entering the gland receives a branch running transversely and just skirting the anterior margin of the left kidney, the conditions being therefore slightly like those of *Peragale* just described, and indeed intermediate between the condition observable in that Marsupial and in those where the one vein bifurcates anteriorly. *Bettongia ogilbyi* is like many other Marsupials; the suprarenal portal is single and anterior in position, being formed by the union of two affluents which join at an acute angle. As *Thylacinus* is a scarce type and not likely to be much dissected in the future, I venture to give a particular account of the veins connected with the suprarenal body, which I noted during the dissection of a specimen which died in the Society's Gardens in January 1906. The suprarenal vein enters the postcaval (as is shown in text-figure 124, A) a little anteriorly to the entrance of the left renal vein. It emerges from the suprarenal body some little way in front of the posterior border of the gland. The suprarenal portal vein enters the gland on the right side a little way behind the anterior border. It is formed of three affluents. The middle one arises from the diaphragm and joins a branch arising from the parietal musculature to the right of the suprarenal body. Just before entering the suprarenal body the trunk formed by the union of these two vessels is reinforced by a vein arising to the left of the suprarenal body. The common trunk is thinner than the suprarenal vein.

I have examined a number of Mammals belonging to orders other than the Marsupialia, but have not found anything at all resembling this apparently characteristic Marsupial feature in the blood-supply of the suprarenal bodies. I believe myself at present justified in asserting that this character, whether or not it be held to be a persistence of a condition to be met with among Reptiles and other lower Vertebrata, is distinctive of the Marsupialia.

## V. *Resumé.*

I extract from the foregoing pages the principal new facts which I have been able to add to our knowledge of the intestinal tract of mammals and to certain features in the anatomy of the Marsupialia.

(1) The most important features in the visceral anatomy of *Antechinomys* are: the intestine borne upon a continuous mesentery, the absence of a Spigelian lobe in the liver, the wide dilatation of the uteri at their junction with the Fallopian tube, the development of a short unpaired cæcal chamber at the junction of the uteri.

(2) A specimen of *Phascologale macdonellensis* showed a persistent umbilical membrane (proving an umbilical placentation in this species), which passes between the fibres of the rectus muscle divided for its passage, and is continuous with the great and splenic omentum. The umbilical membrane is also attached to small intestine. The intestinal canal is short and carried on a continuous mesentery. The liver in this species, as in *P. penicillata*, has a Spigelian lobe, also present in the genus *Sminthopsis*.

(3) In many (? in all) Marsupials the suprarenal bodies receive

a vein from the parietes as well as emit one to the renal vein or postcaval as the case may be; there is thus a rudiment of a suprarenal portal system in these animals, not found in at least many Eutherian Mammals.

(4) Though the intestinal tract of Marsupials is on the whole simple, there are traces (*Didelphys*, *Trichosurus*) of the ansæ coli and (*Trichosurus*) of the colico-duodenal ligament of more differentiated forms.

(5) A gut suspended upon a continuous mesentery is described for the first time not only in *Antechinomys*, but in *Tamandua*; on the other hand, a number of genera of Carnivora are described and the alleged continuous mesentery in *Ursus* is shown to be only apparent and due to the reduction of the ligamentum cavoduodenale. The continuous mesentery of *Centetes* is shown to be not universal in the species and is therefore probably to be looked upon as a reversion.

(6) To the numerous descriptions and figures of Rodents' alimentary tracts gathered together or published for the first time by Tullberg, a description of the colon and ansæ coli of *Otomys*, *Aulacodus*, and some other forms is added. The enormously long ansa coli dextra of the latter shows that the spiral found in certain Rodents is not necessarily to be looked upon as due to the need for packing away such a long loop. The spiral of *Hydrochœrus* is shown to be a late development since it does not occur in half-grown examples. The colon of the minute *Arvicanthis* (with one ansa only, the a. paracæcalis) shows that in this group reduction of size is not necessarily accompanied by entire simplification of the gut.

(7) The older descriptions of the spiral coil in certain Lemurs, e. g. *Nycticebus*, are shown to be correct as against more recent statements. *Microcebus* is shown to possess a simple colon without ansæ. *Galago* (2 spp.) is shown to possess a spiral like *Nycticebus* &c. And it is pointed out that all the forms with a specialised gut, *i. e.* with this spiral, are also specialised in the loss of the elsewhere characteristic carpal vibrissæ.

(8) Some account is given of the alimentary tract of the little known species *Theropithecus gelada* and *Semnopithecus melalophus* and the American *Chrysothrix sciureus*.

(9) The intestinal tract of *Hyrax*, contrary to some statements, has been shown to possess an ansa paracæcalis which may perhaps be compared to that of the Perissodactyla, and to possess the ligamentum colico-duodenale of more differentiated forms.

(10) As a very general rule the loops of the small intestine are loose folds not in any way fixed. Rarely, however (e. g. *Dasypus vellerosus*), I have found them to be fixed.

(11) That the colic loops vary is shown by the instance of *Lagostomus trichodactylus*, in which each of the three individuals dissected by myself or Tullberg is slightly different in the proportions of those loops, and by *Hyrax capensis*.

(12) It has been pointed out that in man the omentum is at

first attached to the right side of the transverse colon and subsequently to the left side, the intermediate space being filled up later. The two earlier stages are represented in lower mammals; in *Trichosurus* the omentum is attached to the colon only on the extreme right of the transverse bend, and in *Orycteropus* and *Hyrax* the attachment is double, to the early part of the colon and to a more distal region—the intervening tract being free of the omentum.

(13) The view, deducible from previous investigations, that four stages of advancing complexity are shown in the Mammalian gut, is strengthened by fresh facts; the Lemurs are shown to be the only group in which all but one of these four stages occur.

## 4. The Armour of the Extinct Reptiles of the Genus *Pareiasaurus*. By H. G. Seeley, F.R.S., F.Z.S., King's College, London.

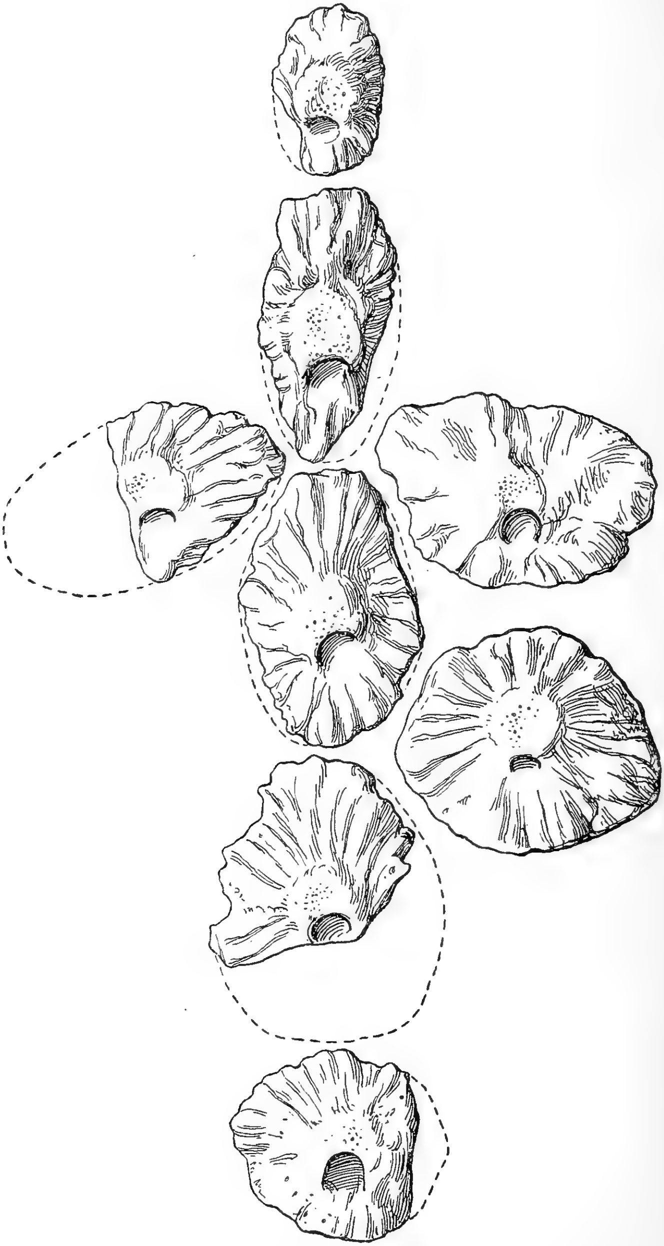
[Received April 29, 1908.]

(Text-figures 125–129.)

In "Further Observations on *Pareiasaurus*," Phil. Trans. B. Royal Society, 1892, I gave a short account of the dermal armour, pp. 345–6. It is limited to the dorsal region, and is figured in plate 17, and indicated by the letters *ds* in the description of the plate, p. 368. The scutes are only known in this example of *Pareiasaurus baini*, extracted from the rock by myself. They were originally covered with matrix. Their existence was not suspected, and it is possible that the more anterior scutes may have been partly lost in removing the intractable rock; and those seen in the British Museum specimen were preserved by great skill in chiselling. The ossifications are flat and inconspicuous, except where the lateral plates overhang the neural spines.

In the small figure of the skeleton given in the 'Story of the Earth,' 1895, text-fig. 18, p. 126, the scutes were made more evident by dark outlines. Each scute is about 2 inches wide by $1\frac{3}{4}$ inch long. There is a median row extending down the back, which as preserved now rests upon the summits of the neural spines of the dorsal vertebræ and the interspaces between them. There are also two lateral rows, one of which flanks each side of the median row. These are arranged symmetrically in pairs, and extend transversely outward from their contact with the median row, but alternate with them by being placed at the junction between each two median scutes. The lateral scutes in *Pareiasaurus baini* are not flat but convexly curved as they extend outward, giving some support to the idea that this armour formed an elevated ridge on the back. In the present condition of the specimen this armour is only seen on seven consecutive later dorsal vertebræ and one or two earlier dorsals; and there is no evidence that it was present over more than twelve vertebræ.

Text-fig. 125.



Dorsal armour of *Pareiasaurus steenkampensis*; the scutes are arranged as in *P. baini*.

Therefore the restorations which show elevated scutes extending from the skull to the extremity of the tail, or three parallel rows of scutes on the back entirely separated, and those which show the body clustered over with rows or groups of scutes, are entirely imaginary, for the only evidence for the armour is the skeleton in the British Museum.

Some writers in this country, and in Germany, have denied that any armour at all is present. The British Museum skeleton is sufficient evidence of its characteristics. If it had been more extensively developed over the body it is improbable that it would have escaped detection in the careful removal of the matrix during the two years that I watched the development of the skeleton; and there is no reason to modify in any way the original description or figure.

That evidence may now be added to by a short account of specimens of scutes already referred to (*l. c.* pp. 315, 346) as collected by Mr. J. van Renen, R.N., at Steenkamps Poort, south of Fraserberg. I had just collected the *Pareiasaurus* and was passing north, when this gentleman showed me a series of badly preserved bones collected as weathered, and invited me to select any example which might be necessary. I had no doubt they were Pareiasaurian, though the essential characteristic parts of the skeleton were not preserved. I accepted one caudal vertebra, and a series of nine scutes as giving evidence of armour, which I had not seen at that time.

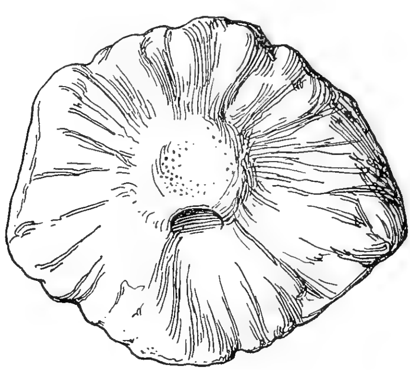
The scutes are free from matrix, vary greatly in size, and belong to a different species from *P. baini*, which I propose to indicate on the evidence of these scanty materials as *Pareiasaurus steenkampensis*. The scutes can only be supposed to have been arranged as in *P. baini*; that is, in a single longitudinal row down the back, with lateral scutes directed transversely outward on each side from the union between each two successive scutes of the linear series. All the ossifications are irregular, and about half are broken (text-fig. 125). It is possible that all of those preserved belong to the median series only, for none show the curved convex forms of the lateral scutes of *P. baini*, and this difference may be a specific character. Four or five can be recognised as median by their elongated forms; and the remainder may be median or lateral, if lateral scutes were present, as I think the evidence of the surface characters indicates. They are smooth on the under side, marked on the upper surface with a central conical blunt boss, from which numerous short grooves radiate irregularly to the margin, which is commonly thick and rough, as though the plates were imbedded in the skin. Behind the central boss, which is more or less flattened above, and less than half an inch in diameter, is a distinct pit nearly as wide, which is seen in half a dozen examples. The radiating ridges are more or less pitted, and all the surfaces, superior and inferior, are pierced with fine vascular markings. The largest plates are about $2\frac{1}{4}$ inches long by $1\frac{1}{2}$ inch wide, and fully half an inch thick at the central boss. In form they are irregularly ovate; some appear to be transversely ovate and have the central boss less conspicuous.

The smallest is $1\frac{4}{10}$ inch long, 1 inch wide, and half an inch thick. Its inferior surface is slightly convex, and the external margin is a sharp edge. The central part of the plate being occupied by the boss, the radiating ornament is very short and is a marginal fimbriation.

The second plate, slightly broken in front, is $2\frac{1}{4}$ inches long as preserved, and just over an inch wide in front of the boss, but is narrower posteriorly, though the lateral margins are weathered. The boss, $\frac{6}{10}$ inch in diameter, is shield-shaped, its hinder border being concave, with the excavation of the pit behind it. The substance of the plate is fully $\frac{1}{4}$ inch thick, both in front and behind the boss. The radiating ornament is chiefly seen anteriorly, and is irregularly pitted and corrugated. The convexity of the base made the lateral margin sharp, but the edge is almost removed by weathering.

The third plate is an elongated irregular pentagon with the base in front, about as long as the second plate, but wider. It is an inch and a half wide as preserved, but the margin appears to be worn. The boss is somewhat smaller but not less elevated, and the excavation of the pit behind it gives the aspect of a posterior position. The radiating ornament is similarly irregular, and like that on the second plate; but the base also develops in a less degree some short-ribs, especially towards the hinder margin.

Text-fig. 126.



Dorsal scute of *Pareiasaurus steenkampensis.*

The fourth and fifth median plates are both imperfect. The central boss is rather less elevated, but the posterior pit continues to be a marked characteristic.

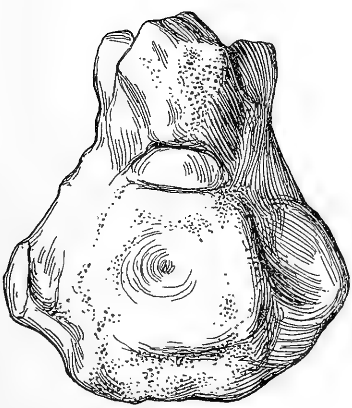
Of the remaining plates, three are wider than long on the hypothesis that the pit below the central boss is always posterior in position; and these ossifications are regarded as being placed laterally. They are rather large plates, like the lateral plates in

*P. baini*, and may have been in lateral contact with each other (text-fig. 126). The best preserved is thick at the margin, concave on

Text-fig. 127.

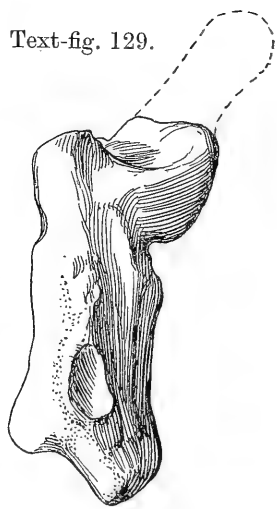
Anterior aspect.

Text-fig. 128.



Posterior aspect.

Text-fig. 129.



Lateral aspect.

Anterior, posterior, and lateral views of caudal vertebra of *Pareiasaurus steenkampensis*.

the under side. They may have been inclined obliquely backward. Their external surfaces have the same type or ornament as the median plates. The last specimen is a fragment about 2 inches wide and half an inch thick at the margin, much thinner at the fracture, and without indication of boss or pit, so that its position cannot be located.

We can only regret the imperfections of this evidence of dermal armour, but when I saw the remains they had already been removed for some time from the rock, and it is certain that they would have been carried away by the torrential drainage in the wet season, but for the interest taken by Mr. Van Renen in their preservation.

This armature differs from that of *Pareiasaurus baini*, first in the elongated form of the median scutes, secondly in the presence of the central truncated boss with the depression behind it, and thirdly in the radiated ornament—features which are absent from *Pareiasaurus baini*. In that species the anterior median scutes appear to be subcircular, or subquadrate, with a few circular vascular openings or small pits; but in the later plates no ornament is recognised, and the plates appear to be thinner and arched outward.

The caudal vertebra is from a position between the fifth and tenth in the tail. This early position is indicated by the transverse width of the anterior face of the centrum exceeding its vertical depth (text-fig. 127); by the strong vertically compressed lateral ridges above the transverse processes for the caudal ribs, which are directed outward and slightly downward; by the large size of the transverse posterior facet for the chevron-bone, which gives the centrum the aspect of being obliquely crushed from front to back (text-fig. 129); and by the vertical position of the prezygapophyses, with the facets looking inward and upward (text-fig. 127).

When this centrum is compared with the earlier tail-vertebræ of *Pareiasaurus baini* the centrum is shorter from front to back, for it only measures one inch; and in the species referred to, the measurement is always longer when the anterior face of the centrum is wider than deep. The neural canal is smaller (text-fig. 128), as in later caudals of *Pareiasaurus baini*. These differences would indicate a shorter tail with less lateral movement.

The neural arch is not distinctive. The neural spine is broken away, but its base has the usual triangular form. The anterior articular face of the centrum is roughly hexagonal with the margin slightly rounded, and a moderate central concavity. It is $1\frac{8}{10}$ inch wide and $1\frac{1}{2}$ inch deep. The posterior face is rather smaller and rather more concave. It is roughly four-sided, with the lateral margins approximating superiorly (text-fig. 128). It is $1\frac{1}{10}$ inch deep, $1\frac{7}{10}$ wide above the chevron articulation, and 1 inch wide on the neural canal. The oblique surface for the articulation of the chevron-bone measures half an inch from front to back, and extends over the width of the vertebræ which it truncates.

## 5. Additional Evidence as to the Dentition and Structure of the Skull in the South African Fossil Reptile Genus *Diademodon*. By H. G. Seeley, F.R.S., F.Z.S., King's College, London.

[Received May 26, 1908.]

(Text-figure 130.)

The genus *Diademodon* was founded on the molar teeth and imperfect middle portions of small skulls. Four species were figured in Phil. Trans. Royal Society, 1894, B, pl. 89, referred to *D. tetragonus*, *D. brachytiara*, *D. mastacus*, and *D. browni*. They were the most remarkable evidences of dentition of mammalian type in extinct reptiles which have been found in South Africa. There would have been grounds, had the remains been mammalian, for referring them to three genera; and in the description of plate 89, figure 11 is described as the left maxillary region of *Diademodon* (or *Gomphognathus*) *mastacus*. And in the original description of *D. browni* (*l. c.* p. 1039) it is observed, "it is probably the type of a distinct genus." Later in the same year the group Gomphodontia was defined as comprising animals with a Theriodont type of dentition, in which the molar teeth are expanded transversely, and as having more or less tuberculate crowns, of the type shown in *Diademodon*. In that group the genus *Diademodon* was included (*l. c.* 1895, B, p. 3). The types of *Gomphognathus* had the crowns of the molar teeth well worn, but the elevation of the external cusps or ridge in *G. polyphagus* made a suggestive resemblance to *Diademodon mastacus*; while the condition of the single well-preserved crown in *Diademodon browni* makes an equally suggestive approximation to *Diademodon brachytiara*. In 1896, in a short communication to the British Association at Liverpool, I briefly noticed another skull discovered by Dr. D. R. Kannemeyer. I have removed the matrix in the laboratory of King's College, so as to demonstrate the sutures in the middle part of the skull and to expose the palate. The specimen is slightly squeezed so as to have a lateral obliquity towards the right side, from which the similar example of *Diademodon browni* is not free. There is a coincidence in the anterior and posterior fractures being in identical positions in both specimens, favouring comparison. They are closely related species, but the snout in the new example is narrower and rather smaller, and the dentition being unworn favours the idea of specific difference, though the forms of the transversely ovate sections of the molar and premolar teeth are almost identical.

As preserved the specimen is $2\frac{1}{2}$ inches long. It extends between an anterior transverse fracture through the two concave pits on the snout, which lie at the junction of the maxillary and nasal bones, which in *Gomphognathus* are situated midway between the orbits of the eyes and anterior nares, and a posterior fracture behind the orbits, just behind the post-frontal bones, which are imperfectly preserved. The lateral margins converge forward in a wedge-like outline similar to the corresponding part of the skull of *Gomphognathus.* Owing to the lateral compression the anterior transverse measurement is narrowed by one or two tenths of an inch. As preserved it is one inch wide, and the vertical height from the median longitudinal ridge on the palate to the nasal bones is the same. The corresponding measurements in *Diademodon browni* are: vertical $1\frac{1}{10}$, transverse $1\frac{4}{10}$ inch. The pre-orbital lateral areas of this, formed chiefly by the maxillary bones, are inclined towards each other, are gently convex from the alveolar border to the nasal region, longitudinally furrowed by two shallow concavities on each side, and then round with a gentle convexity into the upper surface formed by the nasal bones.

*Diademodon browni* distinctly suggests an angle between the sides of the face, which are more vertical, and the roof of the snout; but the difference between the specimens is one of degree. In both there is some lateral concavity of the pre-orbital region from front to back.

The head widens backward to the posterior fracture, which passes through the back of the frontal bone, the post-frontal bones, and the pterygoid bones. The specimen is about $2\frac{3}{10}$ inches wide behind the dentary tract, which is in a line with the middle of the orbits, and $1\frac{4}{10}$ inch high at the back of the frontal bones.

The bones seen on the superior aspect of the skull are the frontal, post-frontal, pre-frontal, nasal, lachrymal, and maxillary. The naso-maxillary region is convex from side to side, but as the nasal bones extend between the orbits their flattened upper surface merges in the flattened frontal region. The orbits are inclined so to look outward, and to a less extent upward and forward. The vertical measurement of the rounded cavity is one inch, and the transverse measurement between them over the pre-frontal bones is $1\frac{2}{10}$ inch. In *D. browni* it appears to have been $1\frac{11}{20}$ inch.

Only the part of the post-frontal bone which is above the back of the orbit is preserved. It is rather less than half an inch wide between the temporal vacuity and the suture with the pre-frontal bone. It is transversely channelled owing to elevation of its front and back borders. These bones are slightly raised above the frontal bones, which extend longitudinally between them. As preserved the frontal bones are oblong, $\frac{8}{10}$ inch long, and more than half an inch wide towards the middle at the suture between the post-frontal and pre-frontal bones, and narrow anteriorly to the transverse suture with the nasal bones. Both bones are longitudinally concave with the median sutural line raised. This feature is absent in *Diademodon browni.* The lateral sutures with the post-frontal and pre-frontal bones are similarly raised as slight ridges, but there is no ridge between the frontal and nasal bones.

The pre-frontal bone forms much of the superior border of the orbit where the margin is compressed posteriorly and rounded in front. The bone is in front of the post-frontal, external to the frontal, makes an oblique suture with the nasal, and a narrow junction with the lachrymal bone, as its sutural junctions diverge outward and forward. It is $\frac{3}{4}$ inch long from the post-frontal to the lachrymal and $\frac{9}{20}$ inch wide at the fronto-nasal suture, where it is widest in about its middle length. The inner short border next the frontal is parallel to the longer external border above the orbit and lachrymal. The pre-frontal bone forms a large part of the internal anterior wall of the orbit.

The nasal bones, somewhat lanceolate in form, are imperfect anteriorly. They extend from the frontal bones forward as preserved to between the pair of pits on the front of the snout, which are not seen in *Diademodon browni*, with a length of $1\frac{4}{10}$ inch, and in this length they are not in contact with the pre-maxillary bones. They are separated from each other by a fine straight suture, and widen from the frontal suture anteriorly, with the lateral divergence of the sutures dividing them from the pre-frontal and lachrymal bones, to $1\frac{1}{4}$ inch at the front of the lachrymal bones; and anteriorly the sutures between them and the maxillary bones converge forward, to a transverse width over the nasal bones of half an inch, at the anterior fracture through the lateral-nasal pits. The bones are smooth, convex from side to side, and slightly raised posteriorly, with a partial prolongation forward of the median frontal sutural ridge.

The lachrymal bone is best exposed on the left side, where I have partially removed the matrix from the orbit. It is at the front of the orbit between the maxillary bone below and the nasal and pre-frontal bones above. Externally it is of irregular sub-quadrate form, half an inch in each measurement. It has a considerable extension in the front of the orbit internally, below the pre-frontal bone. On the lower part of the inner front border the bone is pierced by two circular canals placed one below the other.

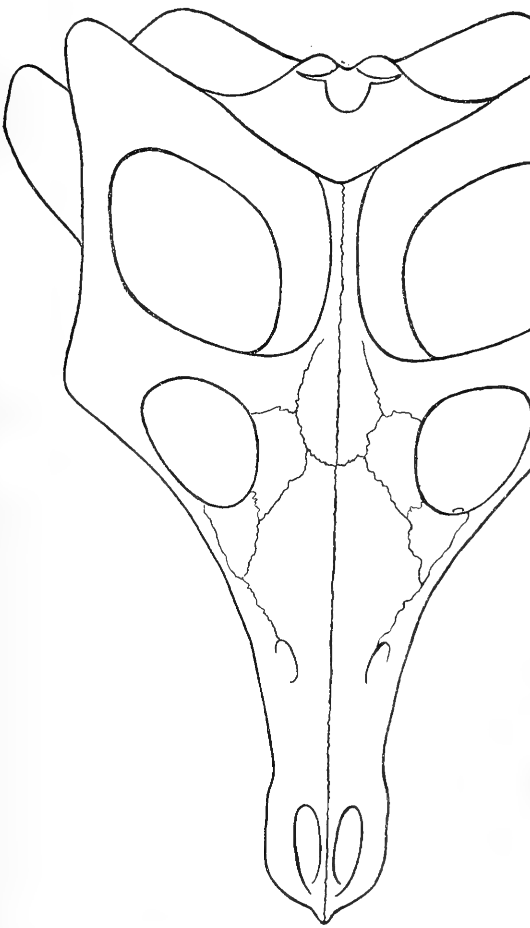
The maxillary bones form the sides of the face from the hinder fracture at the back of the alveolar tract below the orbit, where the bone is $\frac{4}{10}$ inch deep, forward to the anterior fracture, where the depth is $1\frac{1}{10}$ inch. The ascending orbital border below the orbit is compressed, rounded, and slightly reflected outward. Below the lachrymal canal the depth to the alveolar border is $\frac{17}{20}$ inch. A slight wide shallow concavity extends longitudinally forward, from the orbital junction between the lachrymal and maxillary bones; but on the right side the bone appears to be accidentally impressed in this region. The lower part of the maxillary bone is moderately concave in length, and markedly convex downward owing to the compression of the bone immediately above the molar teeth. On the convex ridge above are two ovate foramina above the teeth, such as occur in many fossil reptiles.

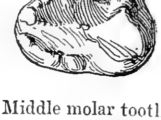
The palate has shared in the side to side compression and distortion of the specimen and is probably narrowed by a tenth of an inch. The teeth extend in diverging curves as they range backward and outward. The transverse width over the premolars in front is $\frac{17}{20}$ inch; over the last molars it is about $2\frac{2}{10}$ inches. These measurements are less than in *Diademodon browni.* Ten teeth are indicated or preserved, of which the two in front, with small circular fractured bases to the crowns, are classed as premolars, and the eight succeeding teeth are molars. They have the crowns transversely ovate, each with its axis at right angles with the concave external alveolar border, except the last tooth, which is parallel to the alveolar border. The crowns increase in width to the fifth molar and then become smaller, the seventh and eighth rapidly narrowing acquire a triangular or comma shape. The length occupied by the eight molars is $1\frac{13}{20}$ inch.

The anterior teeth are separated by the hard palate between them. They rise with a vertical inner alveolar border corresponding to the compressed external border. As preserved the hard palate is $\frac{11}{20}$ inch wide between the last premolar teeth, and $\frac{3}{4}$ inch wide where it terminates between the fifth pair of molars. It is narrower than in *D. browni*, in which the fourth molar appears to be the largest. The hard palate as preserved is made by the maxillary bones, which extend behind the second molar teeth, and unite by a transverse suture with the palatine bones, so that the suture is in about the same position as in *Gomphognathus polyphagus* (Phil. Trans. 1895, B, p. 16, fig. 7). Its distinctive feature is a strong elevated median ridge dividing the palate into two concave channels. This ridge is continued backward by what I regard as the vomerine bone, dividing the posterior nares, extending upon the median union of the posterior palatine bones. This ridge on the hard palate is absent from *D. browni*; its presence makes the transverse hinder border of each half of the hard palate concave, instead of both bones combining to form one concave posterior surface. The back of the palate behind the posterior nares has a close general resemblance to the corresponding region of *Gomphognathus.* There are the same pair of convex rounded tumid areas behind the hard palate converging backward from the hinder cheek-teeth to terminate in a pair of hemispherical convexities which were just in front of the median post-palatal ridge in that genus, flanked externally by the broken bases of the pair of transverse processes which descended between the rami of the mandible (compare *l. c.* p. 24, fig. 11). The transverse width over these processes in this specimen is $1\frac{7}{10}$ inch. Those processes are regarded as being made chiefly by the transverse bones and as defined by sutures which converge inward from behind the maxillary bones backward to the hemispherical tubercles at the posterior fracture.

The teeth have been more or less broken, possibly by strain or compression. Small parts of the enamelled surfaces of the tuberculate crowns remain in the first and second molars of the right side. The first shows a marginal external rim behind the crown and laterally, and a small central tubercle in front. The second indicates two lateral external tubercles. None of the crowns show the slightest trace of wear by the apposition of the mandibular teeth, in this respect being in striking contrast to *Gomphognathus*, in which the crowns of all the molar teeth are always worn so that nothing remains of tuberculate structure except the external cusp. The fifth, sixth, seventh, and eighth crowns are preserved on both sides.

Text-fig. 130.





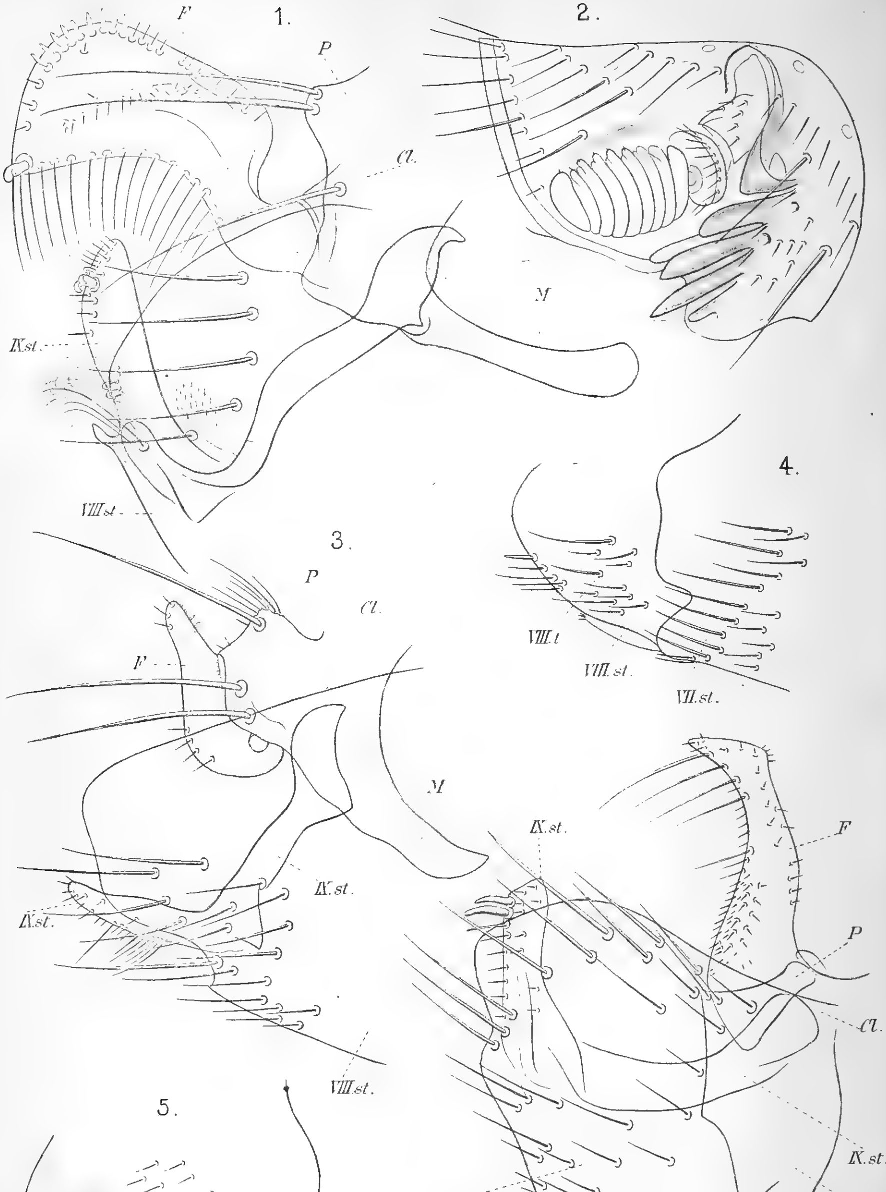
Middle molar tooth crown, enlarged.

Restoration of the skull of *Diademodon entomophonus*. About $\frac{2}{3}$.

The fifth and sixth crowns are transversely ovate, less than $\frac{4}{10}$ inch wide and $\frac{1}{4}$ inch from front to back. They have a strong external crenulate border and a median crenulate transverse ridge, dividing the concave posterior half of the crown, which has a crenulate external margin, into larger external and smaller internal concave spaces (see text-fig. 130). In front there is a sharp or crenulate marginal border, with transverse crenulations or cusps; on the middle of the crown two small anterior cusps and two posterior cusps. These crowns are essentially of the type of the described species of *Diademodon*. The last tooth of *D. mastacus* shows a tendency to develop a posterior talon (*l. c.* 1894, B, pl. 89. figs. 11, 12). The penultimate tooth of this specimen has the posterior talon so developed as to make the form of the crown almost triangular. The crown is only a quarter of an inch wide, and slightly shorter from front to back externally. The strong external anterior cusp is broken, but a small external cusp rises from the talon. On the inner border of the crown are two or three cusps or crenulations like those similarly placed on the fifth and sixth molars. The last molar is compressed from side to side, $\frac{2}{10}$ inch long by $\frac{1}{10}$ inch wide, broader in front than behind, with small tubercles back and front. The small size of these teeth gives the molars the aspect of exceptional divergence posteriorly. The transverse internal measurement between the last pair of molar teeth is $1\frac{8}{10}$ inch; between the fifth pair it is $\frac{3}{4}$ inch, and between the first pair of molars about $\frac{11}{20}$ inch. From front to back the crowns form a convex curve.

The dentition is imperfectly preserved, but not more than two or three premolar teeth appear to be lost. From the resemblances of the skull to allied types I infer that there was a toothless diastema between the first premolar and the canine, where the jaw contracted from side to side. I should expect four incisors as in *Gomphognathus*. The missing extremity of the snout would be about $1\frac{8}{10}$ inch long; the missing hinder part of the head was about $2\frac{1}{2}$ inches long, giving the complete skull a length of $6\frac{1}{2}$ inches. The skull may be restored on the type of *Gomphognathus* (text-fig. 130).

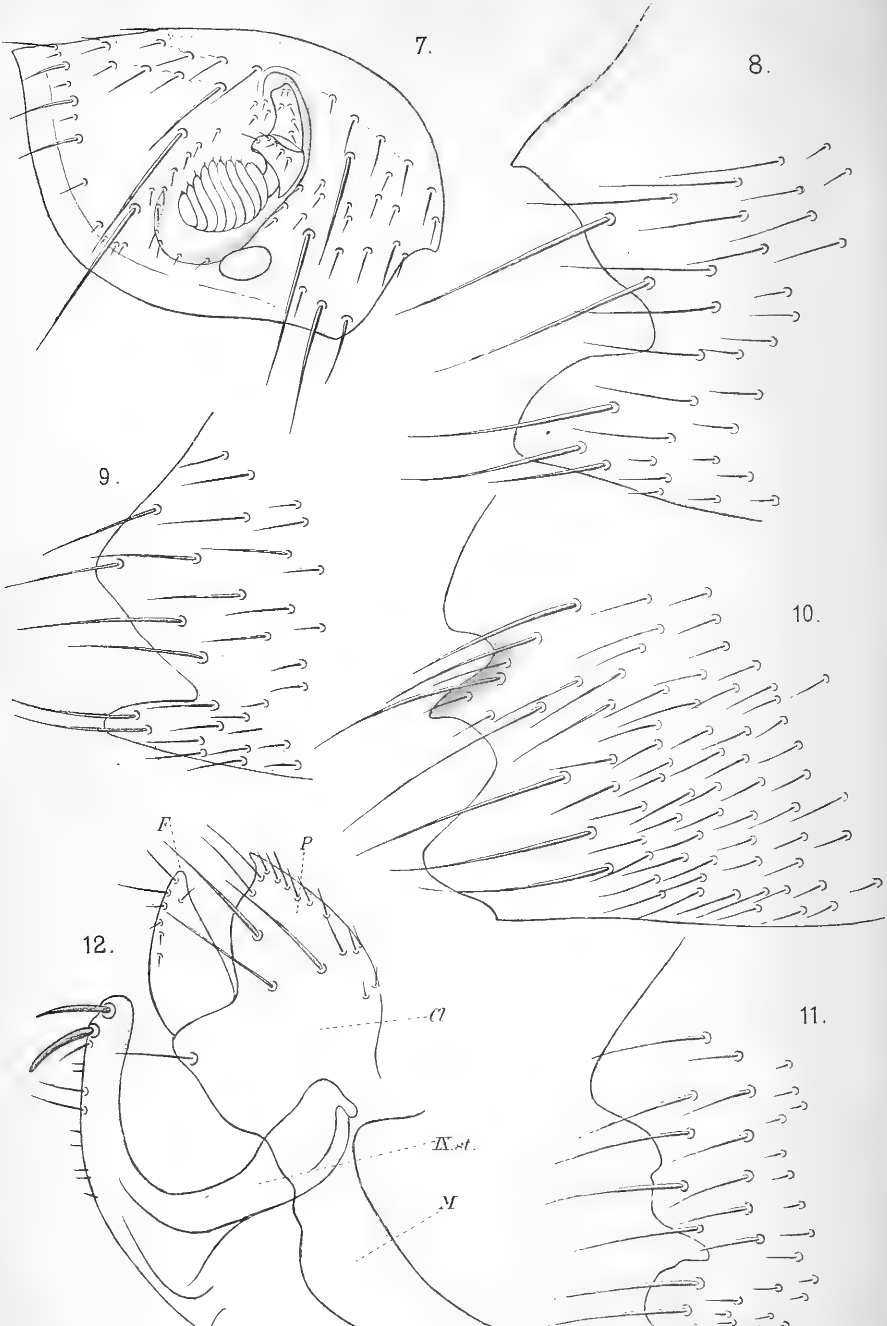
The most remarkable feature of the dentition is the unworn condition of the crowns of the teeth, also seen in other species of the same genus. The transversely ovate forms of the molar crowns acquire new interest from the teeth of *Procolophon* having this form, with inner and outer cusps recalling the tooth of *Diademodon browni*. But while *Procolophon* is typically reptilian in its dental armature (Proc. Zool. Soc. 1905, vol. i. p. 225), in this fossil the teeth suggest mammalia. The transversely ovate form of the crown, with the slight cingulum, approaches the condition in lemurs, but the molars are more numerous and the other dental characters unlike. The diastema occurs among mammals as various as marsupials, tapirs, rodents, but is never associated with a transversely ovate molar, and full series of incisor and strong canine teeth as in these fossil reptilian types. Mammals of various groups have the molar teeth progressively increasing and afterwards decreasing in size, as




K. Jordan del.

Lith. Anst. v. K. Wesser, Jena.

New Siphonaptera.

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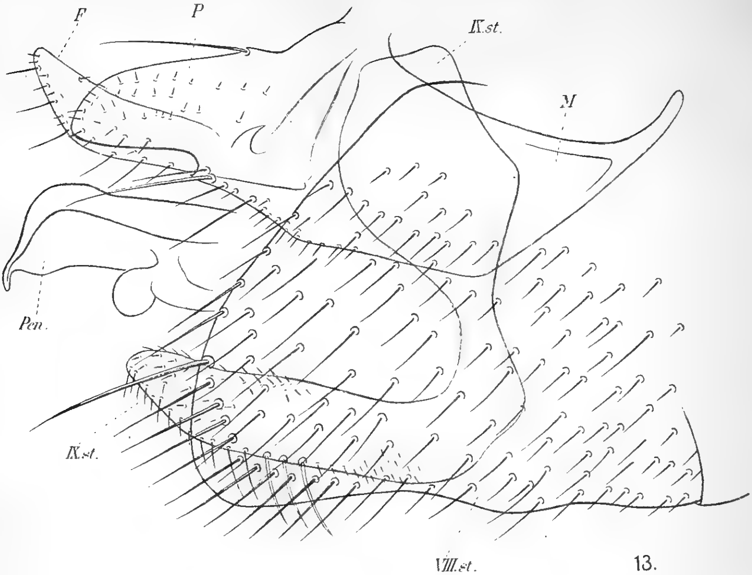


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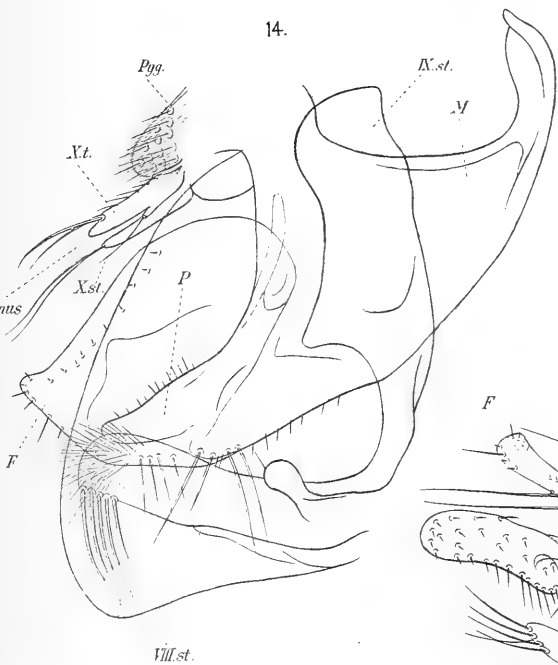


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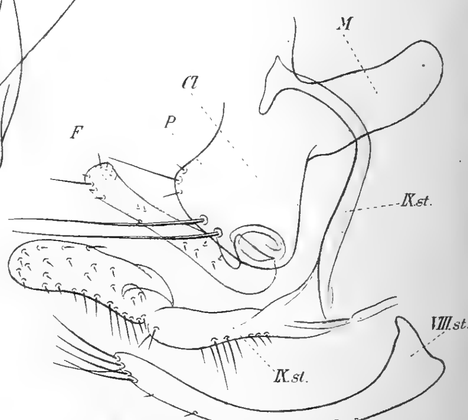


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New Siphonaptera.

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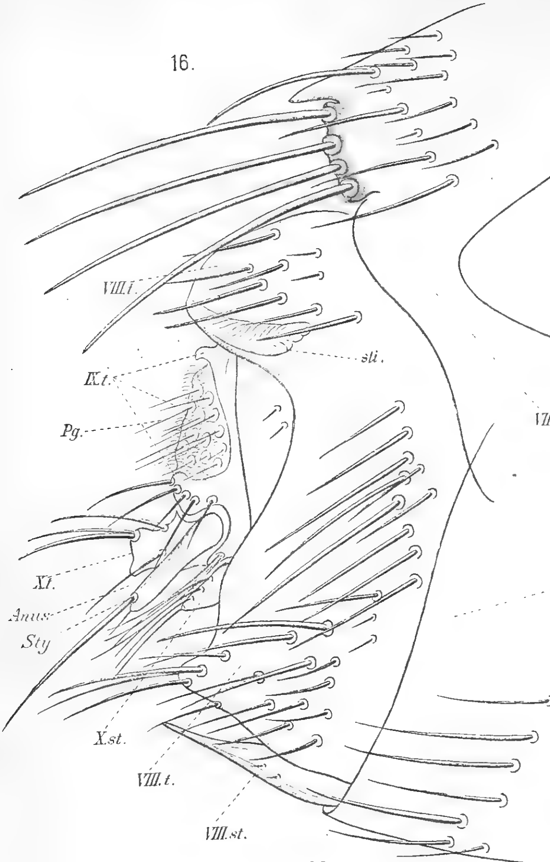


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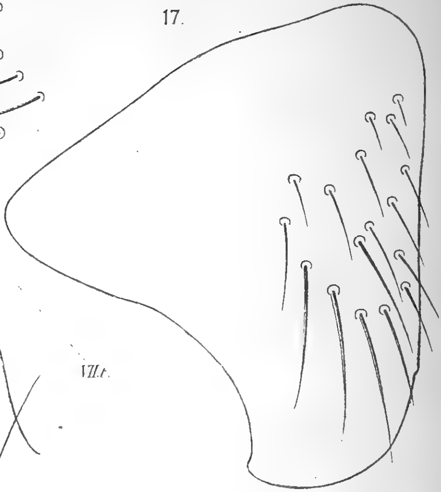

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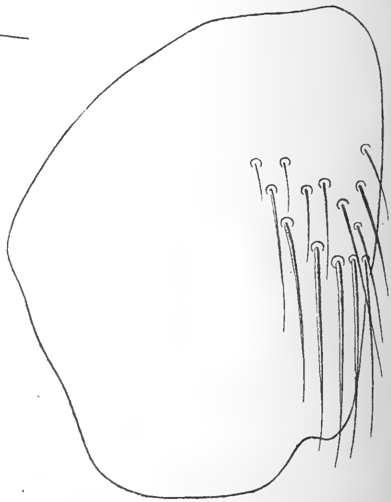

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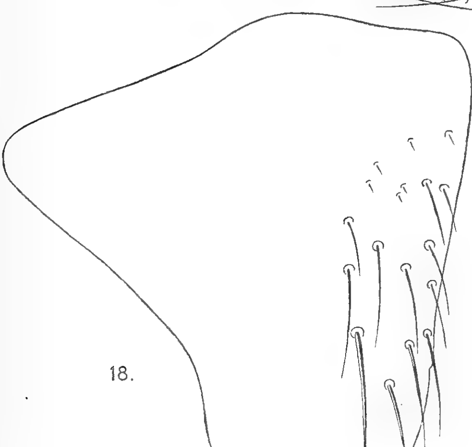

K. Jordan del.

Lith.Anst.v.K.Wesser, Jena.

New Siphonaptera.

among lemurs, insectivora, carnivora. But the feature of this reptilian type is its generalised mammalian resemblances in dental characteristics, which are highly specialised distinctions among mammals, so that the teeth have undergone an evolution of mammalian type. It is not to be anticipated that a complete skeleton of *Diademodon* will make a closer approximation to that of a mammal than is already evidenced by other Theriodont reptiles; but the dental characters emphasise the mammalian approximations which have been found in the shoulder-girdle, pelvic arch, and limb-bones.

I propose to distinguish this species, characterised by the median ridge on the palate, the ovate unworn multituberculate crowns of the middle molars, the moderate interspace between the orbits, and slender snout rounded above, as *Diademodon entomophonus*. The absence of wear to the crowns is only consistent with a diet which did not involve trituration. It is in contrast with the condition in *Diademodon browni*, which it approximates in general characters.

## 6. New Siphonaptera.

By the Hon. N. Charles Rothschild, M.A., F.Z.S.

[Received May 1, 1908.]

(Plates XXVIII.–XXXI. *)

### Genus Pygiopsylla.

*Pygiopsylla* Rothschild, Ent. Mon. Mag. (2) xvii. p. 221 (1906) (type: *hilli*).

The species belonging to this genus are easily distinguished from *Ceratophyllus* Curtis (type of name: *hirundinis*) by the sensory plate (so-called pygidium) of the ninth abdominal tergite being strongly convex (*cf.* Pl. XXX. fig. 14). All the species are very hairy. They are inhabitants of the Old World, being known both from the Oriental and Æthiopian Regions. Nine species are known, namely: *hilli* Rothschild (1904), *novæ-guineæ* Rothschild (1904), *robinsoni* Rothschild (1905), *colossus* Rothschild (1906), *echidnæ* Denny (1843), *ahalæ* Rothschild (1904), *torvus* Rothschild (1908), *woodwardi* Rothschild (1904), and *rothschildi* Rainb. (1905), the last two appearing to me to be but doubtfully distinct from each other. In the present paper six more species are described—namely, two from Australia, two from New Guinea, one from Ceylon, and one from West Africa (Angola),—making in all 15 species of this genus. The wide distribution of the genus renders it probable that these fifteen forms are only a small percentage of the actually existing species of *Pygiopsylla*.

* For explanation of the Plates, see p. 629.

*P. echidnæ* is a more specialised species than the others. The genal edge of the head is produced into a broad tooth-like lobe, corresponding to the lobe found in the *Sarcopsyllidæ* and in *Pariodontis* Rothschild (1908) and *Lycopsylla* Rothschild (1904), and the comb of the pronotum is reduced to a few spines (4 to 6), which are dorsal. The head of *P. echidnæ*, moreover, is short, bearing two regular rows of three bristles each on the frons, there being no row of small bristles between the anterior corner of the frons and the base of the antennal groove, as is the case in all the other species of *Pygiopsylla* (*cf.* Pl. XXIX. fig. 7). It may possibly become necessary to move *echidnæ* from *Pygiopsylla* and place it in a new genus. For the present, however, there is no necessity for this change.

1. Pygiopsylla afer, sp. n. (Plate XXIX. figs. 7, 8.)

**Head.**—The head (Pl. XXIX. fig. 7) is gradually rounded, the lower part of the frons not being curved backwards (*i. e.* towards the fore coxæ). The rostrum does not quite reach the apex of the fore coxa.

**Thorax.**—The pronotum bears a comb of 23 spines and two rows of bristles. On the mesonotum there are 4 rows of bristles, the anterior row being abbreviated and there being also some dorsal bristles in front of this row. The mesopleura have 8 long bristles and a few short ones. The metanotum bears 4 rows of bristles, the first row consisting of but a few bristles situated on the back. The epimerum of the mesothorax bears an irregular anterior row of 7 or 8 bristles, a central row of 3, and a posterior row of 3 or 4 long and some short bristles.

**Abdomen.**—The first tergite is practically hairy all over. The other tergites bear 4 rows of bristles, the first row being represented only by a few bristles on the fifth to seventh segments. There is a stout apical spine on each side of tergites 2 to 5. The basal sternite bears an oblique patch of short bristles on the side, consisting of 3 irregular rows. On the sternites of the third to seventh segments there is a subapical row of 4 or 5 long bristles, proximally to which are numerous small bristles.

**Legs.**—The mid and hind femora bear on the outer side three subapical ventral hairs, which are of nearly equal size, there being no other ventral hairs between these three and the widest point of the femora. The hind tibia bears about 20 bristles on the outside, arranged in three irregular rows, besides a number of smaller bristles situated at and near the anterior edge of the tibia. The first fore-tarsal segment is longer than the second and has four thin and long bristles on the hinder side. The first mid-tarsal segment is much longer than the second. The hind tarsus is long, especially the first and second segments, the third segment being longer than the fifth. The first and third pairs of lateral bristles of the fifth segment are moved towards the mesial line, especially in the fore and mid tarsi.

**Modified segments.**—The seventh abdominal sternite has a deep triangular sinus (Pl. XXIX. fig. 8), the upper lobe being broad, but tapering to a point. The bristles on the eighth tergite are more numerous than in *P. robinsoni*, to which the present species is allied. At the apical margin of this segment, there is one long bristle, and above it are situated two short ones and beneath it one moderately long one. There is a row of 5 or 6 long bristles along the ventral edge, the most distal bristle being the longest of all. Above this bristle there are two more long ones, and further proximad about 16 short ones. The anal sternite is rounded beneath near the base, bearing on this rounded portion a row of 4 bristles on each side, there being a further pair of bristles on each side close to the apex.

Length: 3·6 mm.

One ♀ from Benguella, Angola, 200 miles from the coast, found at an altitude of 4780 ft. by Dr. F. Creighton Wellman the host not being stated; received from Mr. Oldfield Thomas, F.R.S.

2. Pygiopsylla rainbowi, sp. n. (Plate XXVIII. fig. 5; Plate XXX. fig. 13.)

The present species apparently agrees in all details, except the modified abdominal segments, with *P. colossus* Rothschild 1906, of which only one ♀ is known.

♂. The small eighth tergite bears about 8 short bristles above the stigma. The eighth sternite (Pl. XXX. fig. 13), on the other hand, is very large, being covered with numerous bristles, of which those placed near the dorsal and apical edges are longest and thickest. The ventral margin of this segment (in lateral view) is incurved twice, the segment being incised in the mesial line from the apex to the point where the ventral margin bulges out. The clasper (Cl.) is distally produced into a thumb-like process, which is shorter than the pointed and slightly curved movable process (F). The manubrium (M) is triangular, ending in a short process. The vertical arm of the ninth sternite (IX. st.) is club-shaped, and at the apex truncate, with the distal margin of the widened portion rounded. The horizontal arm is of nearly even width, its upper margin being twice incurved. This arm bears numerous small hairs on the apical as well as proximal portions, there being in addition on each side a row of five ventral bristles, of which the most proximal one is the longest and thickest. The penis ends in a short and sharp hook, which points downwards. The anal tergite (X. t.) is triangular in side-view, being about twice as long as it is broad at the base. The tenth sternite is much slenderer than the tergite, bearing two long apical bristles on each side.—♀. The apical margin of the seventh abdominal sternite is rounded, being ventrally obliquely truncate and bearing a small sinus in the centre (Pl. XXVIII. fig. 5). The eighth sternite has fewer bristles than in *P. colossus* at and near the apical and ventral margins. The ninth and tenth segments resemble those of *P. colossus*.

Length: ♂ 3·3 mm., ♀ 5 mm.

We have a long series off *Mus assimilis* from Emerald, Victoria, Australia, collected by Mr. Edw. Jarvis during 1907.

3. Pygiopsylla gravis, sp. n. (Plate XXX. fig. 14.)

This species closely resembles *P. rainbowi*, except in the genitalia. We have only one ♂.

♂. The eighth abdominal sternite (Pl. XXX. fig. 14) is very large, as it is in *rainbowi*, and is densely covered with bristles as in that species. But the long bristles which are placed along the apical and dorsal edges of the segment are more numerous and more slender than in *rainbowi*. The upper margin of the eighth sternite is gradually rounded, the ventral margin being straight. The clasper (Pl. XXX. fig. 14, Cl.) is distally produced into a finger-like process (P), which bears a row of thin hairs at the dorsal margin. The movable flap (F) is very large, being leaf-shaped, with the pointed tip curved upwards. The manubrium (M) is curved dorsad, the apical portion being somewhat twisted. The ninth sternite (Pl. XXX. fig. 14, IX. st.) is very broad. The horizontal arm bears ventrally at the apex on each side five long stout spines, of which the most distal one is the longest. The anal segment (= tenth) is long and slender, the anal sternite bearing a pair of very long bristles at the apex.

Length: ♂ 4 mm.

We have one ♂ from Emerald, Victoria, off *Mus assimilis*, collected on 18th September, 1906, by Mr. Edw. Jarvis.

4. Pygiopsylla laciniosus, sp. n. (Plate XXIX. fig. 10.)

♀. As large as *P. rainbowi*.

**Thorax.**—The pronotum bears two rows of bristles and a comb of 19 spines. The pleura of the mesothorax have 7 or 8 bristles, while the mesonotum bears four rows of bristles and some additional ones in front of these rows on the back. The metanotum has likewise four rows of bristles, but the first row contains on each side only about 5 bristles, and there are dorsally fewer hairs in front of this row than on the mesonotum. The epimerum of the metathorax has four irregular rows of bristles (5, 5, 2 or 3, 3), the bristles of the posterior row being the longest. There are also one or two additional short bristles in front of the posterior row.

**Abdomen.**—The first tergite is hairy all over. The other tergites bear fewer bristles than in *P. rainbowi* and *colossus*, the second and third having four rows and some additional dorsal bristles, while the sixth and seventh tergites bear three rows and a few bristles representing a fourth row; the basal sternite has no bristles on the sides, apart from a few extremely small hairs.

The short bristles on the sternites of the third to sixth segments are less numerous than in the allied species just mentioned.

**Legs.**—As in *colossus*.

**Modified segments.**— ♀. The seventh sternite (Pl. XXIX. fig. 10) is bisinuate, closely resembling that segment of *P. colossus*, but differing in the lower lobe and the lower sinus being much wider, in the upper sinus being smaller, and in the bristles being differently arranged.

Length : 5 mm.

We have 3 ♀ from Mt. Albert Edward, British New Guinea, off *Mus mordax* ; received from Mr. E. C. Chubb.

5. Pygiopsylla mordax, sp. n. (Plate XXVIII. fig. 6 ; Plate XXIX. fig. 9.)

**Head.**—The frons is strongly curved, as is the case in *P. ahalæ* Rothsch. (1904), the bristles being thick. The rostrum is shorter than in all the other species, reaching only a little beyond the middle of the fore coxa.

**Thorax.**—The pronotum is short. It bears two rows of bristles, the anterior row being irregular and represented by but a few dorsal hairs. The comb consists of 16 to 18 spines, which are longer than the pronotum. The meso- and metanotum each bears four rows of bristles, the first row not reaching so far downward as the others. The mesothoracic pleura have about twelve bristles, of which four or five anterior ones are short.

**Abdomen.**—The first tergite has four rows of bristles, the second to seventh tergites three rows. The basal sternite bears in the ♂ about 6 minute hairs on the side arranged in two oblique rows. The sternites of the third to sixth segments of the ♂ have on each side a curved row of four subapical bristles and proximately to this row six or eight smaller bristles. In the ♀ the basal sternite has two irregular oblique rows of bristles on the side, each row containing about ten bristles, the bristles being more numerous also on the other sternites than in the ♂.

**Legs.**—The mid and hind femora bear three ventral subapical bristles, the first being smaller than the others. The mid and hind tibiæ have numerous bristles practically all over the outer surface, the bristles being more numerous in the ♀ than in the ♂. The first mid-tarsal segment is much longer than the second, but is shorter than in *P. ahalæ*. The fifth hind-tarsal segment is as long as the third.

**Modified segments.**— ♂. The apex of the large eighth abdominal sternite is irregularly rounded. There are four pairs of long bristles below the upper edge of this sclerite, a single long bristle below the most distal pair, and further down at the ventral margin two or three more long bristles. Between these long ventral bristles and the base of the segment there are about 12 shorter bristles, there being also three or four additional bristles on the lateral surface. The clasper (Pl. XXVIII. fig. 6, Cl.) is distally truncate-emarginate, the lower corner being somewhat produced and bearing a long thin bristle accompanied by a small one. The manubrium (M) is very broad, the apex being pointed and curved dorsad. The movable process (F) is very long. It is pointed and curved, its upper edge being twice incurved. There is a large number of bristles at the ventral margin of this process, the distal ones being long. The vertical arm of the ninth tergite (Pl. XXVIII. fig. 6, IX. st.) is almost evenly curved. The horizontal arm is shorter than the vertical one and bears two strong spines ventrally at the apex, there being also a number of thin bristles along the ventral margin and at the apex, as shown in the figure.—♀. The seventh sternite is deeply sinuate, the upper lobe being broad and the lower one narrow (Pl. XXIX. fig. 9). The eighth tergite bears on each side three or four small bristles above the stigma. On the ventral portion of this sclerite there are about twenty bristles, three or four placed at the apical margin and five along the ventral edge. The lower apical angle of the eighth tergite is produced. The anal sternite has on each side two long bristles near the base, one in the centre and one near the apex, besides two smaller apical ones.

Length: ♂ ♀ 2·1 mm.

We have one ♂ and two ♀ from Mt. Albert Edward, British New Guinea, off *Mus mordax*; received from Mr. E. C Chubb.

6. Pygiopsylla ferinus, sp. n. (Plate XXIX. fig. 11.)

Nearest to *P. mordax*.

**Head.**—The rostrum reaches nearly to the apex of the fore coxa. The bristles of the anterior row of the frons are a little thicker than in *P. mordax*.

**Thorax.**—The pronotum has one row of bristles and a comb of 17 spines. The meso- and metanota have three rows of bristles, a fourth (anterior) row being represented by a few short dorsal bristles only. The epimerum of the metathorax has ten bristles (4, 3, 3), with some small hairs in between the posterior bristles.

**Abdomen.**—The tergites have three rows of bristles, the anterior row being represented by but few bristles, except in the case of the first segment, which bears about four additional bristles on the two sides together, representing a more complete fourth row. The bristles on the sternites are less numerous than in *P. mordax*.

**Modified segments.**—♀. The seventh sternite (Pl. XXIX. fig. 11) is bisinuate, the upper sinus being smaller than the lower. The eighth segment is similar to that of *P. mordax*. The anal sternite, however, is quite different. This sclerite has beneath a prominent tubercle bearing a brush of long bristles.

Length: ♀ 3 mm.

We have one ♀ from Pundaloya, Ceylon, taken off *Sorex* sp by Mr. E. E. Green.

7. Stephanocircus jarvisi, sp. n. (Plate XXIX. fig. 12; Plate XXXI. fig. 16.)

**Head.**—The helmet is rounded, resembling that of *S. simsoni* Roths. (1905), but being broader and bearing on each side 17 or 18 spines. The genal comb consists of 11 or 12 spines, which are obtuse, like those of the helmet, not being pointed as in *S. dasyuri* Skuse (1890). The occiput is shorter than in all the other species, its bristles being thick. The mouth-parts are short, the maxillary palpus as well as the rostrum being only twice the length of the spines of the genal comb. The last segment of the rostrum is broader than it is long. The maxilla is pointed.

**Thorax.**—The pronotum bears a comb of 30 to 40 spines and two regular rows of thick bristles. The mesonotum has about 7 rows of bristles, the anterior bristles being small. On the pleura of the mesothorax there are about 24 bristles, some being short. The metanotum has three rows of bristles and in front of them a few additional shorter hairs. The episternum of the metathorax bears about 6 bristles, while the epimerum has two rows, the first being irregular and containing 6 or 7 bristles and the second containing 5.

**Abdomen.**—The abdominal tergites 1 to 7 bear each two rows of bristles, the seventh tergite having 2 apical bristles in the male, and 4 of nearly equal size in the female. On the first tergite there is a comb of 27 spines in the ♂, which are only a little shorter than those of the pronotal comb, the comb of the ♀ containing 34 spines; the second tergite has a comb of 17 shorter spines in the ♂ and of 22 in the ♀, the comb of the third tergite consisting of 15 spines in both sexes. The fourth tergite bears on each side 2 or 3 shorter and paler apical spines and the fifth and sixth tergite one spine.

**Legs.**—Resembling most those of *S. mars*. The hind coxa is longer than in that species. The hind femur bears posteriorly 3 subventral bristles and between these and the dorsal edge several more bristles, there being also one or two bristles near the base on the outer surface. The tibiæ are very characteristic. In the fore and mid tibiæ the outer bristles of the dorsal pairs are shifted towards the lateral surface, forming a close-set row of thick and equal-sized bristles. In the hind tibia these bristles are in their normal position close to the long dorsal bristles. The dorsal bristles are very long, the fifth being of the length of the tibia. The hind tibia bears numerous bristles scattered over the outer surface. The first mid-tarsal segment is twice the length of the second. The first hind-tarsal segment is only one-sixth shorter than the hind tibia, its longest apical bristle nearly reaching to the tip of the second segment, which latter is twice the length of the fifth segment (claws excluded).

**Modified segments.**—♂. The clasper (Pl. XXIX. fig. 12, Cl.) is produced into a broad, leaf-shaped apical lobe, which bears three large bristles placed on the lateral surface. A number of small bristles are situated along the dorsal edge of this lobe, while two fairly long ones are placed just beneath the pointed apex of the lobe. The clasper, moreover, is ventrally widened into an obtuse triangular lobe, which bears one slender bristle. The finger (F) is asymmetrical, being leaf-shaped with the apex curving upwards, bearing two moderately long bristles below the apex and a few still shorter ones further proximad. The manubrium (M) curves upwards, the ventral margin bulging out in the centre. The ninth sternite (Pl. XXIX. fig. 12, IX. st.) resembles that of *S. simsoni* in general structure, but the inner arm is different in outline, the horizontal arm is longer, and the number, size, and position of the bristles are different. There are, as in *S. simsoni* and *dasyuri*, two apical spines on each side of the horizontal arm of the ninth sternite, as shown in the figure. The anal tergite is very different from that of *S. simsoni*, bearing a few thin bristles and on each side a pair of long apical ones. The anal sternite is divided at the apex, each lobe bearing three long bristles.— ♀. The eighth tergite, which resembles in outline that sclerite of *S. simsoni*, bears about 9 short but strong bristles above the stigma, and from 29 to 34 bristles on the sides and at the apex, as shown in the figure (Pl. XXXI. fig. 16). The eighth sternite is elongate-triangular, ending in a long sharp point as in *S. simsoni*. The tenth tergite is distinctly separated from the ninth tergite, as is also the case in *S. simsoni*. Proximally to this suture there is a transverse row of bristles on the ninth tergite. The stylet is very long.

Length: ♂ 2·7 mm., ♀ 3·3 mm.

We have examined a pair of this species, the ♂ (the type) from Emerald, Victoria, found under a rotten tree-trunk in the virgin forest by Mr. Edw. Jarvis; the ♀, from Victoria, off *Phascologale swainsoni*, was forwarded to us by Mr. D. McAlpine.

8. Ctenophthalmus rettigi, sp. n. (Plate XXVIII. figs. 3, 4.)

Similar to *C. agyrtes*, but differing especially in the bristles of the abdomen and in the modified abdominal segments.

**Thorax.**—The comb of the pronotum consists of 18 spines.

**Abdomen.**—The bristles are longer than in *C. agyrtes*, especially the three apical ones of the seventh tergite. The sternites of segments three to seven in the ♂ have a transverse row of 4 or 5 bristles and generally some small bristles in front of this row. The basal sternite in the ♀ has two or more bristles on the side; the following four sternites have a row of 6 or 7 bristles and from 6 to 10 smaller ones in front of the row; on the seventh sternite the row contains about 10 long bristles.

**Modified segments.**— ♂. The eighth tergite (Pl. XXVIII. fig. 3) has about 6 small bristles above the stigma. The sternite becomes gradually narrower towards the apex, which is truncate; it bears on its lower portion 14 or 16 bristles (Pl. XXVIII. fig. 3). The clasper (Pl. XXVIII. fig. 3, Cl.) is produced into a short square process (P), of which the apical margin is feebly incurved. At the upper corner of this process there are about half-a-dozen slender bristles and one which is very stout and long, whereas at the oblique ventral margin of the process there are two such long bristles. The manubrium (M) gradually tapers to a point, being somewhat curved upwards. The movable process (F) is widest near the base. It is irregularly conical, the ventral margin being somewhat incurved and proximally strongly rounded. There are four short broad bristles near its apex at the dorsal edge and three thin ones near the apex at the ventral margin, there being, moreover, four thin bristles at this margin on the widest part towards the base. The horizontal arm of the ninth sternite (IX. st.) is much shorter than the vertical arm. There are about 17 bristles at and near the ventral margin of this sternite from before the middle to the apex, the four or five proximal bristles being close together and longer than the sternite is broad.—♀. The apical margin of the seventh sternite is sinuate below the centre, the upper lobe being very broad and nearly square (Pl. XXVIII. fig. 4), while the lower lobe is small and obliquely rounded. The eighth tergite bears several small bristles above the stigma and about 16 bristles on the lower portion, there being also ten or more small bristles near the apex on the inner surface. The stylet is nearly three times as long as it is broad at the base.

Length: ♂ 2·1 mm., ♀ 3·2 mm.

We have a large series collected by Mr. A. Rettig at Malcoci, Roumania, off *Mesocricetus newtoni*, *Putorius desertorum*, and *Spalax typhlus*.

9. Ctenopsyllus allophylus, sp. n. (Plate XXVIII. figs. 1, 2.)

**Head.**—The frons (Pl. XXVIII. fig. 2) is strongly and evenly rounded and bears a vertical comb of 6 spines. The first spine is short and very broad, while the third is placed beneath the second and fourth. There is anteriorly a row of 8 bristles, followed by a second row of 3 longer ones; 2 more bristles are situated in front of the comb, whilst a very long one is placed about halfway between the insertion of the maxillary palpus and the anterior row of bristles. The occiput bears 3 rows of bristles. The rostrum is about one-third shorter than the fore coxa.

**Thorax.**—The pronotum bears one row of bristles and a comb of 21 spines. The meso- and metanotum have each 3 rows of bristles, the anterior row being incomplete. The episternum of the metathorax has no bristles, while the epimerum bears 6 long ones (3, 3) and 1 or 2 short ones.

**Abdomen.**—The tergites bear 2 rows of bristles, there being one or more additional bristles in front representing a third row. The second tergite has one or two slender, bristle-like spines on each side at the apical edge. The seventh tergite bears 1 apical bristle, which is short, being about as long as the third post-median bristle of this segment. The sternites of segments 3 to 7 have a row of 4 long bristles on each side, the basal sternite, however, bearing but 1 bristle.

**Legs.**—The mid and hind coxæ are rather narrow and long, both having a single bristle posteriorly at the apex. There are no short spines on the inside of the hind coxa. The fore-femur has on the outside 1 subapical bristle and 4 or 5 lateral ones. The mid and hind femora bear 2 subapical bristles on the outside and 1 on the inside. There are about 18 bristles on the outer surface of the hind tibia. The hind tibia has 7 dorsal notches. The longest dorsal bristle of this tibia is hardly twice as long as the tibia is broad, the longest apical bristle being only about one-third the length of the first hind tarsal-segment. The tibiæ have a long and a short bristle in most of the notches. The first hind-tarsal segment is nearly as long as the hind tibia, the bristles situated at its posterior side being rather long and very thin. The thick apical bristles of this segment are short, the posterior one being only one-third the length of the second segment and the anterior one being about as long as the first segment is broad. The fifth segment bears in all the tarsi 4 strong lateral bristles and a subbasal pair which are placed on the ventral surface in between the first lateral pair.

**Modified segments.**—♂. The large eighth sternite bears a row of 5 long bristles on the side. The clasper (Pl. XXVIII. fig. 1, Cl.) has a short rounded process (P) bearing two long bristles. There is 1 long bristle at the insertion of the movable process (F). This process is very large, being first narrow and curved upwards and then much widened and curved downwards. It bears a row of long bristles at the ventral edge, a short, broad, and somewhat twisted spine at the tip, an irregular double row of bristles on the side and another row at the dorsal edge, the central bristles of this dorsal row being flattened and lanceolate. The manubrium (M) is widest at the apex. The ninth sternite (IX. st.) is likewise very peculiar. The internal (=vertical) arm is broadened at the apex, this widened portion being excised in the usual way, as shown in the figure. The horizontal arm has an almost straight dorsal margin, while the ventral margin is curved, being evenly rounded in the distal third and bearing here a number of bristles. This sternite has basally a lateral horizontal projection crowned with a very dense brush of long thin bristles, which are curly at the end, and among which is one long thick bristle. Beyond the middle of the ventral margin there are 3 short, hook-like spines, and before the apex a large and a small hooked spine, the large one apparently bifurcating at the apex. The tenth segment is long, the sternite bearing two long apical bristles on each side.

Length: ♂ 3 mm.

We have one ♂ from Temuco, Chile, off *Dromiciops australis*, collected by Mr. D. S. Bullock in November 1906.

## *Siphonaptera collected by Mr. M. P. Anderson in Japan in* 1904.

By the Hon. N. CHARLES ROTHSCHILD, M.A.

(Plates XXX. & XXXI.)

The collection contains five species, of which three are new.

1. CERATOPHYLLUS MELIS Walk. (1856).

*Pulex melis* Walker, Dipt. Brit. p. 5. n. 14 (1856) (off Badger); Tasch. Die Flöhe, p. 73. n. 10, t. 2. figs. 15, 15 *a*, t. 3. fig. 16 (1880) (off Badger and Fox).

Five females taken off *Meles anakuma* at Jinrio, Tokushima Ken, Shikoku, Japan, on February 17th.

2. CERATOPHYLLUS ARGUS, sp. n. (Plate XXX. fig. 15; Plate XXXI. fig. 18.)

This species is closely allied to *C. sciurorum* Schrank (1804) and *C. anisus* Rothsch. (1907). These insects agree with one another in almost every detail of the exo-skeleton except in the modified posterior segments of the abdomen.

The rostrum is somewhat longer in the new species than in the others mentioned above, reaching to the apex of the trochanter or a little beyond.

**Modified segments.**— ♂. The eighth tergite bears 4 (sometimes 5) bristles along the upper edge from the stigma anad, there being 3 to 5 additional bristles on the lateral surface, besides 1 or 2 which are placed near the ventral margin. The eighth sternite (Pl. XXX. fig. 15) resembles that of *C. anisus*, being much longer than in *C. sciurorum*. The clasper is produced into a short obtuse process (Pl. XXX. fig. 15, P), which is much broader and more rounded than in the allied forms. The finger (F) of the clasper is very slender. The vertical arm of the ninth sternite (IX. st.) is curved as in *C. anisus*. The proximal portion of the horizontal arm is only slightly dilated, and there are less hairs on this dilated part than in *C. anisus*.— ♀. The seventh sternite of the abdomen (Pl. XXXI. fig. 18) becomes narrower distally, the upper edge being incurved before the apex, while the apical margin is slightly emarginate. This sclerite is as long as it is broad. The eighth tergite resembles that of *C. sciurorum*. It bears about 7 small bristles above the stigma and 1 long and 2 short ones near the margin below the stigma. The apex of this segment is slightly emarginate, there being 3 bristles at the lower angle of the apex, 3 short but rather stout ones proximally to them, 4 along the ventral margin and 4 to 6 dorsally to these. The stylet is more than three times as long as it is broad at the base.

Length: ♂ 2·4 mm., ♀ 4 mm.

We have four ♂ and one ♀, taken off *Petaurista leucogenys*, at Mitai, Miyasaki Kiushiu, Japan.

3. Ceratophyllus indages, sp. n. (Pl. XXXI. fig. 17.)

We know only the ♀. The differences from the ♀ of the preceding species are apparently constant, though slight. This flea is deeper brown than the preceding one. The seventh abdominal sternite is longer, its upper margin being even more emarginate distally, while the apical margin is not sinuate at all (Pl. XXXI. fig. 17).

Length: ♀ 3·1 mm.

We have six ♀, taken off *Sciurus vulgaris orientis*, at Noboribetsu, near Moruran, Hokkaido, Japan.

As the differences between the females of closely allied species in this group of *Ceratophyllus* are generally slight (quantitatively), we consider that the above-mentioned characters indicate that this insect is distinct from *C. argus*. The discovery of the ♂ will doubtless settle the point.

4. Ceratophyllus andersoni, sp. n. (Plate XXXI. fig. 19.)

**Thorax.**—The meso- and metanotum and the abdominal tergites 1–7 bear each 2 rows of bristles, the mesonotum having some additional hairs on the back besides the small hairs situated at the anterior edge. The metathoracic epimerum has 5 bristles (1, 3, 1). The long apical bristle of the seventh tergite is as long as the first hind-tarsal segment.

**Legs.**—The hind femur bears 2 bristles on the inner surface, one being subbasal, the other placed subventrally near the apex. The first mid-tarsal segment is about one-fourth longer than the second (20:16). The bristles situated at the dorsal edge of the hind tibia and at the anterior and posterior edges of the hind tarsus are very deep brown. The first hind-tarsal segment, like the second to fourth segments, bears 2 rows of bristles on the outer surface.

**Modified segments.**—♀. The seventh abdominal sternite is quite unlike that sclerite of the allied species, being less broad vertically and much more rounded (Pl. XXXI. fig. 19). The eighth tergite bears a few more bristles than in the preceding species. The bristles of the tenth sternite are very stout. The stylet is four times as long as it is broad at its base.

Length: ♀ 3·1 mm.

We have one ♀, taken off *Putorius itatsi*, at Takamori, Kumamoto Ken, Kiushiu, Japan, on April 6th.

5. Chætopsylla globiceps Tasch. (1880).

*Pulex globiceps* Taschenberg, Die Flöhe, p. 66. n. 6, t. 2. figs. 10 10 *a*, 11 (1880) (off Fox and Badger).

There are five ♀ in the collection, which are apparently identical with European specimens. Taken from *Meles anakuma*, at Jinrio, Tokushima Ken, Shikoku, Japan, on February 17th.

## EXPLANATION OF THE PLATES.

### Plate XXVIII.

Fig. 1. Genitalia of the ♂ of *Ctenopsyllus allophylus*. Cl = clasper; P = process of clasper; F = movable process of clasper; M = manubrium; VIII. st. = eighth abdominal sternite; IX. st. = ninth abdominal sternite.
2. Head of *Ctenopsyllus allophylus* ♂.
3. Genitalia of the ♂ of *Ctenophthalmus rettigi*.
4. Seventh and eighth abdominal segments of *Ctenophthalmus rettigi* ♀.
5. Sixth and seventh abdominal sternites of *Pygiopsylla rainbowi* ♀.
6. Genitalia of the ♂ of *Pygiopsylla mordax*.

### Plate XXIX.

Fig. 7. Head of *Pygiopsylla afer* ♀.
8. Seventh abdominal sternite of *Pygiopsylla afer* ♀.
9. The same of *Pygiopsylla mordax* ♀.
10. The same of *Pygiopsylla laciniosus* ♀.
11. The same of *Pygiopsylla ferinus* ♀.
12. Genitalia of the ♂ of *Stephanocircus jarvisi*.

### Plate XXX.

Fig. 13. Genitalia of the ♂ of *Pygiopsylla rainbowi*.
14. The same of the ♂ of *Pygiopsylla gravis*.
15. The same of the ♂ of *Ceratophyllus argus*.

### Plate XXXI.

Fig. 16. Posterior abdominal segments of *Stephanocircus jarvisi* ♀.
17. Seventh abdominal sternite of *Ceratophyllus indages* ♀.
18. The same of *Ceratophyllus argus* ♀.
19. The same of *Ceratophyllus andersoni* ♀.

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## June 16, 1908.

Dr. Henry Woodward, F.R.S., Vice-President, in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of May 1908:—

The number of registered additions to the Society's Menagerie during the month of May was 189. Of these 116 were acquired by presentation and 46 by purchase, 15 were received on deposit, 4 by exchange, and 8 were born in the Gardens.

The number of departures during the same period, by death and removals, was 175.

Among the additions special attention may be directed to:—

One Black-faced Chimpanzee (*Anthropopithecus troglodytes*), var. ♀, from Sierra Leone, deposited on May 30th.

One Agile Gibbon (*Hylobates agilis*) ♂, from Sarawak, presented by the Earl of Crawford, K.T., F.Z.S., on May 8th.

Three Grèvy Zebras (*Equus grevyi*) ♂, ♀ ♀, from Abyssinia, purchased on May 9th.

Twenty-one Indian domestic Cattle (*Bos indicus*), representing five different breeds, and 5 Fat-rumped Dumba Sheep (*Ovis aries*), from India, presented by H.G. the Duke of Bedford, K.G., President of the Society, on May 13th.

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Dr. A. Smith Woodward, F.R.S., F.Z.S., exhibited photographs and fragments of skin and bone of a Mammoth and a Rhinoceros discovered in an ozokerite mine at Starunia, Galicia. The carcases of these animals appeared to have found their way into an old marsh saturated with petroleum, which had completely preserved them. The photographs and specimens had been received from Dr. George von Kaufmann, who intended to present them to the British Museum.

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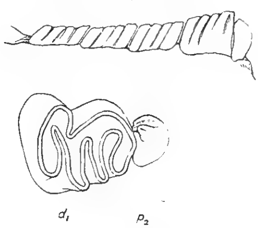
*Jaw of Canadian Beaver, with five lower cheek-teeth.*

Dr. C. I. Forsyth Major, F.R.S., F.Z.S., exhibited, and made the following remarks upon, the lower jaw of a young Canadian Beaver (B.M. No. 55.3.11.4), in which there was present on each side a small conical tooth anterior to the deciduous premolar (text-fig. 131).

Text-fig. 131.

A.

B.




Molar teeth of right lower jaw of *Castor canadensis*.

A. Side view; B. Upper view of $d_1$ and $p_2$. $p_2$=supernumerary premolar.

"No Simplicidentata are known with normally more than four *lower* cheek-teeth; this holds good also with respect to the oldest-known fossil Simplicidentata. We must, however, postulate still older fossil predecessors with five lower cheek-teeth. As a transitional stage between the latter condition and that exhibiting four cheek-teeth, Rodents must have existed, probably in the Lower Eocene, which had *normally* exactly such a diminutive anterior tooth as is *abnormally* shown in the present specimen. I therefore consider this supernumerary premolar to be a case of atavism."

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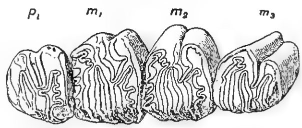
*On species of* Castor, *fossil and recent.*

Drawings of some remains of two species of *Castor* from the East Runton Forest-bed were also exhibited by Dr. Forsyth Major.

(1) Text-fig. 132 represents the four cheek-teeth from a right mandibular ramus in the British Museum (M 7024), from Mr. Savin's collection. They are remarkable for the complex and elegant plication of their enamel, whereby they agree with the Beaver from the Upper Pliocene of the Valdarno, *Castor plicidens* Maj., this specific name implying the principal and almost

the only character by which the fossil remains can be distinguished from recent Beavers. Dr. Bosco some years ago* fully described and figured the Valdarno remains; he points out another characteristic feature of this species, viz. the considerable breadth of the incisors. Herein the fossil from East Runton equally agrees with the Valdarno specimens.

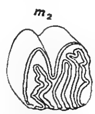
Text-fig. 132.




*Castor plicidens* Maj. East Runton Forest-bed.
Upper view of right lower molar series.

(2) A second species of a *Castor* from the Forest-bed (B.M. M 7025), likewise from the East Runton upper freshwater bed, is represented by a left mandibular ramus, vertically split from before backwards, only its outer half, and of the teeth $m_2$ alone (text-fig. 133) being preserved. It doubtless belongs to the same

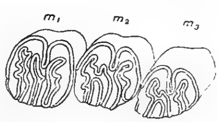
Text-fig. 133.




*Castor* sp. East Runton Forest-bed.
Upper view of left $m_2$.

species as the specimens described from West Runton by Mr. E. T. Newton; as in the latter, the molar is slightly smaller than the corresponding one of *C. plicidens*; the incisor, as apparent from its alveolus, is narrower. The enamel of the molar is considerably less plicated than in the latter species, although slightly more so than is the rule in recent Beavers; a moderate plication of the enamel occurs, however, in old specimens of the recent form (text-figs. 134, 135 B, 136 A).

Text-fig. 134.




*Castor fiber* L. Peat deposit, England.
Upper view of right lower true molars.

Mr. Newton has identified the West Runton Beaver with the

* Palæontographia Italica, vol. v. (1899).

recent European animal; and, in fact, his specimens, as well as the specimen in the British Museum Geol. Dept. No. M 7025 from East Runton, share with *C. fiber* the characters—so far as they are known in the fossil specimens—which distinguish the recent animal from *C. plicidens.* I expect, however, that more complete specimens will reveal differences from the recent form or forms.

The European Beaver ranges, or ranged, from Great Britain to Mongolia, and from Lapland to Spain (according to Strabo) and Italy. There is therefore every likelihood that more than one form will have to be distinguished in this vast region; but in order to arrive at some definite conclusion, we require whole series (at least of skulls) from the different countries: this will be no easy task, considering that in most countries the Beaver has become extinct within historic times.

According to Prof. Matschie *, Desmarest separated the Beaver of the Rhone under the name of *Castor galliæ*, while Owen proposed the name of *C. europæus* for the English sub-fossil Beaver. The German writer restricts the Linnean name *Castor fiber* to the Swedish Beaver, known to him only by the figures of the teeth and the skull in Meves's Atlas †. From the Swedish Beaver that of the Elbe is said to differ by some characters of the skull and the teeth, and is therefore called *Castor albicus.* The name *C. balticus* is given to the Beaver which formerly lived in Pomerania and Holstein and is based on two skulls. For a specimen from Western Poland (drainage system of the Vistula) which lived at the Berlin Zoological Gardens, the name of *C. vistulanus* is proposed, its skull being found to be different from those of "*C. albicus*" and "*C. balticus.*" The skull of "*C. vistulanus*" is declared to differ also considerably from a skull of a Beaver from the Caucasus and from one from Poland in the Kiew Museum, both of them figured by Brandt ‡. Lastly, a skull from Schwerin a. d. Warthe (Posen), although agreeing in most characters with "*C. vistulanus*," is supposed to be possibly a distinct species.

If the Rhone Beaver can be shown to be a distinct form, the name *C. galliæ* will be available for the same; this was not, however, Desmarest's opinion. From the context and the explicit statement of the latter's notice § it results that he introduced this name for the European Beaver in general, which he wished to distinguish from the American species.

In the same way Owen applied the name *C. europæus* to the European Beaver generally, he did not mean to restrict it to the English animal as Matschie assumes. Until further notice "*C. galliæ*" will therefore remain a synonym of *C. fiber* L., and the same is the case with "*C. europæus.*"

* Sitzungsber. Ges. Naturf. Fr. Berlin, No. 8, 1907, pp. 215–220, pls. i. & ii,

† Atlas öfver Skandinaviens Däggdjur, Suppl. pl. iii. figs. 1, 1*a*, 1*b* (Stockholm, 1873).

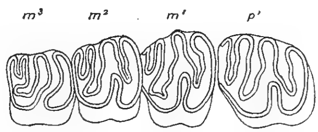
‡ Mém. Ac. Sc. St. Pétersbourg (6) ix. Sc. Nat. vii. pls. i. & ii. (1855).

§ Desmarest, in Nouv. Dict. d'Hist. Nat. v. pp. 372, 373 (1816).

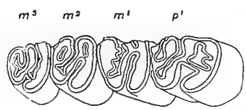
Of the Swedish Beaver Matschie says that in the last upper molar the internal enamel-fold is absent, "und bei den übrigen Molaren legt sie sich nicht an die vorderste Aussenfalte an, sondern verläuft senkrecht zum Längsdurchmesser der Zähne und endigt frei zwischen der vorderen und mittleren Aussenfalte." Besides, "the nasals are obliquely truncated towards the front and not notched near the intermaxillary, so that their anterior margin, seen from the side, seems to be angularly notched." *

Text-fig. 135.

A.



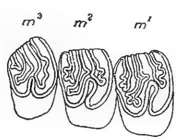

B.



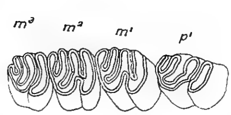

A. *Castor fiber* L. Sweden. Lower view of right upper molar series. Copied from Meves's Atlas öfver Skandinaviens Däggdjur, Suppl. pl. iii. fig. 1*a*.
B. *Castor fiber* L. Lapland. Lower view of right upper molar series of an old specimen. R. Coll. of Surgeons Museum.

Text-fig. 136.

A.




B.




A. *Castor fiber* L. Peat-deposit, England. Lower view of right upper true molars.
B. *Castor fiber* L. Lower Rhone (B.M. No. 94.5.30.1). Lower view of right upper molar series.

An inspection of the figure to which Matschie alludes (see text-fig. 135 A, which is a copy of the figure in Meves's Atlas) shows that the internal enamel-fold is not absent from the last upper molar, only it is fused with the antero-external fold, a condition

* *Op. cit.* p. 216.

which obtains not unfrequently in younger stages of Beavers' molars (especially in $p^1$ and $m^3$) and sometimes persists in the adult. Text-fig. 136 B shows the upper molars of a young adult of the Rhone Beaver, where $m^3$ exhibits the pattern of Meves's figure. A second, rather old specimen of the Rhone Beaver in the British Museum (No. 5.3.9.1) shows likewise on both sides the same conformation of the $m^3$ as in the younger specimen. Text-fig. 135 B, on the other hand, exhibits the upper molar series of a rather old Swedish Beaver in the Museum of the Royal College of Surgeons*, kindly placed at my disposal by Prof. Keith. Here $m^3$ presents the normal condition; and together with the other cheek-teeth, when compared with Meves's figure, illustrates the well-known fact of the considerable individual variation in the pattern of the enamel, chiefly due to different stages of wear.

Text-fig. 137.

*Castor fiber* L. Lapland. Side view of anterior portion of skull.
R. Coll. of Surgeons Museum.

The text-figure 137 exhibits the side view of the anterior portion of the skull in the Royal College of Surgeons, which does not depart from the normal condition in the European Beaver. The figure in Meves's Atlas to which Matschie alludes is apparently taken from the skull of a youngish specimen, and, besides, may not be quite correct.

As to the characters assigned to Matschie's new species, *C. balticus*, notably the greater elongation of the sagittal crista, they are simply those of old age.

* No. 3102, "from an animal taken in Lapland about the year 1830."

H. Goodchild del, et lith. Huth imp.

CAPREOLUS BEDFORDI. ♀

Dr. Forsyth Major also exhibited photographs of Pliocene *Bovinæ* from specimens in the Florence Museum, stating that these unpublished figures showed the great variability of the Pliocene *Bovinæ*. He added that he endorsed Falconer's opinion that these Pliocene *Bovinæ* were nearly related to the primitive Buffaloes from the Siwaliks.

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The following papers were read:—

## 1. The Duke of Bedford's Zoological Exploration in Eastern Asia.—X. List of Mammals from the Provinces of Chih-li and Shan-si, N. China. By Oldfield Thomas, F.R.S., F.Z.S.*

[Received May 2, 1908.]

(Plate XXXII.)

During the four months following his excursion to the Mongolian plateau †, Mr. M. P. Anderson made collections in different parts of the northern provinces of China, Chih-li and Shan-si, and it is an interesting comment on our ignorance of the Fauna of that part of the world that, in spite of the previous work of David, Swinhoe, Styan and others, he has obtained quite a number of new forms.

Throughout the region, the country has proved to be extremely barren and poor in mammals, and the possible collecting-grounds few and far between. But this very fact renders such collecting places as Mr. Anderson has found all the more interesting, for they almost bear the character of faunistic islands, in which the original inhabitants have been locally preserved, and which are separated from each other by a sea of barren treeless plains where few animals can live. The proper exploration of these oases of life is therefore peculiarly valuable. No doubt the difficulties of collecting have been accentuated during the winter months, and we may hope that during the present spring Mr. Anderson will find a number of additional forms which in the winter have been lying dormant.

Of previous literature there is not much to be referred to beyond the well-known publications of David, Milne-Edwards, and Swinhoe, and an interesting paper by O. F. von Möllendorff ‡ giving a popular account of the Mammals of Chih-li, with notes on the Chinese names.

* [The complete account of the new species described in this communication appears here; but since the name and preliminary diagnosis of one were published in the 'Abstract,' that species is distinguished by the name being underlined.—Editor.]

† *Supra*, p. 104.

‡ "The Vertebrata of the Province of Chih-li, with Notes on Chinese Zoological Nomenclature," Journ. N. China Branch Roy. As. Soc. (2) xi. p. 41, 1877.

Prof. Matschie's work* on the Filchner Mammals deals with a somewhat different region, further to the west and south, but, true to his peculiar creed that the animals of different river-basins must be specifically distinct from each other, the author gives new names to some of the Chih-li mammals. The material he worked upon seems to have consisted largely of single purchased skins, mostly without skulls, and the possibility of any such variation in colour as is found in the Shan-si foxes (see *infrà*) is entirely ignored.

No less than 19 species are described as new by Prof. Matschie on undated skins without measurements or skulls, or at least without mention of the latter, and I cannot refrain from expressing the opinion that such work is neither worthy of the high standing of the Berlin Museum nor of the present date, when pains are being taken in all directions to ensure that mammal work should be based only on proper and carefully collected material. The Americans have set us a good example in this respect, and it is to be regretted that work issuing from the Berlin Museum should be done in so retrograde a manner. All the names thus founded will remain an incubus to science until the time when they can be successively examined and weighed in the light of complete material, such material, for instance, as the Washington Museum has received from Dr. W. L. Abbott, or our own National Museum owes to the Duke of Bedford, Mr. C. D. Rudd, Mr. W. E. Balston, and many others.

About 100 specimens are dealt with in the present communication, belonging to 20 species.

The following are Mr. Anderson's notes on the localities he collected in :—

CHIH-LI.

"After returning from my trip to the Mongolian Plateau, I visited Tung-ling, the forest of the reserve of the Eastern Imperial Tombs, and on 12th September, 1907, I began work at Yen-mon, a hamlet about 65 miles north-east of Peking. At this point I was well within the hills which border the Chih-li plain on the north, and my hamlet was at an altitude of about 1000 ft., while the surrounding hills rose to 1800 or 2000 ft. The hills of this region are for the most part very abrupt, rugged and rocky. Difficult peaks and narrow, almost impassable canyons are frequent. Tung-ling is forbidden ground to the wood-cutter and charcoal-burner, therefore woods persist and even grow dense and old in the remoter parts of the reserve. One finds some fine oaks, walnuts, chestnuts, and cottonwoods The frequently occurring open spaces are well covered with deep grass."

SHAN-SI.

"On 25th October, 1907, I reached Tai-Yuen-Fu, the capital

* Filchner Exped. Zool. pp. 134–244, 1907 (postdated 1908).

of Shan-si Province, and on 31st October left that city for the mountain-range some 15 miles west of there.

"At this point, at an altitude of 5400 feet, I found the mountains sparsely covered with pine trees and the canyon sides overgrown with dense bushes.

"On 17th November I began work at Chao-Cheng-Shan, a mountain of 10,000 ft. altitude, situated about 100 miles west-north-west of Tai-Yuen-Fu. There, at an altitude of 8000 ft., I made my home in a peasant's hut. Above me extended a dense forest of spruce and hemlock, below I overlooked the rugged bare hills and cultivated valleys characteristic of North China.

"I remained in this place till Dec. 6th, 1907. The weather throughout was fiercely cold, as a north wind blew almost unceasingly.

"On December 27th I went eastward of Tai-Yuen-Fu about 20 miles to a temple wood among the 'loess' hills. But this proved such a poor collecting-ground, and the weather so very cold, that on 4th January I thought it advisable to return to the city."

1. Rhinolophus ferrum-equinum nippon Temm.

♂. 1571. Cave 30 miles W. of Peking. 600′.

This and the two following species were obtained in a sacred cave which Mr. Anderson might not have been allowed to enter, certainly not to shoot in, had it not been for the kind offices of Dr. J. H. Ingram of Tung-chou, who persuaded the priest of the cave to allow him to do so. Great numbers of bats were hanging from the roof, but besides the one *Rhinolophus*, which was caught low down within reach, and the two specimens of *Myotis*, all proved to belong to one species, a *Miniopterus*.

2. Myotis (Leuconoe) pequinius, sp. n.

♂. 1573, 1589. Cave 30 miles W. of Peking. 600′.

A comparatively large *Leuconoe*, with a fringed interfemoral membrane.

In size one of the largest species of the group, exceeding all the Old-World species of *Leuconoe*, except *M. ricketti*. Fur rather short and velvety, hairs of back about 5 mm. in length. General colour above uniform "drab-grey," the bases of the hairs slaty. Under surface whitish grey, the ends of the hairs nearly white, their bases slaty; under side of hind legs and the anal region edging the membranes white and practically hairless. Ears of medium size, rather narrow, concave on their external border; tragus about half the length of the ear, narrow, not sharply pointed, slightly curved outwards above. Wings attached to the lower end of the tibiæ. Feet of average *Leuconoe* proportions. Interfemoral membrane fringed posteriorly with pale buffy hairs; tip of tail not projecting from the membrane, so far as can be determined on skins from which the caudal vertebræ have been pulled out. In colour all the membranes and the feet are dark drab-grey, except that the terminal half-inch of the interfemoral is slightly marbled with white.

Median upper premolar minute in one specimen, absent in the other, but both are very old examples with the teeth much worn down. Also very minute in the lower jaw.

Dimensions of the type (the starred measurements taken in the flesh):—

Forearm 50 mm. (in the second specimen 48·5).

*Head and body 62 mm.; *tail 42 †; *hind foot (s. u.) 12; *ear 18; tragus on inner edge (dry) 7; third finger, metacarpal 46, 1st phalanx 14·5, 2nd phalanx 14; tibia 18.

Skull—basi-sinual length ‡ (*c.*) 14·5 mm.; zygomatic breadth 12·2; interorbital breadth 4·9, breadth of brain-case 4·7; front of canine to back of $m^3$ 6·9.

*Hab.* China, 30 miles W. of Peking. Alt. 600′.

*Type.* Old male. B.M. No. 8.8.7.2. Original number 1573. Collected 11 October, 1907.

By its size and the presence of a fringe on its interfemoral membrane this very distinct Bat is easily separable from any known Asiatic member of the genus *Myotis*.

The specimens were found hanging in the same cave as the series of *Miniopterus*—the association recalling that so frequent in Europe of *Miniopterus* with *Myotis* (*Leuconoe*) *capaccinii*.

3. MINIOPTERUS SCHREIBERSI CHINENSIS, subsp. n.

2 ♂, 13 ♀. 1574–1588. Cave 30 miles W. of Peking. 600′.

Size averaging slightly larger than in *M. s. japoniæ* Thos., the forearm ranging in length from 47 to 50 mm.

Colour dark, as usual in the Eastern forms, but without the reddish "Prout's brown" suffusion found in *japoniæ*, the general tone being markedly more drabby than in that form. The colour cannot be exactly matched in Ridgway, but is between "seal-brown" and "drab," with something of each in it according to the light the specimens are seen in.

This difference in colour is perfectly uniform throughout series of fifteen specimens of *chinensis* and a dozen of *japoniæ*, so that it seems necessary to recognise the N. China form as a different subspecies from that of Japan.

Dimensions of the type, measured in the flesh:—

Forearm 49 mm.

Head and body 62 mm.; tail 52; hind foot 10·5; ear 12.

Skull—greatest length 15·8 mm.; basi-sinual length 12.

† Probably below the normal; in the other specimen 49 mm.

‡ In describing Bats a name is frequently wanted for the measurement from the basion to the hinder edge of the anterior palatal notch. As the Latin for notch, *incisio*, makes a compound too like one founded on the incisor teeth, I would suggest the above word, based on *sinus*, a bay or gulf, with which this deep rounded hollow may be suitably compared.

*Type*. Adult female. B.M. No. 8.8.7.15. Original number 1585. Collected 11 October, 1907.

Bonhote's *M. s. fuscus* from the Liu-Kiu Islands is smaller, with a forearm about 44 mm. in length.

4. Crocidura coreæ Thos.

♂. 1553. Imperial Tombs, 65 miles E. of Peking.

Closely similar to the typical Korean series.

"Trapped beneath a thick bush among loose rocks in a cold damp canyon."—*M. P. A.*

5. Chodsigoa hypsibia de Wint.

♂. 1558. ♀. 1559. Imperial Tombs, 65 miles E. of Peking. 1000′.

Since Mr. de Winton described his *Soriculus hypsibius* * from N.W. Sze-chuen, correctly noticing the absence of the minute fourth unicuspid found in typical *Soriculus*, Dr. Kashtchenko † has made a new subgenus, *Chodsigoa*, for the species without that tooth. But while recognising the distinction of *Chodsigoa*, and even considering it rather genus than subgenus, I think that the typical species "*Soriculus* (*Chodsigoa*) *beresowski*" is undoubtedly identical with de Winton's animal, coming from practically the same locality, and having just about the same proportions. Nor can I at present see any reason to distinguish Mr. Anderson's specimens from *hypsibia*, in spite of their very different locality.

Mr. de Winton's type was previously the only specimen of this rare group of Shrews possessed by the British Museum.

"Trapped in a radish garden on a rocky hillside."—*M. P. A.*

6. Vulpes vulpes L.

♂. 1645, 1646, 1651. Tai-Yuen-Fu. 2700′.

These three skins illustrate the remarkable colour variation found among Foxes, one of them having a whitish, the second a slaty-grey, and the third a red under-side.

"Common."—*M. P. A.*

7. Sciurotamias davidianus M.-Edw.

♂. 1570. Imperial Tombs, 65 miles E. of Peking.

♀. 1643. 100 miles N.W. of Tai-Yuen-Fu, Shan-si. 8000′.

The genus *Sciurotamias* was formed by Mr. Gerrit Miller ‡ for this remarkable Squirrel, which has a skull very like that of a Chipmunk, with the external appearance of a Squirrel. Prof. Milne-Edwards had previously noticed its near relationship to *Tamias* §.

"Not a common species, as only one was seen besides the

* P. Z. S. 1899, p. 574.
† Ann. Mus. Zool. Acad. Sci. St. Pétersb. x. p. 252 (1906).
‡ P. Biol. Soc. Wash. xiv. p. 23 (1901).
§ Rech. Mamm. p. 160 *et seqq.* (1874).

present specimens. From the native reports I judge this animal to be a rock-loving species. Its colour is very like that of the local rocks.

"Evidently rare in Shan-si."—*M. P. A.*

8. Eutamias senescens Mill.

♂. 1561, 1562. Imperial Tombs, 65 miles E. of Peking.

The type of *E. senescens* was obtained about 15 miles to the west of Peking.

"Rare. I failed to see any alive, but got these two from hunters."—*M. P. A.*

9. Meriones psammophilus M.-Edw.

♂. 1644. Tai-Yuen-Fu, Shan-si. 2800′

This species was discovered by Père David at Suen-hoa-fu, near Kalgan, but although Mr. Anderson, when in that region, obtained a good series of the other species, *M. unguiculatus*, he did not get *M. psammophilus*, which we are therefore very glad to obtain, as the only specimen in the Museum is without a skull.

"Inactive in winter, but doubtless conspicuous in warm weather."—*M. P. A.*

10. Meriones auceps, sp. n.

♂. 1647. East of Tai-Yuen-Fu, Shan-si. 4000′. 31 Dec., 1907. B.M. No. 8.8.7.30. *Type.*

A medium-sized species with the immensely large inflated bullæ of *M. erythrurus.*

Size about as in *M. unguiculatus*, the common species of Mongolia. General colour above of the usual buffy fawn, very much as in that species, Sides with a brighter buffy band edging the white. Belly practically pure white, the hairs mostly white to their roots, but some few with a little grey at their bases. Ears bright buffy, contrasting with the general tone. Hands and feet pure white; claws thin, whitish horn-colour, not blackish as in *M. unguiculatus.* Tail well-haired, but not specially tufted, rich ochraceous-buffy throughout, a few hairs at the extreme end tipped with black.

Skull much more heavily built than that of *M. unguiculatus*, with broad interorbital space and heavy muzzle. Bullæ exceedingly large, the part just in front of the external meatus so swollen as to touch the zygomata, which they surpass in lateral spread.

Dimensions of the type, a rather young adult:—

Head and body 110 mm.; tail 105; hind foot 31; ear 15·5.

Skull—greatest length 36 mm.; basilar length 27·5; zygomatic breadth 19·5; tympanic breadth 20; interorbital breadth 6·2; palatilar length 15·5; diastema 9·2; palatal foramina 7; greatest horizontal diameter of bullæ 14·5; length of upper tooth-row (alveoli) 5·3.

*Hab.* and *Type* as above.

Of the other Chinese *Meriones* described, this very pretty species may be distinguished from *M. unguiculatus* by its whitish claws, buffy ears, whiter belly, and less blackened tail; from *M. psammophilus* by its larger size and buffy ears; and from both by its enormously larger bullæ, which indicate that it is not really closely allied to either of them.

11. Mus confucianus, M.-Edw.

♂. 1551. ♀. 1567, 1569. Imperial Tombs, 65 miles E. of Peking.

♂. 1600. ♀. 1599. Near Tai-Yuen-Fu, Shan-si. 5300′.

♂. 1648. East of Tai-Yuen-Fu. 4000′.

The Imperial Tombs specimens are very similar to the Kuatun examples considered as typical *confucianus* by Bonhote, and are equally distinct from the form found on the Chefoo Peninsula which I have named *M. c. sacer* in a previous paper.

"Not common; trapped among broken rocks and canyon-bottoms on hill-sides."—*M. P. A.*

12. Mus wagneri mongolium Thos.

♂. 1552, 1566. ♀. 1556, 1565, 1568. Imperial Tombs, 65 miles E. of Peking.

♂. 1611, 1617. ♀. 1603, 1621, 1629, 1635. 100 miles N.W. of Tai-Yuen-Fu, Shansi. 8000′.

Although these mice have no trace of an anterior supplementary cusp on their first upper molars, they are not improbably related to the Kan-su *Mus* "(*Leggada*)" *gansuensis* Satunin, a form evidently of the *musculus* group, and not a true *Leggada* at all.

"This small mouse seemed to be the commonest species in the vicinity of the Imperial Tombs, but still it was not met with very often. It lived under half-buried stones among the grass and bushes, or along the rocky banks of streams.

"In Shan-si it was somewhat common in the fields and about the peasants' threshing-grounds at Chao-Cheng-shan, but I did not see it elsewhere."—*M. P. A.*

13. Apodemus speciosus Temm.

♂. 1560, 1563. ♀. 1555, 1564. Imperial Tombs, 65 miles E. of Peking.

♂. 1593. ♀. 1590, 1594. Near Tai-Yuen-Fu, Shan-si. 5300′.

♂. 1623, 1636. ♀. 1608, 1630, 1631. 100 miles N.W. of Tai-Yuen-Fu. 8000′.

The Shan-si specimens are not unlike the Korean subspecies *A. s. peninsulæ*, to which perhaps the whole series should be provisionally referred until further material is received bearing on their relationship to *A. s. chevrieri* and *draco*, of the S.W. and S. of China.

"As common as *A. agrarius*, but usually living among the bushes."—*M. P. A.*

14. APODEMUS AGRARIUS COREÆ Thos.

♂. 1550, 1554, 1557. Imperial Tombs, 65 miles E. of Peking.

As with most of the other Imperial Tombs animals the nearest relationship of this striped rat seems to be with the Korean subspecies, but in such a variable group the present series is not large enough for me to be very positive on the point.

"Moderately common; living in the tall grass which grows in certain open valleys."—*M. P. A.*

15. CRICETULUS TRITON de Wint.

♂. 1622 (immature). Chao-Cheng-Shan, 100 miles N.W. of Tai-Yuen-Fu, Shan-si. 8000′.

"Brought to me by a farmer, who had caught it in a straw-stack in his threshing-ground."—*M. P. A.*

16. CRICETULUS ANDERSONI, sp. n.

♂. 1591, 1592, 1596, 1601, 1602. ♀. 1595, 1597, 1598. Near Tai-Yuen-Fu, Shan-si. 5300′.

♂. 1626, 1641. ♀. 1604, 1605, 1619, 1620, 1627, 1628, 1642. 100 miles N.W. of Tai-Yuen-Fu. 8000′.

♂. 1649. ♀. 1650. East of Tai-Yuen-Fu. 4000′.

A small long-tailed species like *C. longicaudatus* M.-Edw., but with the belly-hairs grey basally.

General colour above drab-grey, the centre of the back indistinctly darker, but without a definite dark line. Sides often with a vaguely marked buffy area just in front of the hips. Under surface dull whitish grey, not sharply defined laterally, the hairs dark slaty for about two-thirds of their length. Ears blackish, with sharply contrasted white tip and edges. Hands and feet white; palms naked; soles hairy except in the region of the pads and on the under sides of the toes. Tail comparatively long, coloured above like the back, white below, and sometimes white all round at the tip.

Skull not strikingly different from that of *C. griseus*.

Dimensions of four specimens, measured in flesh:—

| | | | | | |
|---|---|---|---|---|---|
| ♂. | Head and body | 80 mm.; | tail 38; | hind foot 15; | ear 15. |
| ♂ (type) | „ | 83 „; | „ 38; | „ 16; | „ 15·5. |
| ♀. | „ | 84 „; | „ 44; | „ 17; | „ 15. |
| ♀. | „ | 85 „; | „ 35; | „ 15·5; | „ 13. |

Skull of type—greatest length 25·5 mm.; basilar length 20·3; zygomatic breadth 13·3; nasals 9·2; interorbital breadth 3·7; breadth of brain-case 11·7; interparietal 2·6 × 9·2; palatilar length 10·4; palatal foramina 5·3; length of upper molar series 3·9.

*Hab.* Shan-si—type from 100 miles N.W. of Tai-Yuen-Fu. 8000′.

*Type.* Adult male. B.M. No. 8.8.7.71. Original number 1626. Collected 3 December, 1907.

This Hamster is readily distinguishable from *C. longicaudatus* M.-Edw. by its grey-mixed belly, from *C. griseus* M.-Edw. and *C. dichrootis* Sat.* by its longer tail, and from "*Urocricetus*" *kamensis* Sat.* by its shorter tail and smaller size. I confess I fail to see any sufficient reason why the long-tailed forms of this group should be separated in a special subgenus, even apart from the evidence given by *C. andersoni*, the tail of which is of a more or less intermediate length.

In laying such emphasis on the colour of the ears in *C. dichrootis*, Dr. Satunin does not seem to be aware that particoloured ears are a characteristic of most of the Far Eastern species, *C. griseus* and *C. obscurus* both having similar black and white ears.

I have named this pretty species after its collector, Mr. Anderson, by whom its distinctness from *C. griseus* was noticed.

"The common species of Hamster in Shan-si. It inhabits the neighbourhood of cultivated fields, making many horizontal burrows just beneath the surface of the earth."—*M. P. A.*

17. Craseomys regulus Thos.

♀. 1549. Imperial Tombs, 60 miles E. of Peking.

I cannot perceive any character by which this Vole can be distinguished from *C. regulus*, which was described from Korea.

"Trapped among bushes at the foot of a talus-slide; the only specimen seen, though I made great efforts to find more."—*M. P. A.*

18. Craseomys shanseius, sp. n.

♂. 1610, 1618, 1625, 1632, 1633, 1634, 1637, 1638, 1640. ♀. 1607, 1609, 1616, 1624, 1639. 100 miles N.W. of Tai-Yuen-Fu, Shan-si. 8000′.

"Taken in spruce forest."

A large pale-coloured species with comparatively short tail.

Fur long, soft and loose; hairs of back (in winter coat) 12–13 mm. in length. Upper surface pale greyish *Evotomys*-colour, the reddish more suffused with grey than usual, though possibly this is not so much the case in specimens in summer pelage. Face and sides markedly greyer, without rufous suffusion. Under surface pale cream-buffy, the broad slaty bases to the hairs showing through. Hands and feet white above. Tail heavily haired, brown above, whitish or cream-coloured on sides and below.

* Ann. Mus. Zool. St. Pétersb. vii. pp. 567 & 574 (1902).

Skull rather smaller than that of *C. regulus*; on the whole similar in shape except that the mesopterygoid fossa is unusually narrow, and the ridges bounding it do not slope upwards (dorsad) so much as usual, as they pass above (dorsad to) the posterior edge of the palate; the vertical space formed between the ridges and the hinder end of the palate is therefore of much less vertical extent than in other members of the *Evotomys-Craseomys* group.

Teeth apparently as usual, the last upper molar with six, and the first lower with nine salient angles.

Dimensions of four of the largest specimens:—

| | | | | | |
|---|---|---|---|---|---|
| ♂ (very old). | Head and body 104 mm.; | tail 32; | hind foot 18; | ear 13. |
| ♂ (type) | " 98 " ; | " 33; | " 18; | " 13. |
| ♀. | " 100 " ; | " 31; | " 18; | " 12. |
| ♀. | " 93 " ; | " 29; | " 17; | " 12. |

Skull of type—greatest length 26·2 mm.; basilar length 23·3; zygomatic breadth 14·6; nasals 7·4; palatilar length 12·6; palatal foramina 5·5; length of upper molar series (crowns) 6·2.

*Hab.* As above.

*Type.* Adult male. B.M. No. 8.8.7.85. Original number 1634. Collected 4 December, 1907.

This fine species, which was found by Mr. Anderson high up in the spruce-covered mountains N.W. of Tai-Yuen-Fu, may be readily distinguished from any of its allies by its unusually short tail, which barely surpasses that of average members of the Microtine series of Voles. In addition its pale colour and peculiar palate are characteristic.

No Red Voles have hitherto been found anywhere near Shan-si, the nearest being the Chih-li example of *C. regulus* referred to above. I continue to use the name *Craseomys* in a generic sense for the group of Red Voles which either do not form roots to their molars at all, or only do so in extreme old age. Hardly a specimen of the Far Eastern species has been found with its molar teeth no longer encapsuled, so that it is of interest to mention that in No. 1625 the capsules have almost disappeared, and the molars appear to be on the point of forming roots. In the Scandinavian *C. rufocanus* roots appear to be formed at rather an earlier period of life, so that that species, while technically genotype, is the least typical member of the genus.

"Rather common in the brush-covered valley-bottoms at Chao-Cheng-Shan. Not seen elsewhere."—*M. P. A.*

19. Lepus swinhoei Thos.

♀. 1572. Tung-chou, on the Peking plain.

♂. 1613. ♀. 1606. 100 miles N.W. of Tai-Yuen-Fu, Shan-si. 8000′.

"Said to be common round Peking, but if so is not easily seen."

"A common species at Chao-Cheng-shan, and near Tai-Yuen, as indicated by the number of tracks, but difficult to secure as they do not flush till one is close upon them."—*M. P. A.*

20. CAPREOLUS BEDFORDI Thos. (Plate XXXII.)

Abstr. P. Z. S. 1908, p. 32 (June 16).

♂. 1612, 1614 (skulls only). ♀. 1615. 100 miles N.W. of Tai-Yuen-Fu, Shan-si. 8000′.

Size rather larger than in the European *C. capreolus*, therefore much smaller than in *C. pygargus*. Horns comparatively small, therefore not like those of *C. tianshanicus*.

General colour above of a winter specimen buffy clay-colour, rather paler than the tone often rather loosely called "red" by sporting writers, therefore very different from the greyish brown of *C. capreolus*. Under surface dull whitish. the hairs grey at base, then whitish, washed terminally with pale fulvous. Head rather more rufous. Area behind nostrils blackish, but, at least in the winter coat, without the marked black band characteristic of *C. capreolus*. Lips, both upper and lower, and chin dull white, without blackish marks laterally. Hairs of throat "drab-grey," with whitish tips. Ears grizzled buffy and blackish, with darker edges, their internal surfaces whitish. Limbs dull buffy or pale tawny, more fulvous proximally, paler distally.

Skull larger than that of *C. capreolus*, markedly smaller than in *C. pygargus*. Horns comparatively slender, with the usual three tines.

Dimensions of the type, measured in flesh:—

Head and body 1125 mm.; hind foot 310; ear 130.

Skull of type—condylo-basal length 186 mm.*

Skull of old male—condylo-basal length 207 mm.; greatest breadth 95; length of nasals 70; interorbital breadth 57; palatal length 126; length of upper tooth-series 66.

The condylo-basal lengths of two adult males of *C. pygargus* are 221 and 225 mm., while in a pair of *C. capreolus* this measurement is 184 (♂) and 181 (♀).

*Type*. Old female. B.M. No. 8.8.7.99. Original number 1615. Collected 25 November, 1907.

Although the original description is of a character to make identification difficult, I have little doubt that this is the Roe described by Noack † as *C.*[*ervus*] ‡ *pygargus* var. *mantschuricus*, but this name, being preoccupied in the genus *Cervus*, was invalid *ab initio*, and cannot be reinstated (as was done by Lydekker §), whatever genus the animal is afterwards proved to belong to.

Under these circumstances I have particular pleasure in naming it after the Society's President, the Duke of Bedford, K.G., in

* Slightly distorted, probably below the normal size.

† 'Humboldt,' viii. p. 9, 1889.

‡ That the *C.* stands for *Cervus* and not *Capreolus* is clear from the fact that in this paper the whole of the Cervidæ are included in one genus, the subordinate genera being barely accorded the rank of "groups."

§ 'Deer of all Lands,' p. 231, 1898.

recognition both of his carrying out of the present exploration, by which our knowledge of the Mammals of the Far East is being steadily revolutionized, and of the fact that his own personal acquaintance with the *Cervidæ* and his wonderful collection of living Deer at Woburn have been the basis of much of the considerable ncrease in our knowledge of the group which has taken place of recent years.

"A common deer about the edges of the forest at Chao-Cheng-Shan. They were to be seen at all times of the day in groups of two to five. Rarely were they solitary. During one long tramp I saw fourteen in the day."—*M. P. A.*

## 2. On a Case of Imperfect Development in *Echinus esculentus*. By James Ritchie, M.A., B.Sc., The Royal Scottish Museum, and D. C. McIntosh, M.A., B.Sc., F.R.S.E.*

[Received May 7, 1908.]

(Plate XXXIII.† and Text-figures 138–142.)

The description of abnormalities is of special value when these are of unusual character and occur in a species little liable to deviation from the type. Moreover, there has not hitherto been recorded any case of the special degree of abnormality illustrated by our specimen. Therefore it is that we venture to set down these observations, in spite of the fact that it seems impossible to account with certainty for the origin, or even to determine precisely the status, of the abnormality (whether it should be regarded as an example of congenital variation, or simply as a case of arrested development due to functional disturbance of the organism by some external factor).

The specimen, an example of the most common British Sea-Urchin (*Echinus esculentus* Linn.), for which we are indebted to Dr. A. Bowman, of the scientific staff of the Scottish North Sea Fishery Investigations, was obtained by him, in July 1907, in Basta Voe, Shetland, where it was trawled from a depth of twenty-four metres. In a note regarding it Dr. Bowman says:—"The malformed Urchin occurred amongst a number of typical ones. Unfortunately I took no notice at the time of any peculiarity in the living animal. . . . The sport was not noticed until the spines etc. were nearly all cleared off. I thought at first it was an unusually flat variety."

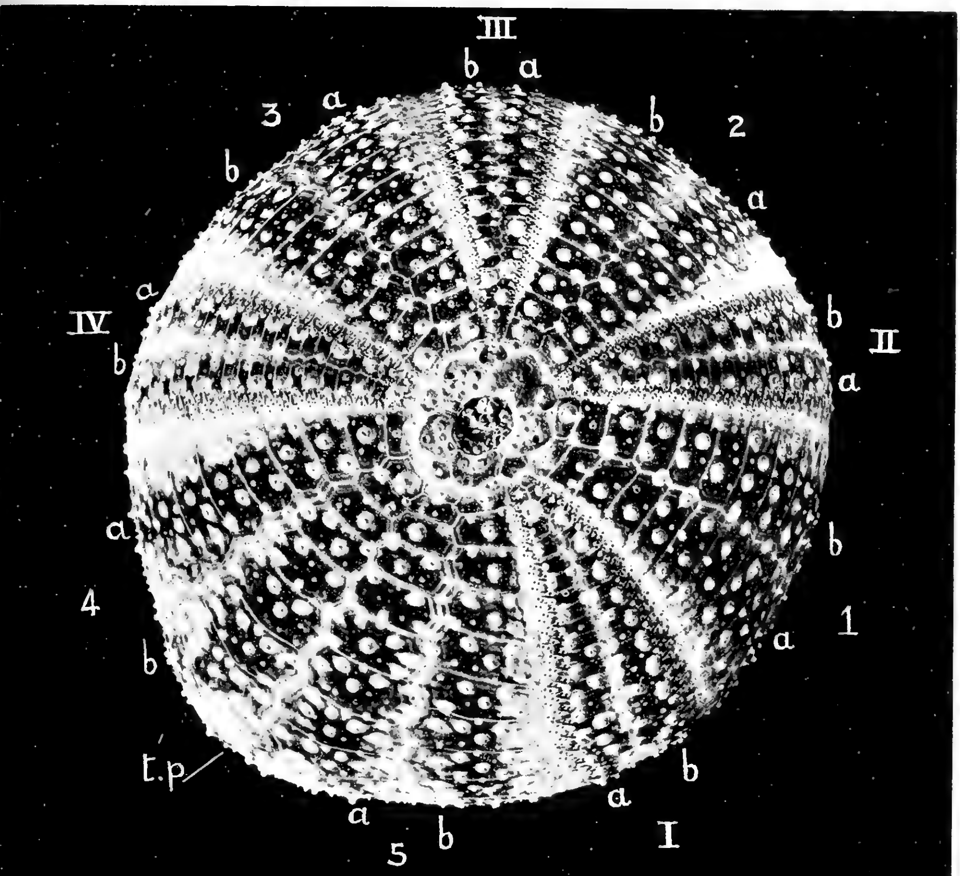
### Description of Specimen.

#### (a) *General Description—Shape, Symmetry, &c.*

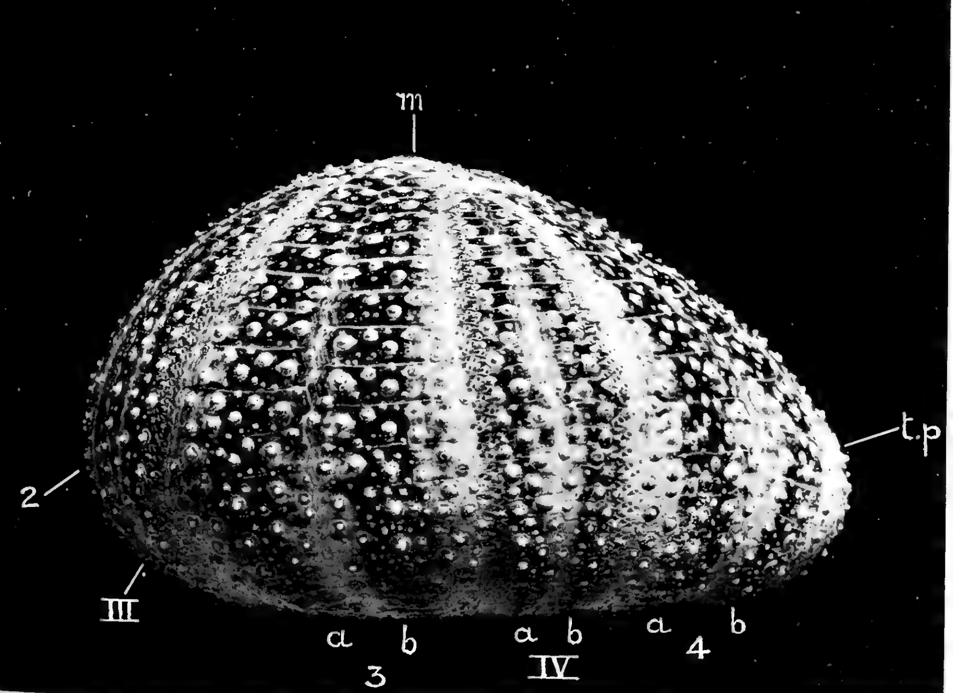
At first sight the specimen appears to be, as Dr. Bowman had noted, merely a rather flat variety, with a large oral surface and

* Communicated by F. A. Bather, D.Sc., F.Z.S.

† For explanation of the Plate, see p. 661.


III
b a
3 a
b 2
b
a
a
IV
b
b
II
a
a
b
4
1
b
a
t.p
b
a
a b
5
I

1


m
t.p
2
III
a b
3
a b
IV
a b
4

2

a depressed apical region. Closer investigation, however, shows that the general shape has departed considerably from the normal. Viewing the test in plan, one sees marked divergence from the apparent radial symmetry characteristic of regular Sea-Urchins. This is due to a distinct bulging on the side remote from the madreporite, which has caused the ambitus to assume a bilaterally symmetrical, almost oval shape (Pl. XXXIII. fig. 1). The same portion, moreover, viewed in elevation, is seen to be considerably depressed as compared with the globular form which characterises the other regions (Pl. XXXIII. fig. 2). Further, it is to be noted that the apical disc has departed from its normal horizontal position, the madreporite standing at a distinctly higher level than the plates on the opposite side of the periproct, for these appear to have been dragged downwards towards the bulging portion of the test. On the oral surface the peristomal opening is excentric, it too apparently having been dragged towards the bulging portion, for in that region the margin of the opening is only 29 mm. distant from the ambitus, whereas on the opposite side the distance is 34 mm.

All those deviations from radial symmetry are due to, or at least are connected with, the fact that a portion of one of the ambulacra is absent. Orienting the specimen in the recognised manner, by placing the aboral surface upwards, with the madreporite in the right anterior position, and adopting Lovén's notation, we find that the incomplete area is number V, the left posterior ambulacrum, the tube-foot area of the left division of the bivium. On the aboral surface this radial area is absent, but commencing a little above the ambitus, at the bulging portion of the test, it runs thence to the peristome, being fully represented on the oral surface.

The most noticeable result of this partial cutting out of the ambulacrum, apart from the general distortion of the whole skeleton already described, is that the two sets of interambulacral plates (areas 4 and 5) come together, four rows of interambulacral plates thus occurring in close proximity. The two sets are separated by a zigzag suture, whereas the edges of interambulacral plates abutting against an ambulacral area (that is, the edges corresponding to those bounding the above zigzag suture) are normally straight. Less noticeable are such minor distortions as the divergence of the line of bilateral symmetry, which passes through the middle of areas III and 5, from its normal straightness, owing to a bending of the interambulacral suture in the latter area towards the locality of disturbance. Quite distinct as this deviation is on the aboral surface, on the oral surface it does not exist, the line through areas III and 5 being there perfectly straight. Again, abnormal distortion occurs in the interambulacral sutures of areas 4 and 5, and in the junction between areas 5 and I., all of these lines bending with gentle curves inwards towards the point where the ambulacrum has disappeared. These curvatures are obviously due to an increase in the size of the plates in the direction of their long axes, but, marked as the curves are, the increase in the size of the plates is measurably of small moment. The following comparative table indicates the differences in length (*i. e.*, in the direction of the long axis) and in depth (*i. e.*, at right angles to the long axis) of certain interambulacral plates forming a band, interrupted by the ambulacra, round the skeleton. The

TABLE I.

| Area… | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Plate. Series. | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* |
| 14…… | 18·5×6 | 19·5×6 | 19×5 | 20·5×4·8 | 19×5·2 | 19×5 | 21×6·8 | 18×8 | 18×7·8 | 18×6 |
| 13…… | 20×6 | 20×6 | 20×5 | 20·5×4·8 | 20×5 | 20×5 | 22×6·5 | 20·8×8·5 | 20×7 | 20×6 |
| 12…… | 20×6 | 20×5 | 19·2×4·5 | 19·2×4·5 | 21×5 | 20×5 | 20×5·3 | 17×7 | 18×6 | 20·8×6 |

TABLE showing size-relation between normal interambulacral plates and those most affected by the cutting out of the ambulacral area. The heavy line indicates the relative position of the area of disturbance. The measurements are in millimetres.

missing ambulacrum is truncated opposite the thirteenth interambulacral plate, the plates being numbered from the peristome. The thirteenth plate of each interambulacral area has, on this account, been measured and along with it, for the sake of comparison, the plate which bounds it on the proximal and on the distal side;

so that in the short series of three there are included the plate formed immediately prior to the truncation (12), that formed concurrently with the truncation (13), and that immediately succeeding the truncation (14). The letters *a* and *b* refer to the plate-rows in an area taken in counter-clockwise rotation.

The above measurements indicate that, in those areas (4 and 5) which bound the centre of disturbance, the plates formed concurrently with the disturbance are on the whole slightly longer than the corresponding plates in the other areas, while the plates immediately preceding and immediately succeeding the disturbance are on the whole shorter. But the depth of the plates in the affected areas is in every case greater than the average depth of the corresponding plates in the normal areas. The details here recorded are of value as showing to what measurable extent definite portions of the test have been affected in the effort of the organism to adapt itself to highly abnormal conditions. This phase of regulation will be referred to later.

The following measurements give some idea of the proportions of the test in various directions:—Height = 55 mm.; long axis = 95 mm.; short axis = 89 mm.; circumference at ambitus = 293 mm.

### (b) *Detailed Description—Abnormalities in Plates.*

Examination of the elements which make up the test reveals additional features of interest. The numbers of the plates in the various interambulacral series are:—

TABLE II.

| Area ...... | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Series ...... | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* |
| No of plates.. | 23 | 24 | 25 | 26 | 24 | 24 | 22 | 22 | 22 | 22 |

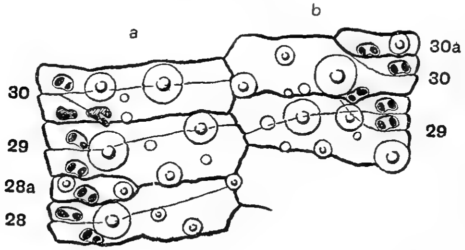
TABLE showing the number of interambulacral plates in the respective series. The heavy line indicates the relative position of the area of disturbance.

In those areas which bound the incompletely developed ambulacrum, all the series have suffered reduction of plates. Roughly, they contain two plates short of the number normal for the remainder of the test. Amongst the interambulacral plates there is little abnormality other than the increase in length and breadth in areas 4 and 5 already recorded, except in the two plates which between them include the termination of the truncated ambulacral area. These, instead of being rudely rectangular, are pentagonal, the extra face abutting against the terminal plate of the ambulacrum; and not only is the aboral half of each longer than the adoral, but the portion facing the ambulacrum is considerably deeper than that remote from it (text-fig. 142).

In the plates of the ambulacral areas there are more frequent departures from the usual form. Fully-developed ambulacral plates are formed by the union of small pore-plates, each bearing a single pore-pair. In *Echinus esculentus* three of these primitive plates formed near the apical area, under the shelter of the oculars, are compressed, by the formation of new plates, to form a compound triad, the ordinary plate of the ambulacral area. Even in the fused plate the original pore-plates can be distinguished by shallow boundary grooves; and we are following the usual terminology in designating the two outer plates, which are bounded on one side by the interambulacral area and on the other by the zigzag intra-ambulacral suture, the adoral and aboral primaries; while the median plate touching the interambulacral area but failing to reach the zigzag suture in its own area, is known as a demi-plate. The three pore-pairs in a compound plate are arranged, not in a single vertical series, but lie in three distinct longitudes. These details of plate structure have been recounted in order to facilitate reference to the abnormalities which occur, and which consist, for the greater part, of an imperfect complement, or an incomplete fusion of the primitive plates which ordinarily go to the formation of a compound ambulacral plate.

In the posterior series, *a*, of the right posterior ambulacral area I (text-fig. 138) the twenty-eighth plate, numbered from the

Text-fig. 138.




I.

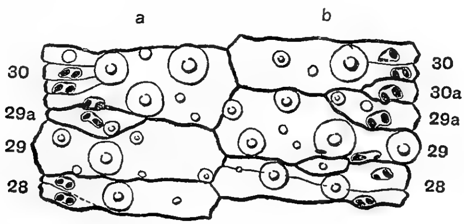
ABNORMALITIES IN AMBULACRAL AREAS OF *Echinus esculentus*.

Roman numerals beneath the figures indicate the ambulacral area in which the abnormalities occur. Arabic numerals alongside the figures indicate the numbers of the plates, reckoned from the peristome. *a* and *b*, series in ambulacral areas. In text-fig. 142 two interambulacral plates are included, and are numbered according to their area, series, and position in series.

peristome, consists of only two complete primaries, a demi-plate being lacking. It is succeeded by a solitary demi-plate, perhaps the remains of the aboral of twenty-eight, the place of which may have been taken by a fully developed median. Twenty-nine is also formed of two primaries; while thirty, complete as regards the number of plates and pore-pairs, possesses an arrangement altogether unusual. The apparent adoral plate is an included plate, for it touches the zigzag suture, but fails to reach the straight suture between ambulacrum and interambulacrum; the demi-plate is present, but instead of being median, it is external, touching plate twenty-nine and lying in the same latitude as the adoral plate; the aboral primary is normal. The pore-pairs of the adoral and demi-plates are surrounded by a deep hollow instead of by the usual faintly-marked peripodal groove. In series *b* of area I the adoral plate of twenty-nine has no pore-pair, but the median and aboral are normal. Plate thirty contains only two single plates, a very deep adoral and an aboral demi-plate. It is succeeded by a solitary demi-plate, the position of the pore-pair of which would indicate that it represents the missing aboral of the preceding plate.

In area II (text-fig. 139), series *a*, the twenty-eighth plate is formed of two simple individuals, probably an adoral demi-plate and an aboral primary, but the obscurity of the sutures renders certainty impossible. Plate twenty-nine is a single primary possessing no pore-pair. It is succeeded by a solitary demi-plate, this again being followed by a compound plate containing four elements, the aboral of which lacks a pore-pair. In series *b*, twenty consists of

Text-fig. 139.



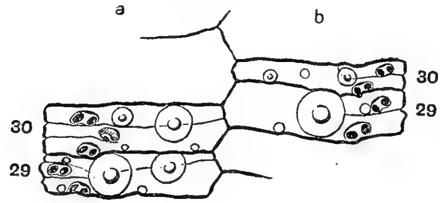

II.

Abnormalities in Ambulacral Areas of *Echinus esculentus*.
(For explanation of the lettering see text-fig. 138.)

a union of six primitive plates, no suture separating a first normal triad from a second, twenty-eight consists of two primaries, twenty-nine of only one, while between twenty-eight and twenty-nine is wedged in a small insulated poreless individual. Succeeding twenty-nine come two separate and distinct demi-plates, the distal about half the size of the proximal; and these are followed by thirty, possessing only an adoral primary and an aboral demi-plate.

In ambulacrum III (text-fig. 140) plate twenty-nine in series *a* contains the normal number of plates, but the aboral is faintly marked and is imperforate. The succeeding plate is also a normal triad, but the peripode of the median element contains only one pore, and must in its present condition have been functionless. It is moreover the nearest to the centre of the plate, whereas the median pore-pair should lie in the outermost row. Series *b* contains two abnormal plates, twenty-nine and

Text-fig. 140.



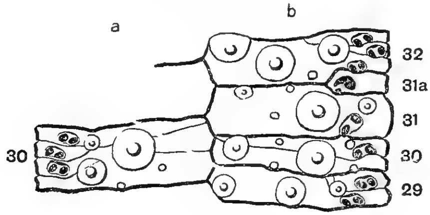

III.

Abnormalities in Ambulacral Areas of *Echinus esculentus*.
(For explanation of the lettering see text-fig. 138.)

thirty, each composed of two pore-plates. The absence of distinct sutures in the first renders identification of plates impossible, but the second is composed of an adoral primary and an aboral demi-plate. Thirty is an intercalated plate having no corresponding individual in the adjoining ambulacral series.

Series *a* of area IV (text-fig. 141) contains but one abnormal plate, thirty, which is composed of four primitive plates, three of which appear to be primaries, only that preceding the aboral being unmistakably a demi-plate. Of the four the adoral is imperforate. In series *b*, twenty-nine is composed of an adoral primary succeeded by a demi-plate; thirty, of two primaries, the adoral without

Text-fig. 141.




IV.

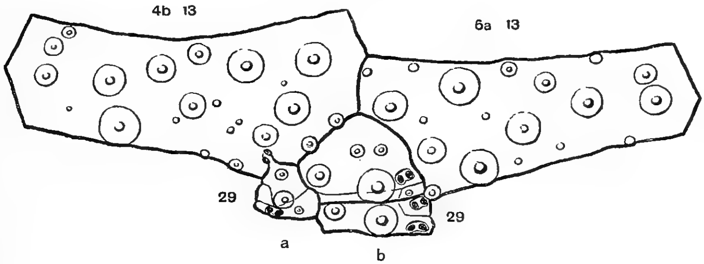
Abnormalities in Ambulacral Areas of *Echinus esculentus*.
(For explanation of the lettering see text-fig. 138.)

pores; thirty-one, of a single huge primary; thirty-one *a*, of a separate demi-plate, perhaps an isolated portion of thirty-one; and thirty-two, of three plates, the adoral a large primary, the other two, small demi-plates crushed into the upper corner of the compound plate. Thirty is an intercalated plate with no corresponding individual in the adjacent row. Thirty-eight is also unusual, being composed of five elements, the adoral and median of which are primaries, while the remainder are demi-plates.

The aboral, however, almost reaches the zigzag intra-ambulacral suture.

Ambulacrum V (text-fig. 142) is the area the development of which is incomplete, and here also abnormal plates occur. In series *a* the twenty-ninth, or last plate of the series, is much deformed, for, while it contains the usual triad, the median demi-plate is poreless; while the adoral and aboral primaries are much misshapen, the latter being roughly square and having its pore-pair lying in

Text-fig. 142.




V.

ABNORMALITIES IN AMBULACRAL AREAS OF *Echinus esculentus*.
(For explanation of the lettering see text-fig. 138.)

a peninsula-like corner almost without the boundary of the plate. In series *b* the penultimate plate, twenty-nine, contains but two elements, an adoral primary and an aboral demi-plate. It is followed by a large rudely-triangular plate whose apex falls at the junction-line of the thirteenth plates of the adjoining interambulacral areas. Each of the terminal plates of this aborted area is bounded on two sides instead of on one by interambulacral plates.

The following table shows at a glance the relative positions of these abnormalities with regard to the respective areas in which they occur:—

TABLE III.

| Area............ | I | | II | | III | | IV | | V | |
|---|---|---|---|---|---|---|---|---|---|---|
| Series ......... | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* | *a* | *b* |
| Total no. of plates. | 49 | 50 | 54 | 54 | 58 | 58 | 53 | 53 | 29 | 30 |
| No. of first plate in each abnormal group. | 28 | 29 | 28 | 28 | 29 | 29 | 30 | 29 | 29 | 29 |

Summarising these observations regarding the ambulacral areas, we find that, of the ten rows of ambulacral plates grouped in the five ambulacral areas, not a single row is free from more or less marked abnormality. Further, all the abnormalities, with two exceptions, are grouped in a band, broken by the interambulacra, which passes round the test at a definite distance from the peristome. The exceptions are the twentieth plate in II *b* and the thirty-eighth in IV *b*.

With regard to the apical disc as a whole there is little worthy of note. The plates are normal in number and arrangement, but the whole disc has become slightly elongated as if the part towards the abnormal area had been dragged downwards by it. Consequently several of the genital plates have lost the bilateral symmetry which usually characterises them. The ocular plate corresponding to the abnormal ambulacrum is of unusual shape, possessing four, instead of five, sides and presenting an angular, instead of an almost straight, boundary to the corona. The ocular pore is absent, but its position is probably indicated by a minute pin-hole, which fails to penetrate to the inner surface of the plate, for neither is there any sign of an internal opening, nor can a strong light pass through.

## Probable Development of the Specimen.

To bring those observations into relation to one another, the most satisfactory way is to trace the probable development of the shell. It is with the idea of attaining an approximation to chronological sequence that the plates have throughout been reckoned *from the peristome*, and not from the apical termination of the series to which they belong. This mode of reckoning has the disadvantage of increasing the difficulty of numerical determination owing to the excessive compression of plates which takes place as the peristomal region is approached, but it has the advantage of following the natural course of development. For it is evident that, since all the coronal plates are formed around the margin of the apical disc and are pushed thence down the sides of the test, the oldest plates will lie around the peristome. Thus, counting from the oldest plates recognisable towards those more recently formed, we get a measure of the age of the animal computed according to a standard, not of time but of development *. Thus, instead of saying that when a certain plate was formed, the test was three months old, a statement which our ignorance of the growth of the Echinoid imago renders impossible, we can say that at that time the test was, say, ten plates old, the actual age of course being indicated by the formula $10+x$, where $x$ represents the number of the plates which have been pushed over the edge of the peristome in any one series. But since we

* Such a measure, it need scarcely be said, is not absolute but comparative, for the first plates, and we know not how many of their successors, have already been pushed over the edge of the peristome and are no longer reckonable. Assuming, however, that in each series the rate of pushing over is approximately the same, we arrive at a measure sufficiently accurate for all practical purposes.

can assume that $x$ is approximately the same for the various ambulacral plate-rows *of the same specimen* at any latitude, it is virtually a constant for a particular latitude and therefore cannot affect our comparison.

In this Shetland specimen the development, up to a certain stage, appears to have been normal. Thus on the oral surface not only is the arrangement of the various rays regular, but the line of bilateral symmetry is straight; while in the minute structure of the plates no abnormalities occur, save the single insignificant deviation on area II *b*, where, although the plates are normal in number and in arrangement, a suture is missing between two triads. We are also justified in stating that during the earlier stages of growth the ocular plate opposite the abnormal ambulacrum was perforated by an ocular pore, and that this pore was occupied by the terminal tentacle of the radial water-vascular system, for in no other way can the presence of the pin-hole already mentioned be explained, seeing that in the ordinary course of development the very existence of the pore is due to the presence of the terminal tentacle *.

At a certain stage, when rather more than twenty-eight ($28+x$) ambulacral plates had been formed, or, judging from young specimens with a similar number of plates, when the test was between 20 and 25 mm. in diameter, some functional derangement took place. As an immediate consequence ambulacrum V ceased to grow, no more plates being added to that area after the thirtieth. But a more general disturbance also occurred, for in each of the rows of the five ambulacra abnormal plates were formed; and in these groups of aberrations, containing sometimes a sequence of as many as five peculiar plates, the first abnormal plate, as a glance at Table III. will show, is the twenty-eighth or the twenty-ninth or, in a solitary case, the thirtieth. This approximation of numbers indicates, as we have already shown, that the plates were formed approximately at the same stage of development; and the significance of the close numerical correspondence between the commencing points of the abnormal series is not lessened when we consider the difficulty of counting the number of plates at the edge of the peristome, and the uncertainty as to the relative numbers that have been pushed off during development. In themselves, considered separately, the abnormalities described are perhaps of little significance, although we have been unable to find, from examination of other tests, that such abnormalities are of frequent occurrence. But that abnormalities so distinct should manifest themselves at all points of the test at practically the same period is indeed remarkable. There can be but one explanation, namely, that a *general* derangement affecting all

* "[Die Primordialtentakel] werden endlich von den sich bildenden Radial-(Ocellar-)Platten deren Rand sie berühren, umwachsen und sind so zu den Terminal- oder Endfühlern geworden. . . . Sie treten dann durch einen Porus der Platte hindurch." Hamann, Otto, "Die Echinodermen"; Bronn's Klassen und Ordnungen des Thier-Reichs, ii. Bd., 3 Abth, p. 1167.

the ambulacral areas took place about the time that ambulacrum V ceased to grow. The derangement was in most cases, however, only a temporary one, for in all the areas, save No. V, the elasticity of the organism appears to have overcome the functional disorder, and after the formation of a few unusual plates, the normal growth was resumed. Nevertheless, a slight indication of after-effect is afforded by differences in the size of the tubercles, for a cursory glance shows that they are smaller above the affected zone than below it. This variation, however, is somewhat discounted by the fact that even in normal specimens a similar, though less marked, difference in size exists between the tubercles above and below the ambitus *.

The disappearance of the two rows of ambulacral plates from area V rendered necessary considerable modifications in the test, and this regulation was carried out mainly in two ways. The plates of the adjoining interambulacral areas increased a little in length and considerably in depth, and closing in around the truncated area came together in the mid-line, where they were united by a zigzag suture. As a direct result of the increase of the plates, the sutures in the neighbourhood became distorted. The increase in the size of the interambulacral plates, however, was not sufficient to make up for the loss of a double row of ambulacral plates measuring over 15 mm. across, hence another modification became necessary in order that the space between the adjoining areas on each side might be spanned. This was brought about by the plates passing directly across the space instead of building a material-wasting globular dome, the result being evident in the flattened portion of the test which lies between the truncated ambulacrum and the apical disc.

The increase in the depth (that is, direction of short axis) of the plates, and the flattening of the surface of the shell have together had the effect of pushing the incomplete ambulacrum further from the apical area, so that it has come to form the centre of a distinct bulge in the outline of the test, while it has also given rise to an abnormally flattened area on the oral surface.

It was perhaps at this period of disturbance that the terminal tentacle disappeared and that fresh deposits of calcareous matter began to close up the unoccupied ocular pore.

## Relation to Previously Described Cases of a Similar Character.

Mr. W. Bateson has brought together the cases of abnormality in the major symmetries of Echinoids recorded prior to 1894 †. The remaining records up to 1902 are mentioned by Hamann ‡.

* F. Jeffrey Bell: 'Catalogue of British Echinoderms in the Brit. Mus. (Nat. Hist.),' p. 152. London, 1892.

† Bateson, W., 'Materials for the Study of Variation,' pp. 441 *et seq.*, London, 1894.

‡ Hamann, Otto, *l. c.* p. 1293.

We can find no later reference to new descriptions of abnormalities of a similar nature in major symmetries, although two early cases are mentioned by Gauthier * which Bateson appears to have omitted. The first, a specimen of *Echinobrissus orbicularis*, is described by Cotteau † as having the anterior ambulacrum completely atrophied; the second, a *Pyrina ovulum*, in which the right posterior ambulacrum was wanting, has also been described by Cotteau ‡.

The majority of the cases cited belong to fossil forms, this being no doubt due to the greater readiness with which an abnormality may be detected in a clean fossil test than in a recent well-preserved specimen, where plate-groupings are obscured by epiderm and spines. The cases to which the present example bears closest resemblance are those grouped by Bateson in his class (2), wherein the specimens are distinguished by the "partial or total disappearance of a definite ambulacrum or interambulacrum." At first glance the parallel between the Shetland specimen and the *Echinus melo* described by Philippi § appears to be almost complete, but in that case, as in the specimens described by Bell ||, Chadwick ¶, and Osborne **, the defaulting member constitutes a complete morphological system, the homologue of an Asteroid ray, whereas in the present specimen only the ambulacral portion of a ray has suffered reduction. There is a much closer resemblance to specimens of *Hemiaster*, described by Gauthier ††, in which only the ambulacral portion of a ray has disappeared. Of those specimens the case of *Hemiaster batnensis*, No. I, appears to show the closest analogy. There the corresponding ambulacrum, the left posterior, has partly ‡‡ disappeared, having at a certain stage received a check in development, the stage being indicated by the dying out of the ambulacral pores and by a slight depression in the test. As a consequence four sets of interambulacral plates follow one another without interruption, and the posterior interambulacral suture

* Gauthier, M. V., "Sur quelques Échinides monstrueux appartenant au genre *Hemiaster*." C. R. Assoc. Franc. pour l'avanc. des Sciences, 13th Sess., 1884 (Paris, 1885), p. 259.

† Cotteau, G., Echinides nouveaux ou peu connus, 1862, p. 66, pl. ix.

‡ Cotteau, G., *l. c.*, 1867, p. 133, pl. xviii.

§ Philippi, F. W., Arch. für Naturg. iii, 1837, p. 241, and plate.

|| Bell, F. Jeffrey, Journ. Linn. Soc. (Zool.), xv. 1881, p. 126, and plate.

¶ Chadwick, H. C., "Note on a Tetramerous specimen of *Echinus esculentus*". Trans. Liverpool Biol. Soc., 1898, p. 288, and plate.

** Osborne, H. L., "A case of variation in the number of ambulacral systems of *Arbacia punctulata*": American Naturalist, vol. xxxii. 1898, p. 259, and figs. (The reference to Lang's 'Comparative Anatomy,' vol. ii, p. 321, is evidently a slip for p. 341.)

†† Gauthier, M. V., 1885, *l. c.*, p. 258, and plate.

‡‡ Bateson seems to err in placing this example among those in which "one ambulacrum is *wholly* wanting in the affected radius" (*l. c.* p. 443); for while the functional part of the ambulacrum is not represented on the test as found, yet in the earlier stages of development the ambulacrum apparently did exist, for beyond the point where the ambulacral groove ought to run "apparaissent quelques paires de pores arrondis, qui continuent l'aire ambulacraire de l'autre côté [that is, the oral side] du fasciole." Gauthier, *l. c.*, p. 259.

has become somewhat distorted. As in our case also, the complement of apical plates is perfect, while the ocular pore (Bateson says merely "ocular") corresponding to the imperfect area is absent. There is therefore a remarkable correspondence between the two examples.

## Possible Origins of the Abnormalities.

In the majority of such cases as have been described, authors have made no reference to the probable origin of the abnormality. Gauthier dismisses the case of *Hemiaster batnensis*, above mentioned, with the rather depreciatory remark, "il ne présente qu'une simple atrophie." Bateson in his remarks prefacing the summary of the Echinoderm variations, says that "it cannot be doubted that the variation[s] seen in Echini . . . are truly congenital. Similarly, though in *Asterias*, &c., reduction in the number of arms might otherwise be thought to be due to mutilation, it cannot be so in Echini." * But while the majority of the abnormalities appear to be congenital, so sweeping a statement must be avoided, since it would preclude our even considering the possibility of reaction to immediate external influences. For, although in the meantime we cannot definitely point to any member of a major symmetry which has demonstrably suffered alteration through external factors, the occurrence of such alteration is not at all improbable, considering the extraordinary sensitiveness of Sea-Urchins to unusual conditions of environment †.

Hamann, realising the difficulty of confining attention to only one of several possible causes, says, in his résumé of the form-abnormalities in Echinoids, that, should the aberrancies not be due to discontinuous congenital variation, their origin might be set down to loss and subsequent regeneration or to fusion ‡. Renamed in accordance with this conception of the potential influence of external factors, Class (2) of Bateson becomes, according to Hamann, that of incomplete regeneration ("unvollständige Regeneration"). But even this conception confines the possibilities within far too narrow limits. "Loss" implies the previous existence of some part which disappears, and it

* Bateson, 1894, *l. c.* p. 433.

† Lo Bianco states that on the coast-line, where, previous to the 1906 eruptions of Vesuvius, thousands of Echini had been scattered on the rocks, not a single *live* specimen could be found subsequent to the ash showers. None of the other marine invertebrate groups mentioned by Lo Bianco suffered to the same extent as the Sea Urchins. Lo Bianco also demonstrates that in the case of the artificial introduction of ashy material into a vessel containing Echini, the Echini had already begun to putrefy on the morning of the third day after the experiment began, while two days later the organs were completely macerated and the spines had fallen off. The rapidity with which the Sea Urchins succumbed shows sensitiveness to derangement of function. Lo Bianco, Salvatore, "Azione della pioggia di cenere, caduta durante l'eruzione del Vesuvio dell' Aprile 1906, sugli animali marini": in Mittheil. Zool. Stat. Neapel, Bd. xviii. Heft i. 1906, pp. 91 *et seq.*

‡ "Wenn die Abnormitäten nicht sprungweise congenitale Varietäten sind so käme für ihren Ursprung Verlust und nachträgliche regenerative Processe . . . . oder Verschmeltzung in Betracht." Hamann, O., *l. c.*, p. 1294.

is almost impossible to conceive that, in a Sea-Urchin where the morphological systems are welded together into a united whole, a definite area could be lost in part, in the way that the arm of a Starfish could be lopped off. It is possible to conceive, however, that damage to the growing point of an area might check, temporarily or permanently, the growth of that area. Moreover, it is not necessary to suppose that the damage be followed by regeneration, although test-regulation must be an almost inevitable consequent. We assume that, since the whole question is one of major symmetries, the regeneration referred to by Hamann is regeneration in a major symmetry as a whole (*i. e.*, the equivalent of the regrowth of the arm of a Starfish) and not the insignificant substitution of new plates for broken ones, a form of regeneration the comparative triviality of which is better indicated by the term *replacement* (the *réparation* of Prouho).

On account of these difficulties the phrase "incomplete regeneration" cannot be taken to comprehend the connotation of Bateson's Class (2), for neither loss nor regeneration is an essential agent in producing such results as are included in that class. As a wider designation and one which seems to include most of the possibilities, we suggest *arrested development*.

Congenital variation—facile phrase—might well account for the original abnormalities, and test-adaption for the subsequent and consequent distortions. But as an alternative to congenital variation, reaction to immediate external influences appears to offer an explanation as probable and more simple. Although lack of experimentation renders conjecture somewhat hazardous, it is possible that some voracious enemy * or some wave-borne rock fragment might break not only the newly-formed and extremely delicate plates at the apical end of an ambulacral area, but along with them might damage, either indirectly, by destroying the controlling nerve, or directly, that portion of mesenchyme in which the ambulacral plates are built up. The check to further development received by the ambulacrum would give an opportunity to the interambulacral plates on each side to push outwards and usurp the position hitherto occupied by the ambulacrum; and even if new generative mesenchyme were thereafter to be regenerated in the old ambulacral position, it is conceivable that by an adaptation of function these new plate-forming cells might, instead of forming new and independent plates, reinforce the interambulacral-forming cells, by depositing their calcareous material along the edges of the interambulacral plates. Such reinforcing power would account for the greater depth which characterises the interambulacral plates between the abnormally truncated ambulacrum and the apical disc. That in such a case

* Prouho has observed young Mullets not only snatching off the spines but even raising the epiderm on the surface of *Dorocidaris papillata*. Such a wound is sufficient to cause the underlying plates to be thrown off and replaced. Prouho, H., "Recherches sur le *Dorocidaris papillata* et quelques autres Echinides de la Mediterranée": in Arch. Zool. Expér. ser. ii, vol. 5, 1887, p. 250.

broken plates would remain to demonstrate the occurrence of an accident is not to be expected, for the researches of Prouho* show that, in *Dorocidaris papillata* at least, broken plates are rejected and are replaced by new ones. All therefore that one could expect to find in place of the plates originally damaged would be plates irregular in outline and in structure, and such exist in our specimen at the truncated end of the ambulacrum (*vide* p. 653).

It is more difficult with a particular-accident explanation to account for the abnormalities which occurred on all sides of the test simultaneously with the destruction of the ambulacrum. A serious accident to any animal is followed by a general loss of vitality, and such a loss is very likely to be reflected in those parts which are in most delicate equilibrium, that is, in the parts where growth is taking place. Of the thirty abnormal plates which occur in the band coinciding with the truncated ambulacrum, twenty-two are deficient in the number of primitive plates of which they are composed, while of the remaining eight, four are deficient as regards the possession of pore-pairs. These deficiencies agree well with the idea of loss of vitatility, for they seem to indicate that at that period, primitive plates were formed with less than the usual rapidity, the result being that owing to the decrease of pressure from newly-formed plates, only two pore-plates, instead of three, were compressed to form a compound ambulacral plate.

An explanation of the abnormalities in the Shetland specimen such as that given above is of necessity largely conjectural. Whether it altogether meets the requirements of the case must be left to the decision of experiments, in which the natural conditions surmised are reproduced as nearly as possible by artificial methods.

## Summary.

The imperfect development of this test of *Echinus esculentus* is expressed in :—

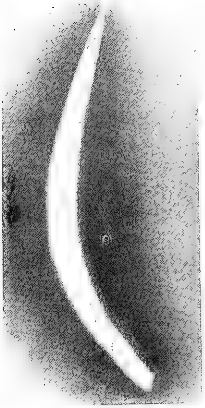
(a) *General shape.*—Flattened, with a bulge at one portion of the ambitus, and above the bulge a depressed area of the corona.

(b) *Major symmetries.*—The left posterior ambulacrum does not exist after its twenty-ninth plate (counting from the peristome). The corresponding ocular plate is present, but its shape is unusual and its pore is a mere pin-hole.

(c) *Plate details.*—On the twenty-eighth, twenty-ninth, or thirtieth plate of each of the ten ambulacral rows a series of abnormalities begins, the abnormalities consisting, for the most part, of deficiencies in the number of primitive plates forming a compound plate.

Less marked divergencies from the normal can be detected in the sizes of some of the plates and in the irregular courses of certain of the sutures.

* Prouho, H., *l. c.* p. 251.



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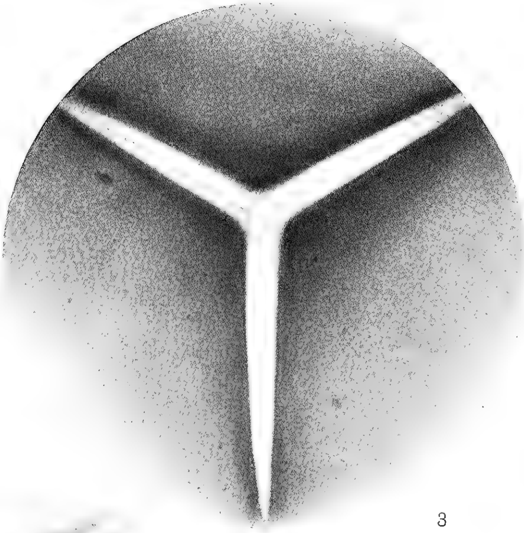

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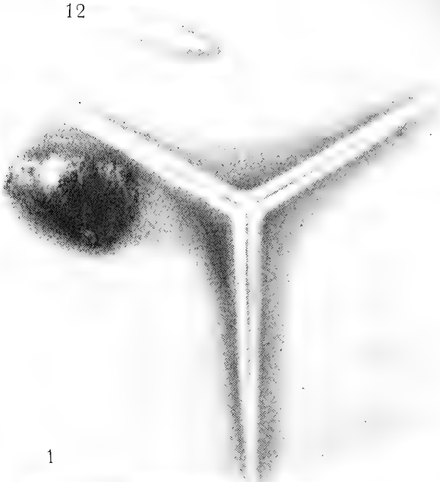

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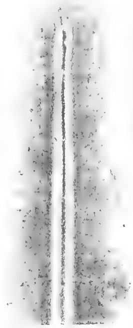

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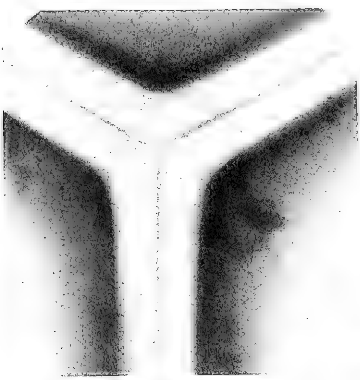

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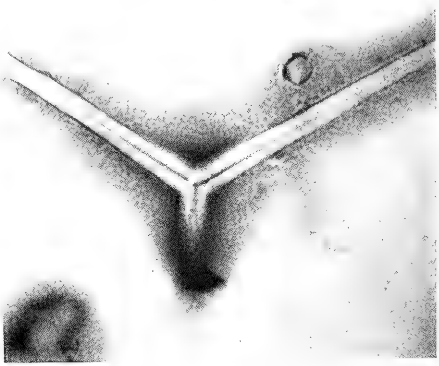

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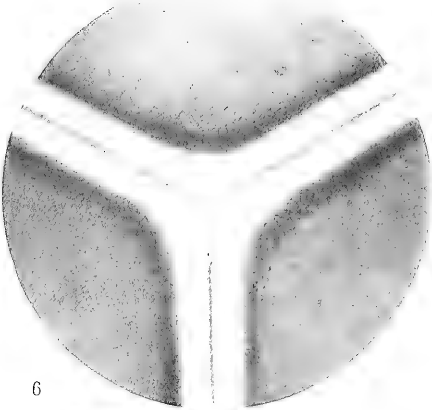

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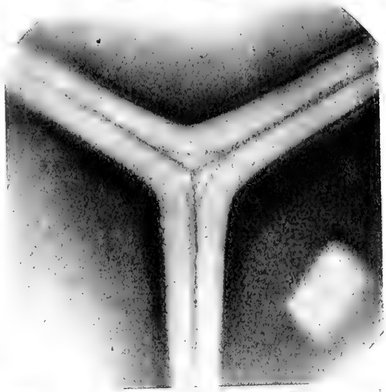

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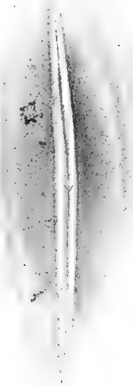

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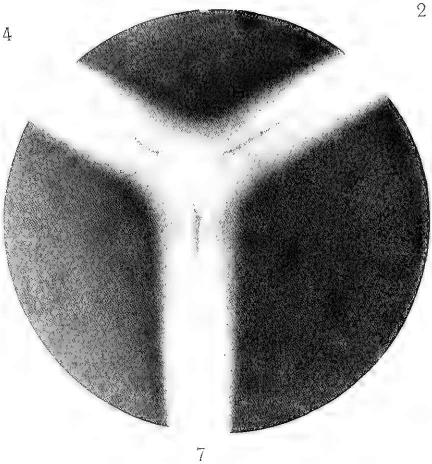

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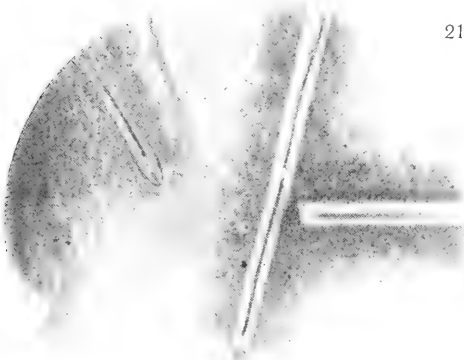
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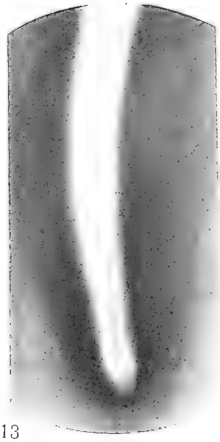

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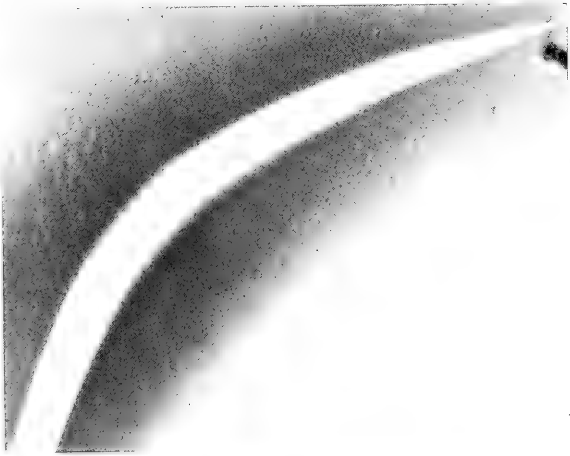

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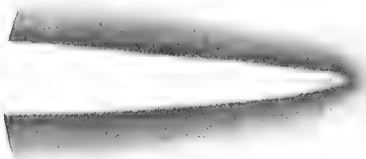

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The stoppage of the growth of the ambulacrum and the plate abnormalities occurred approximately at the same time, and it is suggested that they may be due to functional disturbance caused by some external agent. The distortion of the test subsequent to the arrested development of the ambulacrum has been brought about by a process of regulation.

The specimen of *Echinus esculentus* above described has been deposited in the Royal Scottish Museum, Edinburgh.

EXPLANATION OF PLATE XXXIII.

Fig. 1. Test of abnormal *Echinus esculentus* viewed in plan, natural size.

Fig. 2. Test of abnormal *Echinus esculentus* viewed in elevation, natural size.

Lettering:—*m.*, madreporic plate; *t.p.*, plate which terminates Area V; the remaining symbols indicate the various areas according to Lovén's system.

## 3. Observations on the Minute Structure of the Spicules of Calcareous Sponges. By E. A. Minchin, M.A., V.P.Z.S., Professor of Protozoology, University of London, and D. J. Reid, M.B., C.M., F.Z.S.

[Received May 12, 1908.]

(Plates XXXIV.–XXXVII.*)

### *Introduction.*

The minute structure of calcareous sponge-spicules has been the subject both of much laborious investigation and of many contradictory statements. In regard to the structure of siliceous sponge-spicules investigators are practically agreed upon the following points:—the mineral matter of the spicule, or spicule-ray, as the case may be, forms a hollow tube with a relatively thick wall; in the lumen of the tube, termed the axial canal, is lodged an axial filament of organic nature; the siliceous tube may be homogeneous in structure or may be stratified, that is, composed of concentric layers of silica alternating with fine layers of organic material; and the outer surface of the siliceous tube is enveloped in an outermost layer of organic substance forming a sheath to the whole spicule. Thus in siliceous spicules we find, apparently universally present, the following parts, passing from within outwards:—(1) the axial filament, a definite structure that can be isolated by hydrofluoric acid; (2) the siliceous tube, stratified or homogeneous; (3) the spicule sheath. Turning now to calcareous sponge-spicules, it is found that the only point on which all investigators are agreed is the presence of a sheath enveloping the surface of the spicule. The following brief historical summary of the statements that have been put forward will make this clear.

* For explanation of the Plates, see pp. 675–676.

*Historical Review of the Question.*

Grant (1826 *) pointed out that in certain sponges the skeleton is calcareous, consisting of carbonate of lime, and exhibiting no trace of phosphate of lime. In *Spongia* (*Grantia*) *compressa* he described the rays of the triradiates as "hollow within, shut at their free extremities, and having no superficial openings; but their internal cavities communicate freely at their point of junction and form there a small central reservoir." The monaxons are described as "distinctly tubular and shut at both extremities." Of the triradiates of *S.* (*Leuconia*) *nivea* he remarks, "their internal cavities are very distinctly seen."

Schmidt (1862), on the other hand, included the spicules of calcareous sponges in that category of spicules in which both central canal and lamination were entirely wanting. He considered it beyond doubt, however, that organic substance takes part in building up calcareous sponge-spicules, since heating produces small vesicles in them.

Bowerbank (1864) described the effects of heat on siliceous and calcareous sponge-spicules, and concluded that the latter contained so great a proportion of calcareous matter as to prevent their disintegration by heat. He stated the concentric stratification to be visible in the transverse fractures of any spicule, calcareous or siliceous.

Kölliker (1864), on the other hand, was unable to find any stratification or other internal structure in calcareous sponge-spicules, and considered it doubtful if they contained any organic matter, since no residue was detected if the spicules were dissolved with acids. He described the spicule-sheaths in "*Nardoa spongiosa*" (probably a synonym of *Clathrina contorta*, *vide* Minchin, 1898, p. 533, footnote, and P. Z. S. 1905, ii. p. 17). In siliceous sponge-spicules, however, Kölliker observed and described, in detail, the axial filament and the stratification of the silica.

Lieberkühn (1865) observed in the gastral rays of the quadriradiates of *Leucosolenia* "a fine layer of the contractile substance, which protrudes between the ciliated cells and either envelopes the spicule partially or completely as a fine layer, or only surrounds the foot of it as a stronger thickening (Anhäufung)." These sheaths were left behind when the spicule was dissolved with acetic acid; they were considered by him as retractile. From the description it is evident that the structures observed by Lieberkühn were really the cellular sheaths or gastral actinoblasts enveloping the projecting gastral rays, and not the true spicule-sheaths.

Carter (1869) stated that the spicules of *Grantia ciliata* differ from those of siliceous sponges in lacking a central canal; but in his later note of the same year, he modified this statement and admitted that something like a central canal may often be seen towards the base of the straight arm of a triradiate; while for the most part there is no trace of a central canal nor of the

* For bibliography, see pp. 674–5.

concentric lamination seen in siliceous spicules, although both siliceous and calcareous spicules break with a conchoidal fracture. He points out that a central canal is very obvious in siliceous spicules, "whereas in the calcareous one you can only fancy its existence here and there."

Haeckel (1872) described the structure of calcareous sponge-spicules in a most detailed manner. The spicule-sheaths were stated by him to be structureless envelopes arising as a thickness of, and separation from, the ground-substance; which, it must be remembered, Haeckel regarded as a syncytial mass of protoplasm or "sarcodine" formed by fusion of cells, and not as a secreted gelatinous mesoglœal layer, as it is now universally held to be. Haeckel contradicted Lieberkühn's statement that the sheaths were retractile. Each spicule or spicule-ray, according to Haeckel, consists of a system of numerous very thin concentric laminæ, having the form of hollow cylinders or cones, surrounding a common axis, a very fine central filament. The stratification and the axial filament were stated to be universally present, though the filament was much finer and more difficult to make out than in siliceous spicules, and sometimes not visible unless the spicule were moderately heated, whereby the axial filament was caused to turn brown and then became visible by obliquely transmitted light. The axial filament was stated to run up to the tip of the spicule and become continuous with the "sarcodine," from which it scarcely, if at all, differed in chemical nature. At the centre of triradiates and quadriradiates a small spherical hollow was to be seen, in which the axial filaments unite.

The spicules were stated by Haeckel to consist of calcium carbonate and water together with a varying amount of organic matter, termed by him "spiculin," which was left behind as a colourless and structureless residue when the spicule was dissolved by weak acids. The spiculin substance did not stain in carmine, iodine, &c., and was dissolved by caustic alkalis; its presence was stated to be best demonstrated by moderately heating the spicules. By the amount of spiculin present the spicules could be placed in a series with two extreme types, the one poor, the other rich in spiculin. The two extremes were stated to be distinguishable at first sight under the microscope, the spicules rich in spiculin appearing darker, more refractile than those poor in spiculin, which were dull and pale in appearance. The phylogenetically older forms of spicules, that is to say, the monaxons of simple form and the regular triradiates, were stated to contain least spiculin; the phylogenetically younger forms of spicules, such as the sagittal triradiates, possessed most spiculin.

Lendenfeld (1885) stated that spicules of calcareous sponges consisted of carbonate of lime mixed with organic substance; by treatment with gold-potassium chloride the spicule was shown to consist of "a great number of small prisms, parallel to one another, radiating from the axis," which was "a cylindrical cord of organic matter without lime." The oldest part of the spicule was stated to contain more organic substance than the younger, *i. e.* outer parts.

An entirely new epoch in the study of calcareous sponge-spicules was inaugurated by the elaborate and exhaustive investigations of Ebner (1887), by whom and by Sollas, independently, the peculiar crystalline nature of these spicules was discovered; namely, the fact that each spicule, whatever its form, behaves optically like a single crystal of calcite. As regards the minute structure of the calcareous spicules, Ebner's results differ totally from those of Haeckel. Ebner was unable to find any residue after dissolving the spicules with various acids, and his attempts to demonstrate any such organic residue with stains gave negative results. He explained the optical differences between the two types of spicules, described by Haeckel as rich and poor in spiculin respectively, by the fact that in the regular triradiates the crystalline optic axis is vertical while in sagittal forms it is inclined or even horizontal, in the facial aspect of the spicules. Ebner pointed out further that the "browning" of the spicules produced by heating is not due to the formation of carbon through charring of organic substance, but is due to the disengagement of fine bubbles of gas in the substance of the spicule (compare Schmidt), making it opaque by transmitted light, milk-white by reflected light; with stronger heating the gas breaks up the spicule with decrepitation. Ebner found, however, certain differences between calcareous sponge-spicules and pure calcite, and analysis showed the presence of magnesium, sodium, and sulphates, as impurities mixed with the calcite comprising the spicules.

According to Ebner the axial filament of Haeckel is due to the axial portion of the spicule having a different composition to the peripheral portion, rendering the axis more easily attacked by acids, by the action of heat, &c.; but the difference between axis and periphery is a gradual and quantitative, not a sharp qualitative contrast. Ebner found the alleged stratification to be present only in a few spicules, mostly very large forms. He studied the stratification of the huge triradiates of *Leucaltis solida*, and the large monaxons of *Leucandra aspera* and *L. alcicornis*, and found it also due to a special distribution of more, or less, decomposable substances in different parts of the spicule. Thus the appearance of an axial filament and of stratification are both due to a similar cause, namely, the periodic deposition of more, or less, pure calcite in the building up of the spicule.

Ebner concluded from his observations that the spicules of Calcarea are mixed crystals consisting chiefly of calcite without organic substance, but containing inorganic impurities (Na, Mg, S, probably also water), and that the conditions of the mixture differ at different periods of the growth and in different part sof the spicule.

Lendenfeld (1891), while quoting Ebner's results, reiterated his former statements to the effect that "Each spicule-ray consists of a thin, somewhat turbid (*trüb*) axial thread, enveloped by the hyaline (*glashell*) spicule-substance. In the latter a concentric stratification round the axial filament is to be recognised" (*l. c.* p. 369).

Minchin (1898, p. 569) stated that the spicules of *Clathrina coriacea*, if treated with picro-nigrosin (saturated solution of picric acid in water, 9 volumes; 1 °/₀ nigrosin in water 1 vol.), showed the sheath and the axial filament, left behind after solution of the calcareous matter, and stained blue by the nigrosin.

Bütschli (1901) published elaborate investigations upon the minute structure of siliceous and calcareous sponge-spicules, taking the large monaxons of *Leucandra aspera* as examples of calcareous spicules. His results were, in the main, confirmatory of Ebner's. He found that moderate heating produced a finely alveolar structure in the spicule. No axial canal or filament was found to be present; the axial thread, sometimes visible after moderate heating, was stated to be due to a modification of the calcareous substance, which at the central part of the spicule was distinguished from the remaining part by greater refractility and by being more easily attacked by acids. No trace of an axial filament or sheath was found when spicules were dissolved by acetic acid. The stratification was ascribed to the concentric arrangement of the minute alveoli composing the spicule.

Unlike Ebner, Bütschli found small quantities of organic substance left when the spicules were dissolved with hydrochloric acid. The spicule-sheaths were found to be not purely organic in nature but to contain a certain amount of inorganic matter, probably calcium carbonate.

Maas (1904) and Weinschenk (1905) agree in assuming that the calcite of the spicule must be combined with finely divided organic substance. Maas explains the solvent action of caustic alkalis on the spicules by the supposition that the caustic attacks a substance holding together the constituent particles, and so produces a disaggregation of calcareous elements which were formerly crystallographically orientated. He considers the phenomena seen on heating to be explicable also on the assumption of a finely distributed organic material in the spicule; and he showed that when the sponge is grown in water deprived of $CaCo_3$ the organic substratum alone of the spicule is secreted. Weinschenk dwells on the differences between calcareous sponge-spicules and pure calcite, and considers these differences, and also the peculiar form of the spicules, explicable only by the presence of a fine organic tissue in the spicules.

Bütschli (1906) controverts the statements of Weinschenk upon certain points which are of secondary importance for the subject of this memoir, and maintains his former position. He denies that the opacity and decrepitation produced by heating is due to the presence of organic matter in the spicules.

It is seen from the foregoing that opinions are greatly divided upon the question of the structure and composition of calcareous sponge-spicules, and especially with respect to the amount of organic matter present in them. While Haeckel, Lendenfeld, Maas, and Weinschenk assert or assume the presence of considerable quantities of organic substance in the spicules, Kölliker and Ebner allow none at all except in the sheath, and Bütschli admits the existence only of a trace of organic matter and considers even the sheath to be largely inorganic. It should be further pointed out that the two most detailed investigations upon this question, namely, those of Ebner and Bütschli, were based, so far as the composition of the spicules is concerned, on a very limited number of forms; Bütschli, in fact, studied only the large monaxons of *Leucandra aspera*. Hence there is a possibility that their investigations do not cover the whole range of variation that those spicules may present. Both Ebner and Bütschli worked at the largest types of spicule that they could obtain, in order to facilitate the handling and treatment of the material.

### *Observations upon Calcareous Sponge-spicules.*

Our investigations have been directed towards endeavouring to demonstrate the existence of a residue after decalcification, by means of specific stains, as Ebner attempted to do, but without success. It is obvious that if any organic residue were left after decalcification, it might be expected to have an affinity for certain stains and not for others, and might therefore be demonstrable only by means of particular dyes, so that the negative results obtained by Ebner would not necessarily disprove the existence of an organic residue. We obtained in all cases positive results with nigrosin, as stated previously by one of us (Minchin, 1898), and also with the allied stain indulin. In our investigation we have made use chiefly of the spicules of *Clathrina contorta*, but we have examined the spicules of several other species: of Clathrinidæ, *Clathrina clathrus* and *Ascandra falcata*; of Leucosoleniidæ, *Leucosolenia lieberkühnii* and *L. complicata*; and of Heterocœla, *Sycon ciliatum*, *Leucandra aspera*, and *Heteropegma nodus-gordii*.

Our method of procedure was as follows. A piece of the sponge taken from a specimen preserved in alcohol was washed in water and placed in a tube of a small hand-centrifuge with a few drops of Eau-de-Javelle, and gently shaken. In a short time, generally about half-a-minute, the sponge is dissolved into a cloud of spicules. The tube is then filled up with distilled water and shaken up, and then with the centrifuge the spicules are driven down to the bottom of the tube. The liquid is then carefully poured off, taking care not to disturb the spicules, the tube is filled up again with water, shaken up, and the process repeated. In this way the spicules can be given three or four washings in as many minutes, and are freed both from organic matter of the sponge-body and from the Eau-de-Javelle. The next procedure was usually to add to the tube containing the spicules in distilled water a few drops of ordinary glycerine and albumen-solution, such as is used for sticking sections on slides. The spicules were shaken up in this and then centrifuged down, after which a drop or two of the fluid, with the spicules, was drawn up with a pipette, spread out on a slide, and dried off on the paraffin oven. When dry, the spicules were fixed on the slide by plunging it into absolute alcohol, whereby the glycerine is extracted and the albumen coagulated. The spicules can now be decalcified and stained in any way that is desired. Other methods of imbedding and fixing the spicules were also tried but were not satisfactory. By means of the albumen solution, provided that neither too much nor too little be used, good permanent preparations of the decalcified and stained spicules can be made and mounted in Canada balsam.

In addition to this method, spicules in distilled water, without addition of albumen, were treated with acids and stains and the effects of them watched under the microscope. Since the spicules treated in this manner were not fixed to the slide, it was impossible to wash out the stain and mount them permanently in Canada balsam, but it was possible to observe in detail the effects of the acids and stains upon the spicules, and there was the advantage that the results were not complicated by the presence of the albumen, which is itself stained by both nigrosin and indulin.

### *The Spicules of* Clathrina contorta *.

We shall begin with an account of the results attained with the spicules of *Clathrina contorta*, of which we had a very abundant material; the differences presented by other species will be noted subsequently. Spicules fixed to the slide with albumen were treated for about half-an-hour with a combination of an acid and a stain in the following proportions:—

| | |
|---|---|
| $\frac{1}{2}$% to 1% of acid in distilled water, except in the case of picric acid of which a saturated solution was used ............................ | 9 vols. |
| 1% stain in distilled water ........................ | 1 vol. |

In this way, picric, nitric, acetic, and hydrochloric acids were combined, respectively, with either nigrosin or indulin as a stain. After staining for 20 minutes or half-an-hour, the preparations were washed with distilled water, absolute alcohol, oil of cloves, and mounted in Canada balsam. The results in all cases were the same. The spicule was completely decalcified, and left behind a deeply stained sheath, and an axial filament in each ray (figs. 1–10). The best and clearest results were obtained with the picric acid combinations; with the other acids the filaments were stained just as deeply, but there was a frequent tendency to form a flaky deposit which obscured the result.

* For an account of the spiculation and nomenclature of this sponge, see Minchin, P. Z. S. 1905, ii. pp. 3–20.

The same combinations of acids and stains were also applied to the spicules placed on the slide in water, without any albumen. When treated in this way, the sheath of the spicule stains so deeply as to largely obscure the axial filament, either on account of the spicule being exposed on all sides to the action of the stain, or because the preparation does not go through the processes of washing and clearing necessary for a permanent preparation, processes which probably extract a certain amount of the colour. The deep colour of the sheath is especially marked in the combinations with nitric, hydrochloric, and acetic acids, more so than with picric acid. The fact that the sheath stains so intensely is of interest, since it shows that the action of Eau-de-Javelle in isolating the sponge-spicules does not destroy the sheath. When the spicules are fixed to the slide with albumen, each spicule appears after treatment with the combined acid and stain as a space or mould in the layer of albumen limited by a deeply-stained contour (compare fig. 1, Pl. XXXIV., fig. 5, Pl. XXXV., and fig. 8, Pl. XXXVII. especially); but since the albumen takes the stain also, the sheath cannot be distinguished with certainty as a structure separate from the enveloping albumen, in spicules fixed in this way. The fact that the spicule-sheath is not dissolved in Eau-de-Javelle is in favour of Bütschli's view that the sheath is chiefly inorganic in nature; a conclusion founded by him on the observation that the sheath could be isolated by means of caustic potash (35°/₀), though this reagent dissolved the rest of the spicule, and that sheaths so isolated were dissolved by strong acetic acid.

When the processes of decalcification and staining were watched under the microscope, it was observed that the picric acid combinations did not break up the spicules so much as the other acids, even when these were used in strengths much lower than those quoted above. With picric acid and nigrosin combined, the filament appears first at the tip of the ray, and as the decalcification goes on, the filament appears as if traced by the tip of the gradually receding calcite, until it reaches the centre, when decalcification is complete. With hydrochloric and nitric acid combinations the decalcification does not go on so regularly; fragments of the spicules are frequently seen to be cut off from the rest of the spicule, and when separated, the fragments rush along to the tips of the rays as if impelled by powerful currents. The violence of the action of the acid was most marked with hydrochloric, less with nitric, and least with acetic acid; it probably accounts for the fact that the axial filaments are not, as a rule, so well shown with these acids as with the picric-acid combinations.

In addition to the combinations of acids and stains mentioned above, many experiments were made with acids and stains used separately. When clean spicules, placed in distilled water on the slide without any albumen, were treated with acids, it was usually observed, especially when acetic acid was used, that the whole spicule seemed to disappear, leaving only the axial thread, without any sheath. Bütschli also (1908, p. 317) was unable to find any remains of the sheath after dissolving the spicules with acid. When, however, the acid was combined with the stain, both filament and sheath were left intact and stained. Hence it is probable that the disappearance of the sheath, when acid alone is used, is due, not to the destruction of the sheath by acid, but to its collapsing on the filament. This conclusion is supported by the fact that when spicules stuck on with albumen are treated with a combination of acetic acid and nigrosin, many of them appear to contain unusually thick filaments, which are seen on closer inspection to consist of the true axial filament together with the collapsed sheath. Acetic acid would thus seem to have a solvent or partially softening action upon the sheath. Bütschli also found (1906, p. 317) that spicule-sheaths isolated by caustic potash were dissolved completely by strong acetic acid, but were preserved by very dilute acetic. Attempts to decalcify the spicules with acid first and then to stain the sheath and axial filament subsequently with nigrosin or indulin, were successful when picric, nitric, or acetic acid were used, but not with hydrochloric acid. Various other stains were used without any effect on the filament, for example carmine stains (borax- and alum-carmine), Kernschwarz, indigo-carmine, &c.

### *Appearance and Structure of the Axial Filament.*

The axial filament occupies a central position in the axis of the spicule-ray. By focussing carefully the upper and lower surfaces of the spicule-sheath in a spicule, decalcified and stained, it can be clearly seen that the filament lies midway between the two surfaces. In the optical transverse section of a ray, such as can be easily obtained in the case of the gastral rays of the quadriradiates (fig. 4, Pl. XXXV.), the filament appears as a black dot occupying the centre of the ray, and can be traced up and down the ray by focussing. The axial filament exhibits a certain amount of tenacity and strength: this is shown by the fact that when the decalcification proceeds irregularly in a spicule imbedded in albumen, detached fragments of calcite may be held still for a time by the filament, until set free either by the filament giving way under the strain, or by decalcification taking place at the centre of the fragment round the filament, after which the loose fragment rushes along inside the sheath of the spicule. In spicules not imbedded in albumen, the sheath sometimes breaks across the ray, after decalcification and staining, but the distal part of the sheath is held on by the filament, which stands a great deal of bending and washing about without breaking across. In such preparations it is clearly seen that the sheath is a very delicate structure, much less strong and resistant than the actual filament.

In the triradiate systems the axial filament appears to start from the extreme tip of each ray of the spicule, and to be continuous at this point with the sheath (fig. 8, Pl. XXXVII.). The terminal portions of the filaments are very slender and delicate, but they soon become thicker as we pass towards the centre of the spicule, and in the greater part of the shaft of each ray the axial filament is a coarse structure very obvious when stained. At the junction of the rays the filament widens out very greatly and forms a cobweb-like arrangement, usually of triangular shape, which may be termed the central triangle, and occupies the centre of the triradiate system (figs. 2, 5–7, Pl. XXXV.). By comparing different spicules, it is seen that the structure of the central part varies. In those spicules which have developed a fourth ray and become quadriradiates, each of the three axial filaments of the triradiate system is continued into the central triangle, but usually not quite to the central point of the spicule: the filament seems to break up as it were, to form the triangle (figs. 6, 7). On the other hand, in the triradiates with no gastral ray, the axial filaments are continued scarcely diminished to the centre and there become continuous, and the central triangle is very faint (fig. 2). This arrangement, though specially characteristic of the triradiates, is sometimes seen also in the quadriradiates (fig. 5).

The monaxons of *C. contorta* were found very difficult to deal with on account of their huge size. In the albuminised preparations they are only partly covered by the albumen, hence the sheath stains very deeply, just as in the triradiates when they are stained without being imbedded. Further, when they are cleared and mounted in Canada balsam after staining, the larger monaxons collapse. Smaller monaxons, however, give satisfactory preparations from which good photographs can be taken (figs. 9, 10, Pl. XXXV.). It is seen that the monaxons contain an axial filament which commences at each extremity of the spicule as a fine thread, and as it passes towards the middle point of the spicule the thread widens out so as to be represented by a double contoured band, which extends through the greater part of the shaft of the monaxon. In some monaxons the band may be quite one-third the width of the spicule; in others it is comparatively narrower.

The monaxons of *C. contorta* require decalcification for not less than half-an-hour, or even longer.

### *The Spicules of other Calcareous Sponges.*

In the Clathrinidæ examined, namely *C. clathrus* and *Ascandra falcata*, we have found the filaments exceedingly distinct, as was noted by Minchin (1898), in *C. coriacea*, when stained by the methods above described; and there is scarcely any difference to be noted except in minor points, from what has been described in *Clathrina contorta*. *Ascandra falcata* is a very favourable object for studying the filaments, especially in the characteristic sickle-shaped monaxons (fig. 12, Pl. XXXIV., and figs. 13, 14, Pl. XXXVII.) which are abundant and easily found, and at the same time are not so inconveniently large as in *C. contorta*. It is seen that in the distal blunt curved portion (fig. 13) the axial filament is very thick, and forms a broad band showing a dark double contour enclosing a central lighter portion; in the proximal straight pointed portion (fig. 14) the filament appears as a single thread, as in the rays of the triradiates. Hence the monaxons of *A. falcata* show a noteworthy difference from those of *C. contorta*, a point to which we shall return.

In *C. clathrus* (fig. 15, Pl. XXXVI., fig. 16, Pl. XXXIV., and fig. 17, Pl. XXXVII.) it was found that in the majority of the triradiates the axial filament terminated abruptly at an appreciable distance from the end of the spicule, and was not continuous with the sheath. This condition is probably correlated with a peculiarity in the mode of growth of the spicules of this species which was pointed out by Minchin (1898), namely, that the apical formative cell or "founder" does not leave the ray, but persists and helps, apparently, to secrete the blunt thickened termination of the ray which characterises this species. In a few cases, however, a continuation of the axial filament up to the sheath could be seen distinctly (fig. 16), but from the shape of the rays it is probable that in such cases the spicules were not quite full-grown.

The spicules of Leucosoleniidæ and Heterocœla examined by us appear, with one exception presently to be described, very different from those of Clathrinidæ. The first impression derived from examination of them is that no axial filament is present. A more careful study reveals a filament presenting a certain similarity to that of the monaxons of *Ascandra falcata*, namely, a broad band towards the base of each ray, which narrows to a delicate filament towards the tip of the ray (fig. 18, Pl. XXXVII.). It is very difficult to get satisfactory photographs of the filament, both on account of its feeble staining powers, and of the difficulty of getting it in focus, due to the frequent curvature of the rays. In connection with the phylogenetic speculations of Minchin (1900, p. 109, and 1908), it is of interest to find so great a difference in the structure of the spicules of Clathrinidæ on the one hand, and of Leucosoleniidæ and Heterocœla on the other hand. It may be pointed out further that, as stated above, the studies of Ebner and Bütschli, with regard to the presence of an axial filament, were based entirely upon examples of the Heterocœla.

An exception, however, to the foregoing statements concerning Heterocœla is furnished by the remarkable sponge *Heteropegma nodus-gordii* Polej., of which, by the kindness of Professor Dendy, we have been able to examine a specimen. In this sponge we find the axial filaments very distinct, especially in the triradiates of moderate size *, in which they present the same characters as in *Clathrina contorta*, and can be photographed easily at low

* For figures of the spiculation of *Heteropegma* see Poléjaeff, 'Challenger' Reports, Zool. vol. viii. part xxiv. (1883) pl. iv. figs. 1, *a–d*.

magnifications. The very large triradiates, however, tend to collapse when decalcified, like the monaxons of *C. contorta*, so that it is difficult to obtain satisfactory preparations of them. In the minute triradiates also the filaments are clearly seen, and present no other difficulties to the photographer than such as are caused by their minute size, and by the fact that the rays usually lie in different planes. A study of the filaments in this sponge brings out a point of some morphological interest. The minute triradiates, as is well known, are of two types of form, regular and sagittal. An examination of the filaments shows, however, that in both forms alike the filaments meet at the centre at angles of 120° (fig. 22, Pl. XXXIV., fig. 23, Pl. XXXVI.) *. Thus the spicules of *Heteropegma* are distinctly Clathrinid in type, and the sagittal forms occurring in this sponge are to be regarded as arising simply by secondary curvature of the rays of a primitively regular triradiate; they may be termed pseudo-sagittal. It has already been pointed out by Bidder (1898) and Minchin (1900, p. 109), that *Heteropegma* is a sponge which stands apart from other Heterocœla and approaches the Clathrinidæ in its characters; and the study of its axial filaments certainly supports these conclusions.

### *The Nature of the Axial Filament.*

If we compare one of the photographs given here (figs. 2, 6–8) of the axial filaments of the triradiate systems of *Clathrina contorta*, magnified 1000 diameters, with the figure of a young spicule of this sponge given by Minchin (1898, pl. 42. fig. 49) at the same magnification, we are at once struck by the fact that the central triangle, as we have termed it, formed by the axial filaments, is nearly as large as the whole spicule at this early stage; much larger, in fact, than the earliest stages of the spicules that can be found.

It was further shown by Minchin (*l. c.* pp. 572–579) that the spicules in early stages of development, when examined between crossed nicols, light up scarcely or not at all. Hence in early stages the spicules must contain very little, if any, crystalline substance, that is to say calcite, but must consist chiefly of non-crystalline substances, perhaps both organic and inorganic. We have referred above to Ebner's statements as regards the inorganic impurities in the spicule. It must be supposed that the first portions of the spicule formed consist chiefly of these "impurities," and that the axis of the spicule, as it grows in length, is also formed of substance containing very little calcite. On the other hand, the portion of the spicule formed later is

* In all the preparations the axial filaments are very liable to become displaced, since they are entirely unsupported after decalcification of the spicule. In the spicule photographed in fig. 23, it can be seen that the filament of the left-hand ray is displaced, but that of the right-hand ray shows the typical regular angle.

almost pure calcite; but the layer formed last of all, namely the sheath, is again an "impure" layer.

Having regard to the mode of formation of these spicules discovered by Minchin (1898 and 1908) and Woodland (1905), it would be a tempting hypothesis to refer the two substances secreted to the activities of the two formative cells; the apical formative cell or "founder" may be supposed to lay down the "impure" substance, while the basal formative cell or "thickener" secretes the purest calcite. On the other hand, the formation of the sheath must also be ascribed to the thickener.

The continuity, generally to be observed, of axial filament and sheath, and the similarity of their staining reactions are points in favour of considering these two structures to be of similar nature. We have referred above to Bütschli's arguments in favour of regarding the sheath as being chiefly of inorganic nature, a conclusion for which there is much to be said, and which may be extended to the axial filament. The fact, however, that both filament and sheath have an affinity for special stains, is in favour of their containing a certain amount of organic matter, and we may regard sheath and filament as consisting of an organic basis richly impregnated with inorganic non-crystalline materials. At this point we must leave the question of the nature of these structures to receive more exact and definite solution from more competent observers. We claim merely to have demonstrated the following proposition:—*The spicules of calcareous sponges leave after decalcification a residue in the form of structural constituents, sheath and axial filament, which can be coloured by special stains.*

In conclusion, attention may be drawn to some points relating to the morphology of the spicules, upon which the axial filaments throw some light. It is seen that in the rays of the triradiates, the filament is broad and even band-like at the base, and tapers to a fine point at the apex. Comparing with this the monaxon of *A. falcata* (fig. 12, Pl. XXXIV., figs. 13, 14, Pl. XXXVII.), it is seen that the filament is broad and band-like at the blunt distal end of the spicule, and tapers to a fine thread at the pointed proximal end. This supports the conclusion, based by Minchin (1908) upon developmental data, that the distal projecting ends of the monaxons are homologous with the central ends of the rays of the triradiates.

Comparing, however, the monaxons of *C. contorta* with those of *A. falcata* (figs. 9, 10, Pl. XXXV.), it is seen that in *C. contorta* the filament is band-like towards the middle of the spicule, but tapers to a fine thread at each end. This strongly suggests that the monaxons of this sponge are not really primary monaxons, but are secondarily derived from triradiates and are to be regarded as biradiates as suggested by Minchin (P. Z. S. 1905, ii. p. 10). On the other hand, the monaxons of *A. falcata* would appear to be true primary monaxons.

## Addendum.

### *Intracellular Networks in the Gastral Layer.*

A point of some interest was observed in a preparation made in the following manner. A piece of the body-wall of *Clathrina contorta* (preserved in alcohol) was stained with picro-nigrosin, and passed through water and alcohols into oil of cloves; then the inner gastral surface was brushed gently with a soft paint-brush to remove the gastral layer of collared epithelium; finally, the piece was mounted in Canada balsam with the gastral surface uppermost. The upper surface of the preparation then showed a delicate honeycomb-like network, stained blue with the nigrosin, enclosing irregular polygonal meshes fairly uniform in size, with here and there a much larger rounded mesh and occasionally a small, circular mesh. As the preparation was not all in one plane, only small stretches of the network could be sharply photographed (fig. 24, Pl. XXXVII.). The polygonal meshes represent spaces formerly occupied by collar-cells, many of which are to be seen still *in situ* in the preparation; the large rounded meshes are spaces left by porocytes; and the small circular meshes are shown by their relations to underlying triradiate systems to be the spaces occupied by the gastral rays of quadriradiates. The network itself is an extension of the gelatinous ground-substance between the bases of the collar-cells and gastral rays and round the inner ends of the porocytes, probably forming a cementing substance, as it were, helping to keep the easily detached collar-cells in their places.

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## EXPLANATION OF THE PLATES.

All the photographs are from spicules stuck on the slide with albumen, decalcified and stained with picro-nigrosin, and mounted in Canada balsam.

Figs. 1–10. *Clathrina contorta.*

Fig. 1, Pl. XXXIV. A triradiate. × 400.
2, Pl. XXXV. The central portion of another triradiate. × 1000.
3, Pl. XXXIV. A quadriradiate, gastral aspect. × 400.
4, Pl. XXXV. A quadriradiate, gastral aspect, at a high focus to show the gastral ray in optical transverse section. × 1000.
5, Pl. XXXV. The central part of a quadriradiate. × 1000.
6, Pl. XXXV. The central part of another quadriradiate. × 1000.
7, Pl. XXXV. The central part of another quadriradiate. × 1000.
8, Pl. XXXVII. The extremity of a ray of a quadriradiate. × 1000.
9, Pl. XXXV. A small-sized monaxon. × 150.
10, Pl. XXXV. Another small monaxon. × 150.

Figs. 11–14. *Ascandra falcata.*

Fig. 11, Pl. XXXIV. Central portion of a triradiate. × 1000.
12, Pl. XXXIV. A monaxon. × 250.
13, Pl. XXXVII. Distal extremity of a monaxon. × 500.
14, Pl. XXXVII. Proximal extremity of a monaxon. ×

Figs. 15–17. *Clathrina clathrus.*

Fig. 15, Pl. XXXVI. The extremities of two triradiates and a broken ray of a third. × 1000.
16, Pl. XXXIV. The extremity of a triradiate. × 1000.
17, Pl. XXXVII. The central part of a triradiate. × 1000.

Figs. 18, 19. *Leucandra aspera.*

Fig. 18, Pl. XXXVII. A triradiate showing the double-contoured filaments. × 250.
19, Pl. XXXVI. A quadriradiate. × 500.

Figs. 20, 21. *Sycon ciliatum.*

Fig. 20, Pl. XXXVI. A triradiate. × 500.
21, Pl. XXXVI. The same triradiate at a slightly lower focus. × 500.

Figs. 22, 23. *Heteropegma nodus-gordii.*

Fig. 22, Pl. XXXIV. A small triradiate (one ray broken). × 1000.
23, Pl. XXXVI. A small sagittal triradiate, showing the filaments; on the left the filament has become displaced. × 1000.

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Fig. 24, Pl. XXXVII. Photograph of the gastral surface of the body-wall of *Clathrina contorta*, stained with picro-nigrosin, the collar-cells brushed off; showing the network left between the collar-cells, porocytes, and gastral rays. Owing to this network not being exactly in one plane, it is not seen all over the photograph. × 1000.

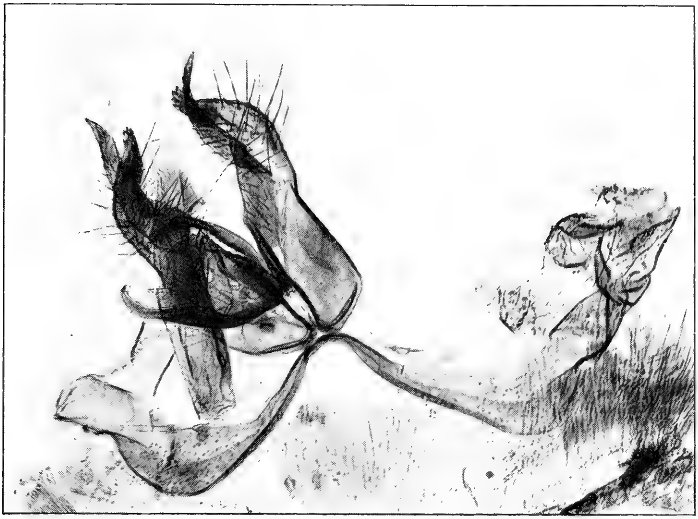
## 4. Two New Genera (and a New Species) of Indian Lycænids. By T. A. Chapman, M.D., F.Z.S.

[Received May 14, 1908.]

(Plate XXXVIII.*)

In trying to gain some knowledge of the genus *Cyaniris* by examining the ancillary appendages, I met with much trouble over *Cyaniris chennellii* de Nicév. I obtained specimens from various sources, and informed various people that they had a *Zizera* or something thereabouts, and not a *Cyaniris*. Herein I was right, but so were they, their insect being *chennellii* de Nicév. I stuck to my guns unnecessarily, largely because Col. Bingham found in his collection a specimen that was certainly not a *Zizera* but probably a *Cyaniris*, and which he had compared with the type of *chennellii* and found to agree. I took it therefore that this was *chennellii*, but could come across no other specimen. I also, of course, assumed de Nicéville to know what was and what was not a *Cyaniris*, and that he would not call a *Zizera*-like species a *Cyaniris*. It turns out, however, that this was precisely what he did do, and in doing which, succeeding authorities appear to have

* For explanation of the Plate see p. 678.



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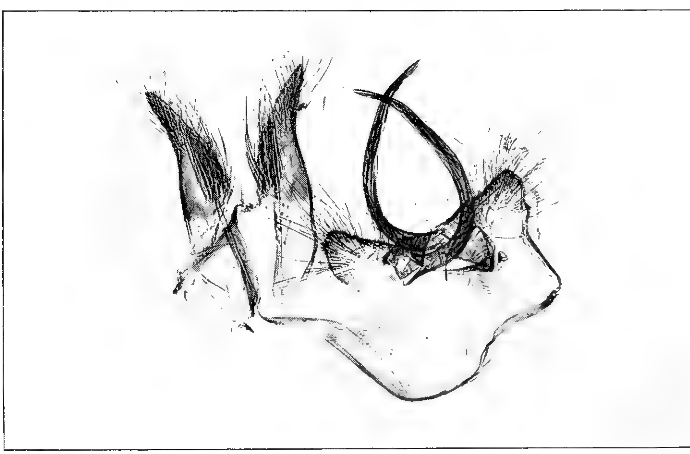


2

Photo F. N. Clark. Bale & Danielsson, Ltd.

ANCILLARY APPENDAGES OF—

1. BOTHRIA CHENNELLII. × 45.
2. NOTARTHRINUS BINGHAMI. × 45.

followed him. Col. Bingham had in his possession (lent from India) the type specimen of *chennellii*, and when I saw this specimen, it appeared at once that it was the insect I had been refusing to recognise as *chennellii*.

*chennellii* has all the aspect of a *Cyaniris*, but the neuration is not that of *Cyaniris* but of *Zizera*. The ancillary appendages are very different from those of *Cyaniris* and also from those of *Zizera*, and approach more nearly to those of *Everes*.

It appears to require a new genus to contain it, and I therefore propose for it BOTHRIA *, n. g.

I would characterise the genus as having *C. chennellii* de Nicéville as type; as closely resembling *Cyaniris* in facies, but having the anastomosing subcostal vein as in *Zizera*; as having the ancillary appendages very different from *Cyaniris* and *Zizera*. The dorsal portion (*tegumen*) consists of a central piece, with two horns jointed to it, both of very similar form and structure to those of *Everes* (*Cyaniris* and *Zizera* have the dorsal armature in two lateral portions, the actual dorsum being merely part of the chitinous ring of the 9th abdominal segment with no armature). The claspers have the two processes (characteristic of Lycænids) of nearly equal size, each being very long and slender but reminding one a good deal of *Everes*. In *Cyaniris* and *Zizera* the ventral, soft (*i. e.*, unarmed with spicules or teeth) process is nearly or quite obsolete.

It remains to deal with Col. Bingham's *Cyaniris*. As a specific description, de Nicéville's description of *chennellii* is all but accurate for this species, which is however a *Cyaniris* (and *chennellii*, as we have just seen, is not).

As a *Cyaniris* it belongs, however, as an extreme instance, to a division that requires a separation generically. This section is especially characterised by each lateral piece of the dorsal armature of the ancillary appendages having a jointed horn or process (as in so many Lycænids) and not merely a simple process, usually rounded and soft but in many species with a more or less developed chitinous point or spike.

I would call this new genus *Notarthrinus*.

### NOTARTHRINUS †, n. g.

Differs from *Cyaniris* in each portion of the dorsal armature of the ancillary appendages having the separate jointed spine (as in *Lycæna*). In *Cyaniris* the spine, when there is one, is merely a chitinous process continuous with its base.

Type, *binghami*, sp. n.

*musina* (and *corythus*, which seems to be identical with *musina*) and *catreus* probably belong to this genus.

* βοθρος a pit, in allusion to the pitfall into which it led de Nicéville. For those who like a little canine flavour to their classics, it may suggest that it is like *both Cyaniris* and *Zizera* without being either, and has perhaps some allusion to the bother which de Nicéville and others did not suffer but passed on to me.

† νοτος αρθρος.

NOTARTHRINUS BINGHAMI, sp. n.

Agrees with de Nicéville's description of *Bothria chennellii*, except that it is without the discal line on the upper side of the fore wing, and the 6th spot of the row on the under side is all but obsolete. A more important difference is that in this row of spots, the first one in *chennellii* is in line with the others, in *binghami* it is markedly moved inwards, as in *argiolus* and many other Cyanirids.

I cannot help a suspicion that de Nicéville had these two species, *chennellii* and *binghami*, mixed (Col. Bingham, also, had not separated them), and when referring *chennellii* to *Cyaniris* had *binghami* in view.

Type in Col. Bingham's collection. A cotype in somewhat finer condition is in the museum at Tring. Col. Bingham's specimen is from Shillong; the Tring specimen is labelled "Khasia Hills, Assam."

EXPLANATION OF PLATE XXXVIII.

Fig. 1. Ancillary appendages of *Bothria chennellii* × 45.

Fig. 2. Ancillary appendages of *Notarthrinus binghami* × 45. The Ædœagus was unfortunately mounted on the slide too far off to come into the photograph. I have not based any characters of genus or species on it.

Both photographs by Mr. F. N. Clark.

## 5. A Contribution to the Knowledge of the Batrachian *Rhinoderma darwini*. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S.

[Received May 26, 1908.]

(Text-figures 143–149.)

I have examined a number of examples of this small Chilian Engystomatid Frog which were presented to the Society by Dr. E. P. Reid some months since. This examination enables me to add something to what is already known concerning this Batrachian, the breeding-habits of which are so remarkable and now so well known through the investigations of Gay, Espada, Howes and others, especially and most recently Prof. Bürger, for the loan of whose memoir written in Spanish I am indebted to Dr. Reid. Dr. Bürger * and Prof. Howes † give lists of the memoirs relating to this species, which I need not therefore recapitulate here. The contributions made respectively by the two authorities mentioned deal with the gular sacs, their structure and development. Incidentally some information is given in these papers concerning the visceral and muscular anatomy with which I have occupied myself for some time past; and so far as the facts go I am able to confirm those authors. As, however,

* La Neomelía de la *Rhinoderma darwini* D. & B., por el Dr. Otto Bürger. Santiago de Chile, 23 pp., 3 pls.

† "Notes on the Gular Brood-pouch of *Rhinoderma darwini*," P. Z. S. 1888, p. 231.

their object was not to enter into the general anatomy of *Rhinoderma*, but only to describe structures associated with the breeding-pouches, there is naturally some room left for a fuller account of this Engystomatid frog, which I specially compare with its African relative the genus *Breviceps*, dissected by myself some time since and referred to in a paper communicated to this Society lately *. *Rhinoderma* is an Engystomatid frog without a narrow mouth. The mouth is not far from being of the ordinary Batrachian capacity. The general aspect also of the species is widely removed from that of *Breviceps*, with which it would certainly not be associated were external characters alone taken into consideration. Externally, in fact, *Rhinoderma* is a typical frog, except indeed for the considerable projection of the upper beyond the lower jaw, and the presence of a narrow projection of the snout region of the head which has nothing to do with the nostrils. This process is not always present, but its presence or absence has nothing to do with sex, for I found the process well developed in one female, and absent in another female, both specimens being of about the same size. I have not, however, examined with care a sufficient number of examples to enable me to contribute any material facts with reference to the development of this "snout" †.

### § *Visceral Anatomy.*

The viscera show a number of differences from those of *Breviceps*.

The *liver* in *Rhinoderma* has not the peculiar form and relations to the heart which I have described in *Breviceps*. It is constituted more on the plan of that of *Rana*. That is, there is a primary division into right and left lobes of which the right is much the larger and is again divided into two lobes. The whole mass of the liver lies entirely behind the heart, which is not in the least hidden by it in the remarkable fashion which I have noticed in *Breviceps*. That this is the case is shown by the attachment to the posterior border of the pericardium of a peculiar muscle, which passes from the body-wall under the lobes of the liver without being attached to them and ends on the pericardium ‡.

The *alimentary tract* is proportionately and roughly of the same general appearance and length as that of *Rana*. There are, however, some differences, especially when the gut is slit up and the characters of the lining membrane in different regions compared with each other and with the corresponding or apparently corresponding sections of the gut of *Rana*. The stomach itself has a tendency to be more spherical in shape than in *Rana*. The part which ensues and corresponds in its position to the duodenum of

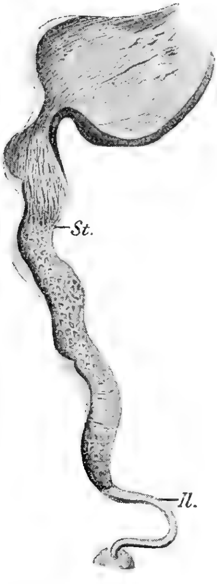
* P. Z. S. 1908, p. 11.

† The skull, showing the cartilaginous basis of this process, is figured by W. K. Parker (Phil. Trans. 1881, pl. 39, figs. i–iv).

‡ This is described below (on p. 684).

*Rana* demands attention before its homologies can be thus rapidly disposed of. Where this tube arises from the undoubted stomach there is no valve or change of a sudden character in its lining membrane. Furthermore, the pancreas does not extend down into the V-shaped loop which it makes with the stomach, and the ducts of liver and pancreas open into the alimentary tract farther up this ascending limb of the gastric U than they are represented to open in *Rana**. I am disposed in fact to assign the greater part of this ascending limb—the first deflection from an antero-posterior course which the whole alimentary tract shows—to the stomach. Its lining membrane has quite the characters of that of the lining membrane of the latter half of the undoubted stomach.

Text-fig. 143.




Alimentary tract of *Rhinoderma darwini* partly opened to show folds of lining membrane.

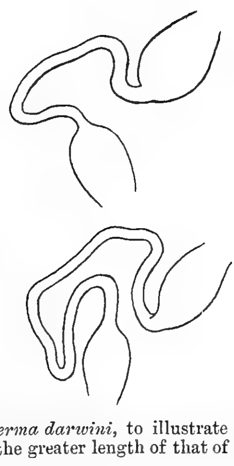
*St.* Posterior boundary of stomach. *Il.* Ileum.

It is very thick and arranged in close longitudinal folds which undergo no change where the tube suddenly lessens in calibre. Later on, a tendency to a reticulate arrangement also observable anteriorly becomes rather more marked. This thick layer suddenly ends near the top of the ascending limb of the V already referred to as characteristic of this and (? all) other frogs. Thereafter the walls of the gut are thin for a considerable distance and the lumen is perhaps slightly wider. The inner surface is very definitely reticulate in a honeycomb fashion. The break between

* Haslam's Translation of Ecker's 'Frog,' p. 296, fig. 195, Dc[2].

this section of the gut and that which precedes is rather in the abrupt thinning of the lining membrane than in anything else. Later on the reticulate arrangement is still retained; but there is a tendency towards emphasising the transversely running folds of the reticulum, but to nothing like the extent that is figured in *Rana* *. These facts are well shown in the accompanying figure (text-fig. 143). The small intestine opens very abruptly into the short dilated colo-rectum. A little way in front of the junction of the two the ileum, as we may term it, becomes somewhat narrower in calibre and it has been for some distance thicker-walled. The end of the small intestine in fact is as thick-walled as that part of the tube (whatever its homologies may be) which immediately succeeds the dilated stomachal chamber. Both these regions contrast very markedly with the thin-walled middle section of the gut. On cutting open, these differences were very apparent. The colo-rectum is also thin-walled—at any rate in comparison with its calibre. The end of the ileum actually projects into it for some distance, like the uterus into the vagina. The figure which I give here of the intestinal tract of *Rhinoderma* (text-fig. 143) may be compared with that of *Breviceps* †, although the former is represented as seen when cut open and the latter is not. I have pointed out in *Breviceps* ‡ that the stomach does not end where it suddenly diminishes in calibre, but that it is clearly continued for a short distance along the upward limb of the U which it forms with the duodenum. I believe that in *Rhinoderma* this extension of the stomach is still greater.

Text-fig. 144.



Alimentary tract of *Rhinoderma darwini*, to illustrate the shortness of that of the male (upper figure) and the greater length of that of the female (lower figure).

The accompanying drawings (text-fig. 144) show the different appearance of the gut in the male and in the female of this frog.

* Haslam, *loc. cit.* p. 288, fig. 189.

† P. Z. S. 1908, p. 32, text-fig. 10.

‡ *Loc. cit.* p. 31, text-fig. 9.

When the body of the male is cut open, the whole of the alimentary tract is displayed and may be seen without moving that tract or adjacent organs. On the other hand, in the female the coils of the gut are rather more complex. The difference, as will be seen, is due to the greater accentuation in the female of the loops of the intestine. This is obviously associated with a considerable difference in the length of the tube in the two sexes. The measurements of two individuals were as follows:—In a male measuring 22 mm. from snout to anus (the anterior process of the snout being omitted) the gut from the commencement of the ascending limb, which may or may not belong really to the stomach, to the point of entrance into the colon of the ileum was only 18 mm. In a female measuring 28 mm. the gut was 35 mm. In the former, therefore, the gut is actually shorter than the body length. It is rather longer in the female.

§ *Uro-Genital Organs.*

The *kidneys* have the flattened leaf-like form that characterises those organs in *Rana*. They were, however,—in an example in which I measured them—proportionately very much larger than in an example of *Rana esculenta*, of which I made measurements for the purposes of comparison. The specimen of *Rhinoderma darwini* measured from the extremity of the snout (this example had not the anterior prolongation so characteristic of the species) to the anus 33 mm. The left kidney measured 8·5 mm., being thus very nearly one quarter of the length of the body—an extraordinary size. In correlation with this great size was the fact that the anterior extremity of the kidney nearly reached the anterior wall of the pleuro-peritoneal cavity, and the fat-bodies were so thrust against that anterior wall by the growth of the kidney that they lay back over it, being directed towards the vent. In a *Rana esculenta* measuring between the same points 175 mm., the length of the corresponding kidney was only 14 or 15 mm. Thus in this Batrachian (possessing a kidney of the usual size—in Ecker's 'Frog' 16 mm. is the length given) the kidney was only one-eleventh to one-twelfth of the body length. The difference is enormous.

The *testes* are spherical, much pigmented, and have the mulberry-like form of those of *Rana*. The fat-bodies in the one male which I dissected were much smaller than in both of two females which I also dissected. And moreover, in all three cases the left fat-body was larger than the right. In view of the peculiarity of the testes in *Breviceps* in possessing only one vas efferens, I was surprised to find that *Rhinoderma* is more normal in that each testis has four or five slender vasa efferentia.

The *oviducts* are long and thick and much coiled, and thus differ from those of *Breviceps*, presuming that the latter were fully advanced in development in the specimen which I dissected. It is remarkable that the proximal part of the oviduct (*i. e.* that section immediately following upon the funnel) in *Rhinoderma* is very short and quite straight, much shorter than is, according to my experience, the rule among frogs. The funnel itself is attached sideways to the surface of the obliquus internus, where that muscle forms the anterior wall of the abdominal cavity, and is of an elongate form, the orifice being a comparatively narrow and terminal slit. The lining membrane is grooved at the mouth of the funnel. The oviducts open into the cloaca by a single common orifice.

### § *The Musculature of the Ventral Surface.*

The *rectus abdominis* shows no great peculiarities of structure. It has five divisions, visible when the skin is removed and no further dissection made. These are divided by four inscriptiones tendineæ. This contrasts in the most marked way with *Breviceps*, where there is but a single inscriptio tendinea. These are all behind the sternum, where the muscle appears to end. The anterior abdominal vein is visible from the last inscriptio tendinea up to just behind the sternum, where it dips down and disappears from view. The abdominal section of the *pectoralis* muscle arises from the first three poststernal masses of the rectus. The sternal portion of the pectoralis is hardly distinguishable from a *sterno-radialis* anteriorly; but the latter—if it exists as a separate muscle—is quite plainly divided off from the adjacent slender head of the deltoid. The posterior part of the *pectoralis sternalis* is distinct from the anterior region in that it comes closer to its fellow of the opposite side in the middle line than does the anterior part of the same muscle.

The *obliqui externus* et *internus* have not the extraordinarily complicated and specialised disposition of their bundles that I have described in *Breviceps verrucosus* *. The *obliquus externus* is a tolerably stout muscle the fibres of which run at right angles to the long axis of the body in the ordinary way, and which forms as usual a continuous sheet covering the sides of the body. Opposite to the second inscriptio tendinea of the rectus abdominis it is overlapped by the pectoralis abdominalis, and in this region arises (or is inserted) from that muscle, or rather from the septum between the two. In front of this area of overlap the obliquus externus is seen—when the here superjacent pectoralis abdominis is dissected away—to end abruptly at the septum between itself and the several compartments of the rectus abdominis. The fibres of the two muscles where they thus nearly come into contact are absolutely at right angles. Anteriorly and much at the same point, or rather along the same line, as in the Common Frog the obliquus externus ends definitely in a straight anterior border. There is not, however, in *Rhinoderma darwini* any trace that I could discover of an *omo-abdominalis* muscle, such as is

* P. Z. S. 1908, p. 22.

well developed and quite obvious in *Rana* and very greatly developed in *Breviceps*. It is rather remarkable that *Rhinoderma* not only shows no likeness to its ally *Breviceps*, but is even more simple than *Rana*. For some distance in front of the end of the obliquus externus the *obliquus internus* becomes obvious, its fibres running at an angle with those of the externus. These fibres end at the edge of the sternohyoideus just as the fibres of the obliquus externus end at the edge of the same muscle and of the rectus abdominis further back. This ending, however, is apparent rather than real. When the rectus is cut across, the obliquus externus is seen really to end abruptly at its outer boundary. On the other hand, the obliquus internus anteriorly dips into the body and forms a portion of the anterior partition between the neck and the trunk in a way which will be described immediately in connection with the *transversus* portion of the obliquus internus complex which was originally compared by Huxley to the Mammalian diaphragm, and which I have named accordingly in the following paragraph.

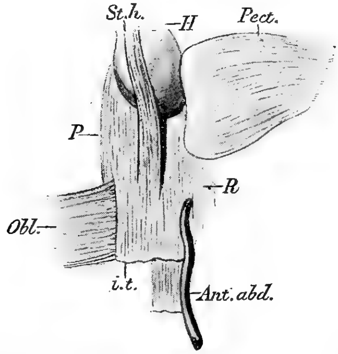
The *diaphragmatic muscle*.—This muscular sheet arises as is usual among the normal Batrachia Salientia—that is, the muscle has not the large extent and backwardly prolonged origin that it has among the Pelobatidæ *. It overlaps the kidney on its way to be inserted on to the œsophagus, which shows the enormous extension of that viscus forwards, upon which I comment elsewhere in this paper †. The muscle is entirely inserted on to the œsophagus from the point where the latter enters the pleuroperitoneal cavity up to nearly its junction with the stomach. The muscle also shares in the formation of the anterior wall of the pleuroperitoneal cavity; for it merges completely into the obliquus internus, the two meeting (though the exact line of junction cannot in the least be distinguished) at about the centre of the concave wall which they together form and which bounds the pleuroperitoneal cavity anteriorly, as has been said. It is difficult to say for this reason whether the muscle does or does not supply fibres to the root of the lung. In any case strands of the obliquus internus end upon the root of the lung.

*Pericardial Muscle*.—In the Common Frog a portion of the obliquus internus has been described as having the following relations to the pericardium and in the following words ‡:—"A third portion [of the muscle in question], placed behind the preceding, runs from the pharynx over the pericardium and is attached to this nearly as far as the middle line, resting on the sternum, the *m. rectus* and *m. sternohyoideus*. The lines of insertion of the muscles of opposite sides form an angle open in front." This is illustrated by a figure; but neither the figure nor the description appears to me to be clear. The portion of the obliquus internus thus referred to is perfectly continuous with the rest of

* Beddard, P. Z. S. 1907, p. 346, text-fig. 98; and p. 886.
† *Suprà*, p. 682.
‡ Ecker's Frog, Engl. Transl. p. 71.

the muscle (I distinguish the œsophageal muscle as distinct) which forms the internal sheet of the abdominal musculature. The region, however, now under consideration is that portion of the obliquus externus which is uncovered anteriorly by the obliquus externus. The latter muscle ceases at about the level of the apex of the heart, its most anterior region being separated off as the omo-abdominal muscle. In front of this the lateral wall of the pleuroperitoneal cavity is formed by the obliquus internus only, and this muscle (of course with its lining peritoneum) limits the abdominal cavity antero-laterally and constitutes the muscular wall of the "cervical limiting membrane of abdominal cavity" (Keith *). Ventrally this section of the internal oblique muscle becomes divided into two insertions. The most posterior ends in a delicate aponeurosis which passes outside of the sternohyoid muscle and is attached to the coracoid and sternum. The anterior

Text-fig. 145.




A portion of the musculature of the ventral surface of *Rhinoderma darwini*.

*Ant.abd.* Anterior abdominal vein. *H.* Heart. *i.t.* Tendinous intersection of rectus abdominis. *Obl.* Obliquus externus. *P.* Pericardial muscle. *Pect.* Pectoralis. *R.* Rectus abdominis. *St.h.* Sterno-hyoid.

section of the muscle is attached by aponeurosis to the pericardium quite anteriorly (in the region of the emergence of the conus arteriosus), and to the roots of the lungs. The whole of the ventricular region of the pericardium is quite free from any muscular insertions. This fact (the freedom of the whole ventricular region of the pericardium from connection with the obliquus internus) is not plainly shown in the figure of Gaupp reproduced by Keith †. In addition to the insertion of obliquus internus fibres upon the anterior and lateral regions of the pericardium, Dr. Keith has remarked that some of "the deep fibres [of the rectus abdominis, behind the sternohyoid] may end on the

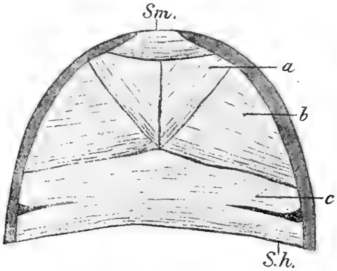
* J. Anat. Phys. xxxix. 1905, p. 244, fig. 1, explan. of figure.

† *Loc. cit.* p. 259, fig. 14.

pericardium." These will then form the ventral part of the diaphragm. I do not find after a careful dissection of an average-sized example of *Rana esculenta* any evidence of a deflection of rectus fibres to the pericardium. I am the more confident in the accuracy of my observation in that I have discovered such a muscle in the small *Rhinoderma darwini*. This I figure in the accompanying illustration (text-fig. 145). The muscle is thin and wide and flat, and its fibres run accurately in a direction parallel with the long axis of the body. It is attached to a good deal of the posterior and lateral margins of the pericardium. It underlies the obliquus externus behind the sternal region (*i. e.* is dorsal to it), and is therefore perhaps to be regarded as a portion of the obliquus internus.

The relations of the *submaxillaris* are different to those which obtain in some other frogs. The muscle is, however, similar in that its posterior region is separated off as a distinct muscle, the

Text-fig. 146.




Musculature of floor of mouth of *Rhinoderma darwini*.

*a*. Genioglossus (?). *b*, *c*. Differentiated portions of submaxillaris. *Sh*. Subhyoideus. *Sm*. Submentalis.

*subhyoideus*. The latter is only plainly differentiated from the former near to the edge of the lower jaw, where it dips down to a lower plane. Its relative dimensions appear to be very much those of the muscle in *Rana*. Nor is there anything in the structure or size of the *submentalis* that calls for particular comment. The muscle appears to be exactly like that of *Rana*. It will be noticed, however, in the accompanying drawing (text-fig. 146, *a*) that two large triangular muscles, one on each side, underlie the submaxillaris, which muscles are not visible in a corresponding dissection of *Rana*. Nor have I seen them in the same place in such Pelobatidæ as I have dissected *. These two muscles, as will be seen in the text-figure referred to, are closely approximated in the middle line; and into the space left by their divergence in front fits exactly the submentalis.

* On *Megalophrys nasuta*, P. Z. S. 1907, p. 338, &c., and on Pelobatidæ, *ib. t. c* p. 871.

These two muscles appear to me to be quite possibly the *genioglossi*, which are thus in the species *Rhinoderma darwini* not only of very large size but rather abnormal in position. They are normal only in that they arise on either side from the mandible; they are abnormal in that they have intruded into an area belonging to the submaxillaris which ceases to exist as a separate layer at the margin of the genioglossi. Furthermore, the intrusion of the genioglossi on to the superficial area of the throat has caused another peculiarity in the arrangement of the fibres of the submaxillaris. It will be seen from an inspection of text-fig. 146 that the fibres of the submaxillaris run in different directions in different portions of this muscle. Laterally to the possible genioglossi the fibres of the submaxillaris run obliquely to each ramus of the lower jaw; posteriorly to them the fibres are at right angles to the longitudinal axis of the head and run therefore accurately across the throat, with no obliquity of direction like the anterior part of the muscles. If I am right in identifying the triangular pair of muscles just described with the genioglossi of other Batrachians, they certainly differ in not being inserted on to the tongue (which of course does not necessarily do away with this suggested homology), for they can be easily dissected away with the submaxillaris, displaying the hyoglossus and geniohyoidei beneath. In any case, whatever be the nature of these muscles, it is clear that the muscular floor of the mouth in *Rhinoderma darwini* is peculiar and unlike that of other frogs. I should mention, furthermore, that there is no vestige in this frog of the small muscles at the side of the mouth lettered "*x*" in my figure of the muscular system of the ventral surface of the body in *Breviceps verrucosus* *. It may be that these muscles are the homologues of the peculiar muscles which I describe in *Rhinoderma* (text-fig. 146, *a*). If so, they have undergone in the one or in the other genus a very considerable shifting of position. It must be borne in mind that the species the anatomy of which forms the subject of my present communication to the Society is hardly to be described as "engystomatous."

### § *The Musculature of the Back.*

The *latissimus dorsi* (text-fig. 147, *L.d.*) is distinctly different from that of *Rana*, as figured. It is a distinctly narrow muscle, being about one half of the diameter of the underlying infraspinatus. Its course is straight and is exactly at right angles to the long axis of the body. It has no obliquity of direction as in other frogs. It is therefore also exactly parallel to the partly underlying infraspinatus. It arises from the middle line of the back behind the scapula. It did not appear to me to arise from the dorsal fascia; but as this pigmented membrane was so delicate it had to be picked away in little bits, and its relations were therefore rather

* P. Z. S. 1908, p. 16, text-fig. 3.

obscure. Still it seemed to be free of the underlying musculature including the longissimus dorsi except just at the spinous processes of the vertebræ.

The *rhomboideus* (or *retrahens scapulæ*) differs, as I have pointed out, in *Rana guppyi* * and *R. esculenta*; for in the former species it arises from the spine of a vertebra and is thus a true rhomboideus and not a serratus.

So also is this muscle in *Rhinoderma darwini*. It arises in front of the latissimus dorsi and is partly overlapped by it. It is at first rather broad, but narrows rapidly when it passes under the cucullaris into a narrower but still flat and strap-shaped muscle to be attached to the scapula.

The *depressor mandibulæ* is partly absent in this frog. There is no trace that I could discover of the dorsal part arising near to the latissimus dorsi. Nor do I think it possible to have missed this part of the muscle which is so obvious in those frogs where I have looked for it. It is important to notice that in this particular *Rhinoderma* agrees with its ally *Breviceps*. The other portion of this muscle, however, that arising from the skull-wall, is very large and passes as usual behind the tympanum, its antithesis, the *temporalis*, passing in front of the tympanum. Both these muscles are large and about equally developed.

The *infraspinatus* appears to cover the dorsal surface of the scapula nearly entirely from the extreme edge of its ventral margin. Only a thin edge of the scapula (indicated by dots in text-fig. 147) is left exposed, not so much as in *Breviceps*.

The *cucullaris*, or *levator scapulæ*, is a large and well-developed muscle as is shown in the figure (text-fig. 147). Its direction is oblique, the obliquity being towards the dorsal median line postero-anteriorly. In this region it covers a part of the anterior section of the longissimus dorsi, that inserted on to the head.

The *longissimus dorsi* is quite like that of *Rana*, and is shown together with the adjacent muscles in the accompanying text-figure (text-fig. 147). They all agree on the whole with those of *Rana*, and a reference to my figure will show this agreement in detail. The *ilio-lumbaris* is rather more marked on the dorsal surface. The view of this muscle from the inside of the body is rather different from that of *Rana* †. It runs uninterruptedly over the transverse processes of four vertebræ (beginning with the sacral ‡), and was finally inserted on to the one in front, *i. e.* the fifth reckoning from behind forwards. This is also the fifth vertebra of the series commencing with the atlas. From this vertebra to the fourth a band of muscles runs in the same straight line as the ilio-lumbaris, but not in continuity with its fibres. This transverse process (that of the fourth vertebra) gives origin

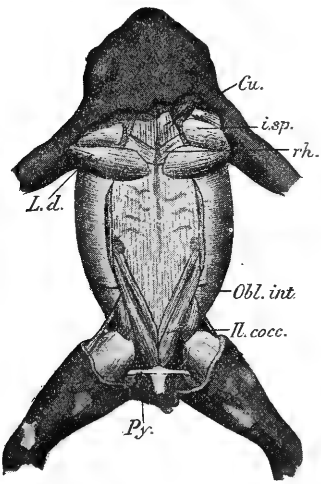
* Anatomy of *Pipa*, P. Z. S. 1895, p. 835. I am able to confirm this statement after a re-examination of that frog.

† Beddard, P. Z. S. 1907, p. 333, text-fig. 94 (*Rana guppyi*).

‡ I may note that this vertebra was not fused with the coccyx.

to the *transverso-scapularis* muscle *, which is best seen on the view presented by the dissection now being described, and which is therefore dealt with here and not in its proper place. The ilio-lumbaris gives off slips to the transverse processes lying between its origin from the ilium and its insertion on to the fifth vertebra; but these are concealed from view when the body-cavity is opened and the muscle exposed, for a considerable mass of its fibres runs directly and without interruption between the extremes of origin and insertion. It suggests, therefore, the long slip of the

Text-fig. 147.




Dorsal musculature of *Rhinoderma darwini*.

*Cu.* Cucullaris. *i.sp.* Infra-spinatus. *Il.cocc.* Ilio-coccygeus. *L.d.* Latissimus dorsi. *Obl.int.* Fan-shaped tract of obliquus internus attached to ilium. *Py.* Pyriformis. *rh.* Rhomboideus.

ilio-lumbaris in *Megalophrys nasuta* †, which appears, however, in that frog, and in the Pelobatidæ generally ‡, to be more completely differentiated from the rest of the ilio-lumbaris than is the case with *Rhinoderma darwini*. More noteworthy is the exact likeness which this muscle shows to the corresponding muscle in *Breviceps*.

The *coccygeo-sacralis* and *ilio-coccygeus* are present and obvious as is shown in the figure (text-fig. 147), but have no special features of interest. On this view the *glutæus*, the *rectus femoris*

* It is noteworthy that only one pair of these muscles appears to exist in *Rhinoderma*; for there are two in *Rana*. The above dissection also showed plainly the *Levator anguli scapulæ* arising from the skull quite as in *Rana*.

† P. Z. S. 1907, p. 332, text-fig. 93, *Il. lumb.*

‡ P. Z. S. 1907, p. 871.

*anticus*, and the *pyriformis* are exposed and very prominent. It will be seen from the drawing (text-fig. 147) that there is no possible room for an enormous lymph-heart like that which I have described and figured in *Breviceps* on either side of the spine. Nothing of the kind can, I believe, have been overlooked by me. A peculiarity of the obliquus internus is shown on the view of the dorsal musculature which is illustrated in text-fig. 147, *obl.int.* A fan-shaped origin of this muscle from the ilium is to be seen underlying the obliquus externus. The origin is by a head of very limited extent from the ilium just above the origin of the glutæus muscle, that is, about halfway down the bone. An iliac origin of this muscle is of course known in *Rana*.

### § *Musculature of Hyoid.*

I have dealt at some length in my paper upon the anatomy of *Breviceps* with the hyoid musculature of that frog. This musculature presents, it will be recollected, more than one peculiar feature. The corresponding musculature of *Rhinoderma* does not present many peculiar features, and agrees on the whole with that of *Rana*, differing therefore from its near ally *Breviceps*, to which however it presents some likeness, as I have identified, and have no particular comments to make upon, the following muscles, which appear to me to be like those of *Rana*, viz., *geniohyoideus* and *omohyoideus*. The *sternohyoideus*, on the other hand, appears to me to be like that of *Breviceps* in that it consists of two portions with a quite separate insertion on to the hyoid. The larger and more superficial half of the muscle has not the same origins as the sternohyoid of *Rana*, for there is no sternum to arise from, and it is simply a continuation of the rectus and completely conceals (when the animal is viewed from the ventral surface in the usual position of dissection) the underlying portion of the muscle. This is very slender, and is connected only in its origin with the abdominal musculature. It is inserted on to the hyoid a considerable distance behind the insertion of the larger half of the muscle, and the insertions are not continuous. Just below this muscle lies the pericardial muscle which I describe on another page (see p. 684). It is interesting to note that the sternohyoid is completely free from the shoulder-girdle, and is merely a continuation of the rectus abdominis.

The *petrohyoidei* are as in most other frogs; *i. e.*, there is an anterior and a posterior petrohyoideus and the latter is divided into three slips. The latter muscle is entirely inserted upon the bony thyrohyals, and the three slips of which it is composed form a continuous mass of muscles which are broad and leave no interspaces. The last of the series, as in some other frogs, lies rather superficially to the rest and is attached to tl e tip of the thyrohyal bone ventrally. It also seems to pass beyond it as in *Xenophrys* *, and to be therefore associated with the vocal apparatus.

* See Beddard, P. Z. S. 1907, p. 898, text-fig. 238, *p.h.* 3.

§ *Muscles of the Thigh.*

When the skin is removed and the muscles of the thigh inspected from the inner aspect (text-fig. 148), some difference is visible from the appearances observable in *Rana* under similar conditions. For figures of *Rana* I may refer to Ecker's 'Anatomy of the Frog,' and to a figure of the muscles of the inside of the thigh in the large *Rana guppyi* *, illustrating a paper by myself on the structure of the Pelobatidæ. I have also figured the corresponding muscles of *Breviceps* †, an African genus belonging to the same family (Engystomatidæ) as that which contains the subject of the present communication to the Society. Although there are

Text-fig. 148.


Thigh-muscles of *Rhinoderma darwini* exposed from the inside.

*R.* Rectus abdominis. *v.i.m.* Rectus internus minor, where it is attached to the skin. *V.i.* Vastus internus. *Sa.* Sartorius.

differences in detail between the thigh muscles of *Rhinoderma* and those of *Rana*, the general aspect of the muscles—with one important exception, to be mentioned presently—is much like that of *Rana*, and is even definitely more like *Rana esculenta* than *R. guppyi*. It is easy to recognise the *vastus internus*, *adductor longus*, *sartorius*, *adductor magnus*, *adductor brevis*, *rectus internus major* and *rectus internus minor*, lying in the order named (and commencing of course at the anterior border of the thigh) and having roughly much the same proportions as the corresponding muscles of *Rana esculenta*. Moreover, it will be noticed that the smallest adductor muscle lies after the adductor magnus as in *Rana esculenta*, and not in front of it as in *Rana guppyi*. There is, however, visible, as is well shown in the above figure (text-fig. 148), an important

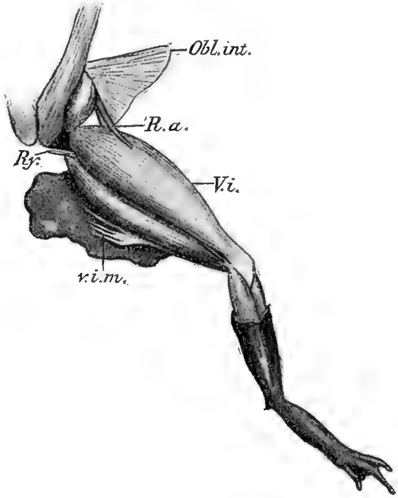
* P. Z. S. 1907, p. 887, text-fig. 234.

† P. Z. S. 1908, p. 25, text-fig. 6.

difference between *Rana* and *Rhinoderma*, which is at the same time a point of agreement between *Rhinoderma* and *Breviceps*. The *rectus internus minor* arises in *Rhinoderma* by a number of more or less separate origins from the skin of the thigh, which origins are very far from reaching the middle line of the abdomen. The muscular strands which combine to form this muscle are spread out upon the skin, when the latter is cut through and reflected, in a divergent fashion. There are four or five of these strands, which are naturally flat bands. In *Breviceps* such an extra-skeletal origin of skeletal muscles in the femoral region is more largely developed than in *Rhinoderma*; but, as will be seen by a reference to my paper already quoted, the rectus internus is similarly involved in this system of skin muscles.

Viewing the thigh muscles from the dorsal aspect (see text-fig. 149) and their origins (in some cases) from the back, one

Text-fig. 149.




Thigh-muscles of *Rhinoderma darwini* exposed from the outside.

*Obl.int.* Fan-shaped portion of obliquus internus attached to ilium. *Ry.* Pyriformis. *R.a.* Rectus anticus. *v.i.m.* Rectus internus minor. *V.i.* Vastus internus, lying to the outside of the vastus externus.

obvious and striking difference from *Breviceps* is to be seen. The coccyx runs very nearly to the extremity of the body; there is not the lengthy exposure of the cloaca with certain muscles attached thereto and accompanying it that I have figured in *Breviceps* *. To the tip of the coccyx is attached the *pyriformis*, which in the usual way reaches the femur by passing between the *vastus externus* and the *semimembranosus*. The disproportion

* P. Z. S. 1908, p. 35, text-fig. 11.

between the two last-named muscles is greater than it is represented to be in *Rana*. The figure of *Rhinoderma* (text-fig. 149) shows that in that frog the vastus is more than twice the breadth of the semimembranous. The *rectus anticus* of *Rhinoderma* is peculiar in that it is a very small and slender muscle covered at its origin from the ilium by just the front end of the glutæus. It is thus an inappreciable portion of the *triceps femoris* complex. The *biceps femoris* is much hidden by the vastus externus and semimembranosus, between which it lies. Indeed it is only visible for a very short distance at its insertion. In this the genus agrees with *Breviceps*.

The *semitendinosus* is not shown in the two figures (text-figs. 148, 149), which illustrate the musculature of the thigh, since it is completely hidden on the inner aspect of the thigh by the rectus internus major. When the latter is cut through and reflected the semitendinosus is brought into view. It is formed by the union of two heads as in *Rana*; but these do not unite until more than halfway down the thigh. They are moreover fleshy throughout and roughly speaking of equal size. One head arises, as the thigh is seen dissected from the ventral aspect, superficially to the other. It arises from the symphysis pubis in close apposition to the great adductor and the two recti abdominis. The second head is better shown when the first head is cut through and reflected, since it is distinctly deep of it. It is then seen to run back to its origin in close apposition to the rectus internus major and to arise from the pubis very close to it. I observed no tendinous origin of this head, and no such connection with its head as is figured and described in the Common Frog.

### § *Resumé of facts and Systematic Position of* Rhinoderma.

As might be expected from their very different way of life, the genus *Rhinoderma* presents, as we have seen, numerous anatomical differences from its ally *Breviceps*. Several of these are already known, and are described in such works as Mr. Boulenger's 'Catalogue of the Batrachia Salientia,' and in Dr. Gadow's treatise on Amphibia and Reptiles in the 'Cambridge Natural History.' I leave aside in the present enumeration those external and osteological features which are dealt with in those and other works. A general survey of the structure of the muscles shows plainly that *Breviceps* has departed much further from the more usual structure of the Batrachia Salientia than has *Rhinoderma*. And this statement applies also to the viscera. The extraordinarily enlarged posterior lymph-hearts of *Breviceps* are not found in *Rhinoderma*; the liver of the latter has the more normal form of that of *Rana*. It is, however, in the musculature that the most numerous divergences between the two types are to be met with. The remarkable specialisation of the obliquus muscles, which I have described in detail in *Breviceps*, does not occur at all in *Rhinoderma*, which is broadly speaking like *Rana* in this respect.

Partly in consequence of this the hyoid musculature of *Rhinoderma* is closely like that of *Rana*, the omohyoid being present, which muscle has disappeared in *Breviceps*. On the other hand, the musculature of the floor of the mouth is quite specialised in *Rhinoderma*, and different from that of any other frog the anatomy of which has been described.

On the other hand, there are a few points in which *Rhinoderma* does resemble *Breviceps* and departs so far from the structure of *Rana*. The sternohyoid seems to be a double muscle in both, though the duplicity of the muscle is not so strongly marked in *Rhinoderma*. The attachment and general appearance of the iliolumbaris of *Rhinoderma* is distinctly like that of *Breviceps*. In both, the rectus internus minor of the thigh arises partly from the skin, and in neither frog is there the dorsal part of the depressor mandibulæ muscle present. In my paper upon *Breviceps* I have selected 17 characters of importance to distinguish that frog from *Rana*. It is only in four of these characters that *Rhinoderma* agrees with *Breviceps* to differ from *Rana*.

Nor are there any special points of likeness between the two genera here considered in any other features not mentioned in the list of the seventeen principal characters referred to, except, of course, such general features as both *Rhinoderma* and *Breviceps* share with *Rana*.

The divergences are most remarkable; and yet there are at least two equally remarkable points of resemblance, *i. e.* the origin of the rectus internus femoris and the absence of the dorsal part of the depressor mandibulæ. There can be no doubt, however, that, whatever may be the value of these points of resemblance, the two genera are quite as far removed from each other within the limits of family relationship as diversity of geographical position would lead us to expect. A wider knowledge of this order of animals may reveal surer bases for anatomical criteria.

## 6. Some Notes upon the Anatomy of *Chiromys madagascariensis*, with references to other Lemurs. By Frank E. Beddard, M.A., F.R.S., F.Z.S.

[Received May 26, 1908.]

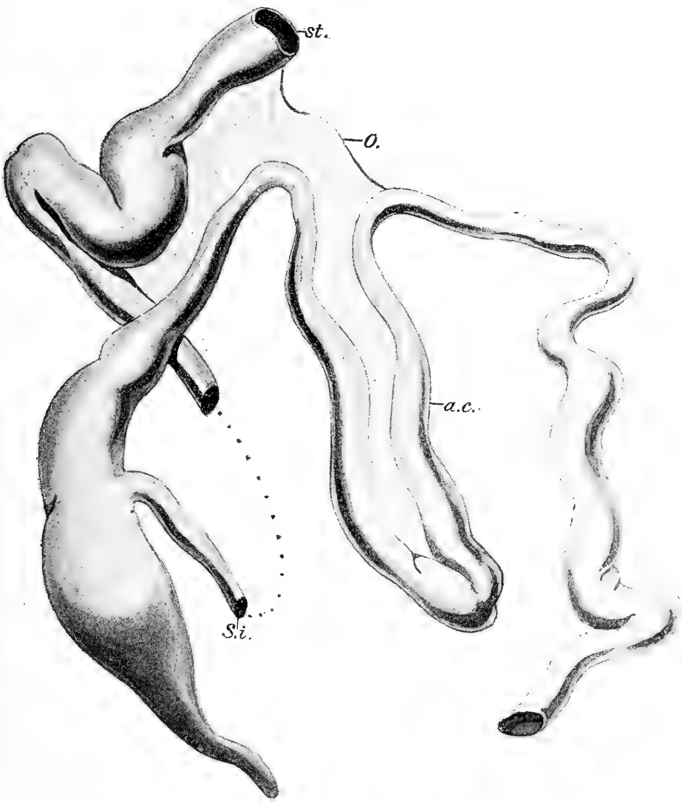
(Text-figures 150–153.)

The opportunity of examining three specimens of the Aye-Aye (*Chiromys madagascariensis*) has enabled me to add a few new facts to what is already known concerning the structure of this remarkable Lemur. The three principal Memoirs dealing with the structure of *Chiromys* are (in order of appearance) those of Owen *, Peters †, and Oudemans ‡. These authors have dealt with the preceding literature relating to the animal. The

* Trans. Zool. Soc. vol. v. † Abhandl. k. Akad. Wiss. Berlin, 1865.
‡ Verh. Akad. Amst. 1890. See also Chapman, P. Ac. Philad. 1900, p. 419.

structure of the brain (with which I am not concerned here, since the specimens were sold for museum purposes which rendered the extraction of the brain inadvisable) has been quite recently dealt with by Dr. Elliot Smith *, who quotes previous memoirs.

Text-fig. 150.




A portion of intestinal tract of *Chiromys*.

*a.c.* Ansa coli. *O.* Edge of omentum. *S.i.* Small intestine. *st.* Opening of duodenum into stomach.

The greater part of the small intestine has been removed; the two cut ends are connected by a dotted line.

These authors have dealt at length with the external characters, osteology, visceral and muscular anatomy of *Chiromys*, and to the general descriptions given by them of the different organs I have nothing to add. There are, however, some facts, and these not altogether without importance, which have not met with much

* Cat. Mus. Roy. Coll. Surgeons, vol. ii. 1902, p. 359.

attention or have been altogether passed over by the authors mentioned, largely doubtless by reason of the apparent unimportance of those facts at the time when the memoirs in question were written. Sir Richard Owen found himself obliged to vindicate the Lemurine affinites of *Chiromys* from assertions of its Rodent affinities by comparing it definitely with *Sciurus*. Though this is no longer necessary, certain obviously Lemurine characteristics of *Chiromys* have not been sufficiently emphasised either by Owen or by his successors. With these and with some other points I propose to deal in the present communication.

*Intestinal Tract.*—The gut is figured by both Owen * and Oudemans †, but neither of these figures is at all satisfactory. I therefore take the present opportunity of refiguring (in text-fig. 150) a portion of the gut which shows not merely the characteristic ansa coli (flexura coli, colic loop) of *Chiromys madagascariensis*, but certain mesenteric attachments which are of importance in the morphology of the intestinal tract of mammals. Divergent in its general structure from other Lemurs though *Chiromys* may be, the intestinal tract points unmistakably to its affinity with the genera *Lemur* and *Hapalemur*, probably with the subfamily Lemurinæ. *Chiromys* possesses in fact, as do those genera ‡, a single ansa coli which is a flexure of the colon shortly after its emergence from the cæcum. The two limbs of this loop were, as in *Lemur*, closely applied to each other and the loop as a whole was fully as long as—perhaps even rather longer than—the loop in the genus *Lemur*. The loop was perfectly simple and **U**-shaped, as is shown in the figure (text-fig. 150), and there was no approach to the spiral of the Galagininæ, Lorisinæ, and Indrisinæ.

There is some indication in Oudemans' figure of this loop; but it is not properly represented; and the various mesenteric attachments which are of importance from the point of view of a comparison with other forms are omitted altogether.

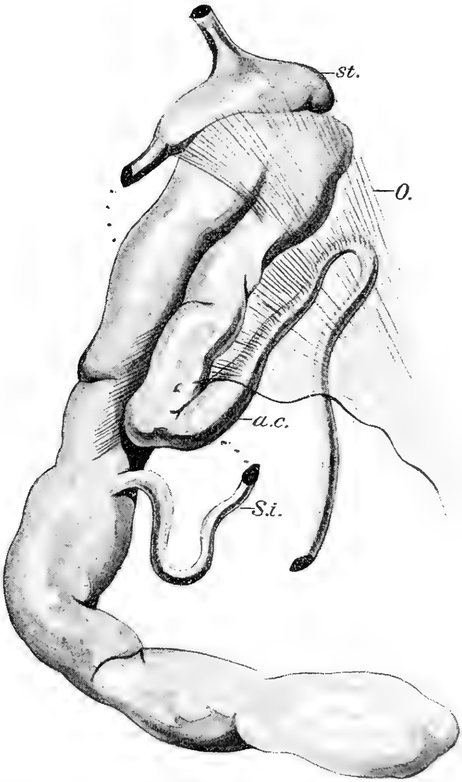
As text-figure 150 shows, the omentum is attached to the region of the colic loop where it bends to the left to become the straight portion of the transverse colon. Furthermore, as in some other Lemurs at any rate (there is not at present accurate information with regard to the simple forms *Microcebus* and *Cheirogaleus*), there is an attachment between the duodenum where it leaves the stomach and the colon where it dips down to form the proximal limb of the ansa coli. This is also shown in my figure to which I have just referred. The duodenal attachment is of limited extent, and the omentum is like that of some other forms in that it is only modified as a bridge between the stomach and the colon for a portion of the duodenal region of the former, and as already said for a very

* *Loc. cit.* pl. 26. figs. 1, 2. † *Loc. cit.* pl. iii. fig. 14.

‡ For *Lemur* see Flower (Med. Times & Gazette, 1872), Mitchell (Trans. Zool. Soc. vol. xvii.), Beddard (P. Z. S. 1908, p. 577); for *Hapalemur*, Klaatsch (Morph. Jahrb. xviii. p. 667).

limited tract of the other. In my recent memoir upon the intestine in several mammals *, I have referred to more than one species in which the attachment of the omentum to the large intestine is of the same limited extent as in *Chiromys*. But it is greater in the genus *Lemur* (see text-fig. 151) †. I may take this opportunity of remarking that the attachment of the omentum

Text-fig. 151.




A portion of the intestinal tract of *Lemur rufifrons* corresponding to that of *Chiromys* as displayed in text-fig. 150.

Lettering as in text-fig. 150.

to the colon in *Hapale penicillata* is hardly if at all greater than in *Chiromys*. I find myself therefore in disagreement with Klaatsch, who represents a more lengthy base of insertion of the omentum upon the colon (in *Hapale albicollis*).

* "On the Anatomy of *Antechinomys*, &c.," P. Z. S. 1908, p. 561.

† At any rate in *L. albifrons* and *L. rufifrons*, where it is attached all over the colic loop, and in *L. brunneus*, in which species it is attached to halfway down the loop.

It is interesting to note that, so far as the intestine is concerned, *Chiromys* comes closer to the Lemurinæ than to any of the other subfamilies of the Lemuroidea. I have pointed out that in the more specialised Lemuroidea, so far that is to say as concerns the intestine, the elsewhere characteristic carpal vibrissæ have disappeared. This conclusion will require amending since they are undoubtedly absent in *Chiromys*, a fact which my colleague Mr. Pocock observed independently of myself. Nevertheless it cannot be doubted that in other respects *Chiromys* is a specialised Lemur, so that after all the statement may still hold.

The rest of the colon is disposed in a curved course to the rectum, and there are no traces of any further ansæ coli.

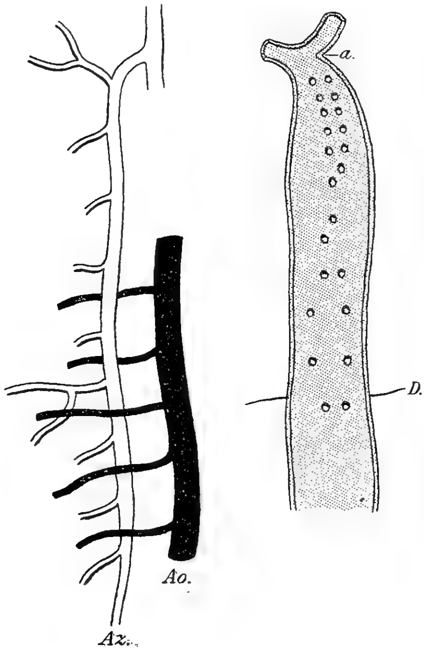
There is in *Chiromys* the usual cavo-duodenal ligament, which was not so clearly a single sheet of membrane as is generally the case. In one specimen it was single ligament of the usual type; in the two others a duodeno-renal portion could be differentiated off, attaching the end of the loop of the duodenum to the right kidney. An hepato-caval ligament was present also in the same two specimens. On the left side of the body the lieno-rectal ligament was plain, and also the lieno-renal. I may add that the right lateral lobe of the liver was attached—naturally on the right side—by a ligament to the parietes just at the origin of the dorsal part of the diaphragm. I identified this ligament in all three individuals. In an example of *Lemur brunneus* the right lateral lobe of the liver was also attached to the parietes by a ligament. I also recognised in this Lemur the hepato-caval and hepato-renal ligaments. On the left side of the body of this species of *Lemur* the lieno-renal and lieno-rectal ligaments were also very plain.

The *vascular system* has not been much dealt with by my predecessors. As is already known the aortic arch gives rise to two trunks. The intercostal arteries of mammals show some variation in their mode of origin from the aorta. Here again, however, there are not sufficient facts known to deduce any results of classificatory importance. I take this opportunity of comparing the mode of origin of these little arteries in *Chiromys* with those of some other mammals.

In *Chiromys* the first pair of intercostals arise symmetrically and very close to each other. The next four are also symmetrical but a trifle further apart. Then follow two pairs which are as displayed in the accompanying figure (text-fig. 152), the artery of the one side being much in advance upon its fellow. The remaining pairs are symmetrically paired as are the first of the series, but the distance between the orifices of each pair of arteries differs. In an example of *Pseudochirus peregrinus*, of which I cut open the aorta and examined the mouths of the intercostal arteries, they were strictly paired and quite regular. In *Hystrix cristata* I counted seven intercostals in front of the diaphragm, which however did not commence until the ninth rib. These arteries were single at their origin from the aorta.

In another specimen, however—and this is important as showing the variation of these structures—the first intercostal was single, the next two were paired but the left-hand arteriole was smaller than, and lay behind, the right. Then followed a strictly paired and equisized couple rather far apart, and after this another pair closer together. In a Beaver (*Castor canadensis*) the intercostal series commenced with a single vessel on the left side; then followed three pairs the orifices of each pair getting closer

Text-fig. 152.




Right-hand figure.—The commencement of the aorta of *Chiromys* cut open to show origin of intercostals.

*a.* Commencement of descending aorta. *D.* Position of diaphragm.

Left-hand figure.—Azygos (*Az.*) of *Chiromys*.

*Ao.* Aorta with some of intercostal branches indicated.

together, then a single median intercostal, followed by three pairs, and these again by a single median artery. After this point the artery traversed the diaphragm, and the intercostals behind the diaphragm arose singly, and were median in position. In a Chinchilla (*Chinchilla lanigera*) the first intercostal was median and unpaired. Then followed a single vessel on the right side and then two pairs. The remaining intercostals were median and unpaired. In an example of *Dasyurus maugæi* the anterior series of intercostals were all paired at their origin excepting the last three in front of the diaphragm which arose by a single median trunk, each trunk dividing of course into the right and left intercostal of its segment. After the diaphragm the intercostals were at least chiefly paired in origin. I have figured these arteries in the genera of Carnivora *, *Helictis*, *Galictis*, and *Suricata*, where they arise as paired trunks. There exist, naturally, descriptions of these arteries in many mammals †; but there is need for further collection of facts before they can be utilised for systematic purposes, for which purposes, however, it is obvious from what has already been said that their variability will have to be taken into careful consideration. In the meantime I venture to record such facts as I have happened to ascertain myself, without attempting anything like a revision of the existing knowledge of these arteries.

I have also ascertained some facts with regard to the *venous system* of *Chiromys*, and I take this opportunity of incorporating some facts concerning the venous system of *Microcebus smithii*, of which there is apparently no published information so far as I can discover. I dissected the postcaval vein (text-fig. 153) in both of the adult specimens. It was a single vein throughout and lay as usual to the right of the aorta. The renal veins as is also usual were asymmetrical, the left lying some way behind the right. The mode of origin of the ovarian veins varies somewhat in mammals. In *Chiromys* the vein supplying the right side arose from the postcaval not far in front of the posterior bifurcation of the latter. The left vein, on the other hand, arose from the left renal, as is often the case. This particular asymmetry is very general in mammals, but it is not always the case that the right ovarian vein flows into the postcaval so far down. In the male specimen there was an interesting difference in the place of influx of the two spermatic veins. That of the right side corresponded on the whole with the right ovarian vein. But that of the left side did not arise from the left renal vein but from the postcaval behind that vein, though some way in front of the point of origin of the right spermatic vein. The homologue of the ovarian vein of the female was, however, also present on the left side. The renal vein, in fact, received a branch at a point exactly corresponding with the entrance of the left ovarian vein in the female example. But this vein ended in the muscular parietes and was evidently concerned alone with the venous system of the lumbar parietes. These facts are illustrated in the accompanying text-figure.

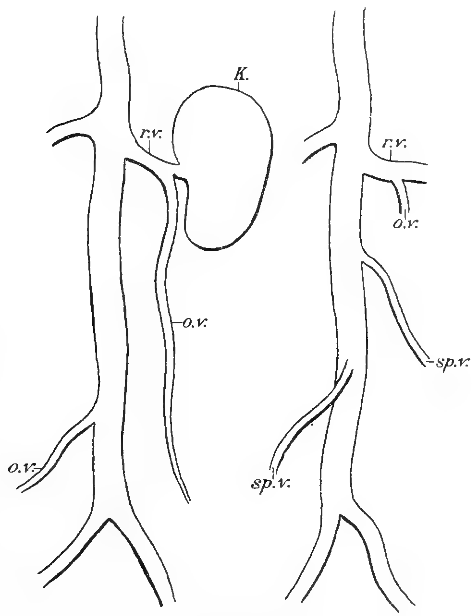
In *Microcebus* the arrangement of the corresponding veins was

* "On the Anatomy of *Helictis personata*," P. Z. S. 1905, vol. ii. pp. 27, 28, text-figs. 11, 12.

† *E.g.* in *Ornithorhynchus*, Manners-Smith, P. Z. S. 1894, p. 714; Manatee, Murie, Trans. Zool. Soc. vol. viii. pl. 26, fig. 44; Horse, Chauveau & Arloing, Traité d'Anat. Comp. Anim. domest. 1871, f. 555, and many special treatises.

somewhat different. In the specimen which I dissected the right renal vein, which poured its contents into the postcaval headward of the left renal, was formed by two trunks which, however, united before entering the postcaval. This may well be a mere variation. But it is worthy of note that double renal veins particularly on the right side are very usual among Armadillos. It is also very general in *Tragulus**. And here, again, it is on the right side that the anomaly occurs.

Text-fig. 153.




Postcaval vein of *Chiromys*, the right-hand figure of a male, the left of a female.
*K.* Kidney. *o.v.* Ovarian vein. *r.v.* Renal vein. *sp.v.* Spermatic vein.

The primitive nature of this little Lemur was also shown by the mode of connection of the ovarian veins with the postcaval. There was no such asymmetry as has been described in *Chiromys*, and which is so general among mammals. The veins in question are opposite to each other not far from the posterior bifurcation of the single postcaval. On the left side the vein was more complex than on the right side. It divided at once into three vessels. This, however, is not the only peculiarity of these veins in *Microcebus*. From each renal vein a slender vessel ran backwards parallel with the postcaval trunk, and in the case of that

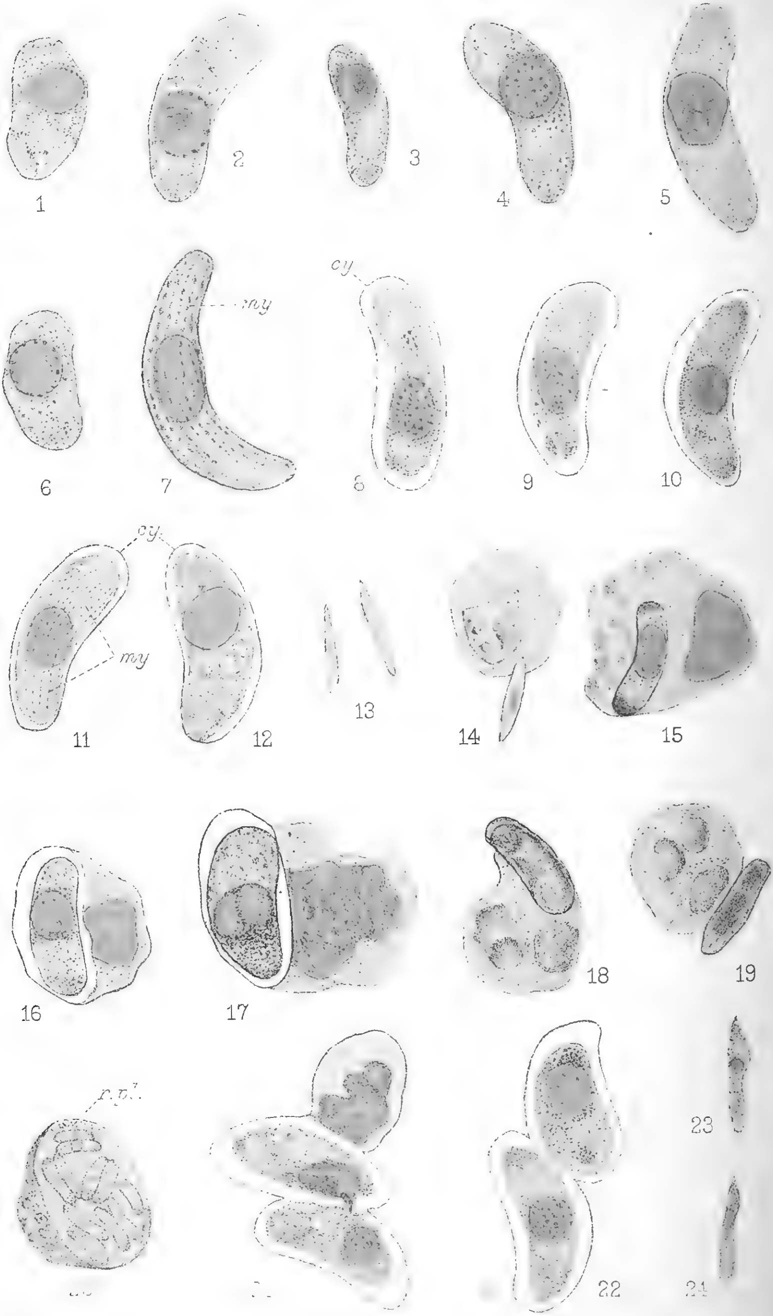
* McClure, Anat. Anz. Bd. xxix. 1906, p. 375; Beddard, Am. Journ. Anat. 1907, p. 112.

of the left side poured its contents into the ovarian vein at its origin. I did not succeed in tracing the corresponding vein of the right side all the way; but in any case it commenced anteriorly in exactly the same way as the other vein. It will be noted, therefore, that the conditions obtaining in *Chiromys* could be arrived at by an obliteration of the connection of the ovarian vein of the left side with the postcaval, and the retention only of its embouchure into the renal.

I may observe that in an example of *Galago garnetti* the origin of the ovarian veins was quite as in *Chiromys*. On the other hand, in a male of *Nycticebus tardigradus*, the arrangement was slightly different from, though not in great disagreement with, *Chiromys* and *Galago*. In *Nycticebus* in fact the left spermatic vein poured its contents into the left renal. The right, on the other hand, opened into the postcaval, though very near to the point of origin of the here more or less symmetrically arising renal veins.

The *internal mammary veins* of *Chiromys* run one on each side and in association with the artery at some distance from the middle line of the sternum. The two veins are connected with each branch of the single precaval vein where it bifurcates at the front end of the thoracic cavity. This is quite the normal arrangement for these veins, but I mention the facts since there are sometimes differences. For example, in *Lutra vulgaris* I found the internal mammary a single vein on the right side, but with several branches supplying the left side of the middle ventral line. Moreover, it is also desirable to note that each of these veins runs closely accompanied by its artery strictly parallel to the middle line of the sternum but at some distance from it.

The azygos vein is not figured by previous investigators of the anatomy of *Chiromys*. I have examined this vein (text-fig. 152) in each of the three specimens which I dissected, and most carefully in the last example which was a young female. It is developed only upon the right side of the body, as in all Lemurs hitherto studied. It is a well developed vein and extends backward to nearly the diaphragm. The first branch supplies two intercostal spaces, and the last branch of the series but two is also divided in the same way. There was no trace that I could discover of any corresponding vein upon the left side, neither was there a hemiazygos. The point at which the intercostal arteries pass outside of the azygos vein is a matter which varies much among mammals. But the material does not as yet exist for a use of the facts for systematic purposes. It is, however, obviously permissible to state the conditions observed in *Chiromys* with a view to future generalisations. I found, in fact, that in this Lemur the first of the series of intercostal arteries to cross over the azygos vein, as viewed in the ordinary position of dissection, was that lying behind the tenth rib. Thereafter all the intercostal arteries had the same position. In front of this point they underlay the vein.




A. P. del. West, Newman chr.

LEUCOCYTOZOON MUSCULI.

# 7. *Leucocytozoön musculi*, sp. n., a Parasitic Protozoön from the Blood of White Mice. By Annie Porter, B.Sc. Lond., Zoological Research Laboratory, University College, London.*

[Received May 26, 1908.]

(Plate XXXIX.† and Text-figure 154.)

CONTENTS.



## I. Introduction.

The microscopic organism described in this memoir was found in the leucocytes or white blood-corpuscles of white mice. It is a parasitic Protozoön belonging to the class Sporozoa, and being a blood parasite, it is included in the order Hæmosporidia. As it occurs in leucocytes, it should be placed in the genus *Leucocytozoön*. Similar parasites have been described during the last three or four years from the leucocytes of dogs, rats, palm-squirrels, and cats among mammals, and a few from other Vertebrates. These will be briefly considered at the end of this memoir. So far as I know, such a parasite has not been recorded previously from the mouse.

As the parasite is shaped like a Gregarine, it is closely related to the genus *Hæmogregarina*, and some authorities, as Laveran and Mesnil, would place the Leucocytozoa in that genus. I prefer, however, to retain the generic name *Leucocytozoön*, and since the parasite occurs in the mouse, *Mus musculus*, I propose the specific name "*musculi*" for it. This creation of a new species is made, not with the intention of merely multiplying species, but to avoid confusion with the parasites found in rats. The nomenclature of these parasites of rats is in a very confused

* Communicated by H. B. Fantham, D.Sc., A.R.C.Sc., F.Z.S.
† For explanation of the Plate, see p. 715.

state. The specific name "*muris*" has been applied by Balfour [2, 2 A]* to the parasite he described from *Mus decumanus* at Khartoum. A similar parasite has been described by Adie [1] from *Mus rattus* in the Punjaub, under the name of *L. ratti*, while a third has been described by Cleland [7] from Perth, Western Australia.

I think it is very probable that this Leucocytozoön is different from that in rats. In this connection it is worthy of note that the Trypanosomes of rats and mice belong to different species.

The name that I propose for this parasite from the leucocytes of white mice is, then, *Leucocytozoön musculi*.

## II. Materials.

The first infected animal received was a white mouse which came from a stock kept at St. Mary's Hospital Medical School. This white mouse, when in an almost comatose condition, was brought to the notice of Dr. Fantham. Some symptoms were feebleness of movement (constantly moving slowly, more or less in a circle, with a tremor or waltz, though the animal did not appear to be related to Japanese waltzing mice), partial closure of the eyes with discharge therefrom, and incontinency of urine.

A few parasites were found in the peripheral blood of this mouse, but the rodent soon died. As soon after death as possible, smears were made of the heart, spleen, kidney, liver and gut-contents. There was an extravasation of blood into the gut of the mouse and in this parasites were found. However, in the gut many Bacteria occurred, and it is not suggested that the Leucocytozoön was the sole cause of the death of the mouse.

A second white mouse, from the same stock as the first one, was procured and kept under observation for nearly three weeks. A few parasites only occurred in its peripheral blood. Accidental death overtook this mouse and immediately smears were made of its internal organs. In these parasites were seen but in much fewer numbers than in the first specimen. A third mouse from the same stock was found to be infected to a greater extent than the preceding one.

The first two mice were scarcely, if at all, verminous, but on the third one, many lice, *Hæmatopinus spinulosus*, were seen. These were dissected and examined for stages in the life-history of the parasite, as stated in the sequel.

The material was examined as far as possible in both the living and fixed condition, as the examination of living material is most important and tends to be overlooked.

The above-mentioned material was kindly given to me by Dr. Fantham.

## III. Occurrence of Parasite.

The blood of the mouse contained parasites of two forms:—(1) large, vermiform organisms, free-living in the plasma; and

* The numbers in square brackets refer to the list of Literature at the end of this paper.

(2) smaller forms, which are cytozoic. At first the latter are free in the plasma, then later, they penetrate usually into mononuclear leucocytes where they feed and grow, finally assuming again the free form. Very rarely do they occur in polymorphonuclear corpuscles, but specimens were seen in transitional corpuscles.

No parasites were seen within tissue-cells, whether of liver, heart, spleen, lung, kidney or gut. They seem purely blood parasites, though their presence appears to cause enormous hypertrophy of cells in their neighbourhood. This was especially well seen in the liver smears. The parasites were most abundant in these smears and in the portal blood, were fairly numerous in heart and kidney smears, but very few occurred in either lung or spleen preparations, though the latter organ (spleen) was enlarged. Bone-marrow preparations were also made, and schizogony was found to occur therein.

In the case of the first mouse, extravasation of blood into the gut had occurred and the gut-contents showed free parasites in this blood. Live parasites were studied usually from freshly shed peripheral blood.

Examination of the organs of the lice showed vermicule stages of the parasite in the gut and Malpighian tubes.

The Leucocytozoa were never associated with Trypanosomes in these mice, though such an association has been described for other Leucocytozoa [**1**] [**7**].

The lice appear to act as mechanical agents in propagating the disease, for lice removed from the third mouse and placed on another resulted in a very slight infection of the hitherto unaffected one. In the case of *L. canis*, Gerrard [**9**] reported that puppies, which were placed together, were cross-infected by the agency of ticks.

## IV. Methods.

### (a) *Fresh material.*

Freshly drawn blood, usually taken from the tip of the tail of the mouse under examination, was mixed with a small quantity of normal saline solution, to which in most cases a little alkaline methylene-blue was added. A drop of the mixture was examined in the well of a micro-slide provided with such a depression, or else on the slide or on the cover-slip, forming a hanging drop in the latter case. The cover-glass was always vaselined round the edges and so air in quantity was excluded from the preparation.

In this way, living parasites could be observed for several hours. Intra vitam staining with methylene-blue could also be thus accomplished. Much time was spent in examining the parasites in the fresh state.

Lice found on the third mouse were carefully examined for probable stages in an Invertebrate host. Hemiptera removed from the mouse were at once dissected in normal saline solution. Especial attention was paid to the alimentary canal, Malpighian tubules, salivary glands, reproductive organs, and body-cavity of the lice. Smears of these organs, fixed wet with osmic vapour, were afterwards stained and examined microscopically, but fresh preparations in normal saline to which a little methylene-blue had been added, were also examined in this case.

(b) *Fixed material.*

The blood smears were usually fixed wet with osmic vapour or with osmic vapour and alcohol. Occasionally they were allowed to dry quickly and afterwards treated with methyl alcohol before staining. The chief stains used were Giemsa's mixture of azur II. and eosin, Loeffler's alkaline methylene-blue, and Delafield's hæmatoxylin, the latter used alone or sometimes followed by safranin. Azur II. followed by lichtgrün was tried occasionally, and safranin alone—suggested by the presence of a refractile cyst-like envelope round some of the parasites—was tried, but found to be too transparent and diffuse. The best results were obtained with Giemsa's stain, alkaline methylene-blue, and hæmatoxylin. The same stains were used for the organ smears of lice.

The preparations were usually mounted in Canada balsam, sometimes left uncovered.

The various methods outlined above were tried for the purpose of correlation and corroboration, and to eliminate possible errors.

## V. General Structure.

The general shape of this parasite, which occurs either inside a leucocyte or free in the blood-plasma, may be described as vermiform or gregariniform, in fact, that of a vermicule (Pl. XXXIX. figs. 1, 2). However, there is very often no marked difference between the ends, which are then somewhat rounded; and further, as some of the parasites are comparatively broad for their length, they may be quite accurately described as bean-shaped or reniform. The size varied from $17\mu$ to $7\mu$ in length and $5{\cdot}9\mu$ to $4\mu$ in breadth.

The free parasites, averaging $10{\cdot}9\mu$ long by $5{\cdot}1\mu$ broad, are usually surrounded by a cytocyst which is very refractile and does not stain at all easily (Pl. XXXIX. fig. 8). Their cytoplasm is rich in granules which react vigorously toward stains and thereby obscure the oval nucleus lying beneath them. The distribution of the granules varies, and this accounts for the differences in the nuclear apparatus as seen in the figures. The nucleus is generally nearer one end in position.

Differences between the ends of the organism occur in cytozoic forms. One end may be larger than the other. This may be the natural result of the cytozoic habit, the organism assuming the form most suitable to a limited space, or it may be due to the twisting of the body on itself and within the spherical leucocyte, which results in the "thin edge" or "tailed" appearance of some of the parasites (text-fig. 154 D–K). **U**-shaped forms as described by Wenyon [**14**] were not seen. The average size of endo-globular forms was $8\mu$ long by $5\mu$ broad.

Among the free forms, some are relatively shorter and broader than the others (Pl. XXXIX. figs. 1, 6). Some writers [**12, 13**] would consider these broader forms as female Leucocytozoa, while the longer thinner ones (Pl. XXXIX. figs. 5, 8) would be regarded as male. I have no evidence to support this view, but regard them as extreme forms of a continuous series.

## VI. Movements.

### (a) *Movements of Trophozoites.*

When a parasite has penetrated a leucocyte, it remains at first near the periphery and so directs its movements that it ultimately comes to surround the nucleus to a very great extent.

Osmotic diffusion between host cell and parasite occurs and produces movement within the cell. When this is very vigorous, the oscillation produced may be so great as to cause semi-rotation of the leucocyte, even to the extent of 180°.

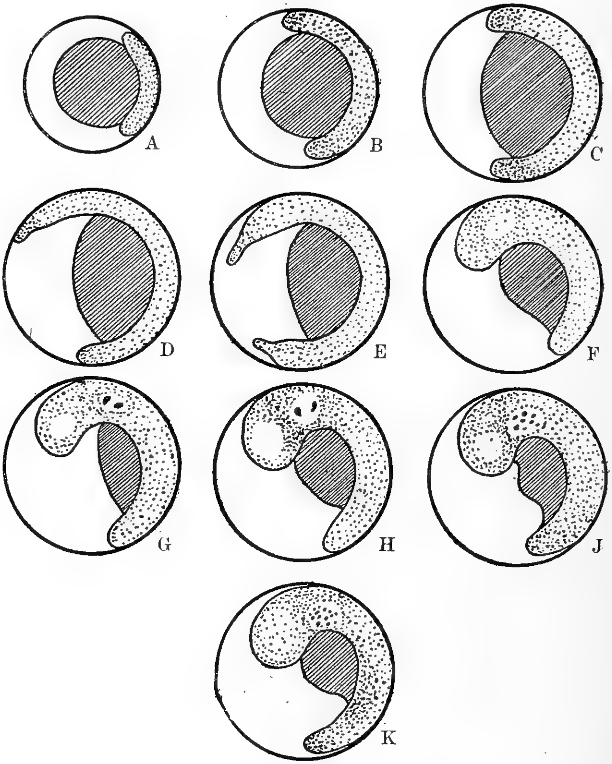
The movement of the parasite is more noticeable at one end. This appears to advance steadily by an outflow of the cytoplasm. This outflow is easily seen, for the protoplasm is richly granular and stains readily intra vitam with methylene-blue. The parasite lies near to the nucleus of the leucocyte, and its presence causes a movement of the nucleoplasm which appears in a state of agitation. Osmosis seems to be taking place from the leucocyte nucleus to the parasite, and the latter rapidly grows during this period (text-fig. 154, A–E).

The gliding movement continues, and the nucleus of the leucocyte, which was originally globular, becomes much altered in shape. Its nuclear membrane becomes less and less distinct, and at times it resembles a somewhat lens-shaped mass lying within the horns of a crescent formed by the parasite (text-fig. 154, D, E).

The organism continues its gliding movements and one end becomes much larger than the other. This is the more obvious and may be termed the anterior end. A comma-like appearance then results (text-fig. 154, G–J). The posterior end, being thinner, might be termed a tail, though this is not an accurate description. It certainly appears very filamentous at times, but this is because the organism has turned on its side and so exposed an edge to view.

On examining the surface of the parasite, numerous granules are evident. These are usually arranged in more or less regular rows. During movement of the organism as a whole, movements of the rows occur, and this suggests that the arrangement of the granules in rows is due to myonemes upon the body. Stained preparations show that such is the case (Pl. XXXIX. fig. 7). The slow gliding movement would be due then to contractions of these myonemes, and, further, the bowed appearance of the parasite within the cell could be explained as being the result of the stronger contractions of the myonemes at the inner edge of the organism with successively smaller contractions of the myonemes toward the outer (greater) curvature, where there would be a ring of relaxed myonemes. The axial line of the body, where, judging from the action of the granules, the movement is least, would be, according to this arrangement, a neutral area, neither contraction nor relaxation of the myonemes occurring within it.

Text-fig. 154.




Living *Leucocytozoön musculi.*

Diagrams of a young intra-corpuscular parasite observed in the living condition for seven hours.

In these diagrams the cytoplasm of the parasite is represented by small dots, more closely aggregated where the protoplasm stained more deeply. Vacuoles are left clear. The chromatin of the parasite is represented black in G–K, and the nucleus of the leucocyte is shown by shaded lines. The outline of the leucocyte is indicated by a circular area.

The nucleus of the leucocyte is not yet much displaced by the parasite, and no marked hypertrophy of the host-cell has yet occurred.

The time required for the assumption of the various forms mentioned varies with the specimen and with the stage of development at which the parasite may be. At the initiation of the trophic, intracellular phase of the life-history, the activity of the organisms is very great, and, correlated with this, there is the phase of most vigorous motion. The infected leucocyte figured in text-figure 154, A–K, was observed for a period of seven hours, and even then the exit of the parasite from the leucocyte was not seen, owing to the death of the leucocyte.

An early stage is seen in text-figure 154, A, where the parasite was lying in the leucocyte so that the nucleus of the latter was practically in full view. About twenty-five minutes later, the organism had spread itself out and become crescentic in form (text-fig. 154, B, C). The movements till then were very vigorous, and much oscillation of granules in both parasite and leucocyte nucleus was observed. Half an hour after the observation was commenced, the forward movements of the parasite slowed very much, though the movements of the granules remained much the same (text-fig. 154, D). About the same time the protoplasm of the parasite began to move from the periphery towards the anterior end, which became much more globose and began to curve (text-fig. 154, E, F). An anterior end could be distinguished definitely as such at the end of 55 minutes (text-fig. 154, F). Two hours after the first observation was made the parasite had assumed the "comma" form and a vesicle began to make its appearance (text-fig. 154, F–J). It remained in this condition for a long time, the only change that occurred being that the protoplasm became much more granular and there was a slight retraction of the posterior end, while the vacuole increased in size and chromatin masses appeared in it (text-fig. 154, G–K). Death of the leucocyte prevented further reliable observations being made on this parasite, but the exit of the organism from its host-cell was seen in other specimens (Pl. XXXIX. figs. 18, 19).

Extrusion of the parasite is brought about by internal pressure. The Leucocytozoön moves forwards with a slow, gliding movement. This continues steadily until extrusion is completed. There is slight resistance at the periphery of the leucocyte, but on the exit of the parasite, the protoplasm of the host-cell closes up and the point of exit is invisible (Pl. XXXIX. figs. 18, 19). The freed parasite remains quiescent for a short time after leaving the corpuscle.

Stages of endoglobular parasites are figured in Pl. XXXIX. figs. 15, 16, 17.

(b) *Movements of the small, free Merozoites.*

In some of the peripheral blood mixed with normal saline to which a little methylene-blue was added, sausage- or bean-shaped bodies occurred (Pl. XXXIX. fig. 13). These moved fairly actively, the movements being much more energetic if the organism were in the neighbourhood of a leucocyte. The body of the parasite would seem to be somewhat flattened, for it is able to turn freely somewhat in the fashion of *Nyctotherus*. The anterior end remains still, but the posterior part of the body turns over so that the upper surface becomes folded over the under, which, at the distal end, is now uppermost. The line of folding is somewhat oblique. Reversal of this movement occurs, and the organism appears to roll from side to side as a result of the combined movements.

Accompanying this movement there is a second. One surface of the body of the parasite contracts, and as a result, the ends of the body approximate somewhat more closely to one another than before. Relaxation follows, and the body straightens with a jerk which has the effect of forcibly propelling the organism forwards.

The path of the organism is never straight. Movement appears to be initiated at either end indifferently. The path is often very restricted and the organism remains for long periods at practically the same spot, though one of its ends may have vibrated in practically every direction.

## VII. Detailed Morphology.

### (a) *The Trophozoite.*

*Ectoplasm.*—In the trophozoite this is not markedly differentiated. It appears as a somewhat clearer portion in some specimens. Contractile elements or myonemes are present, arranged in longitudinal rows. These myonemes are very evident in some specimens (Pl. XXXIX. figs. 7, 11) and often are well seen in the region of the nucleus. A refractile cytocyst is often present, and when this is well marked, a clear space usually intervenes between it and the ectoplasm (Pl. XXXIX. figs. 8, 9, 10, 11, 12). The cytocyst is always thin and membranous.

*Endoplasm.*—This is richly granular (Pl. XXXIX. figs. 1, 4) and the granules react vigorously towards stains. In some specimens the endoplasm appears almost alveolar (Pl. XXXIX. fig. 12) owing to the disposition of the granules in regular networks. There are concentrations of granules beneath the myonemes and also in the region of the nuclear membrane. Frequently a relatively clear space appears near one end, almost suggestive of a large vacuole (Pl. XXXIX. figs. 3, 4, 7, 21). In a few specimens isolated chromatic granules are present (Pl. XXXIX. fig. 8). The latter do not seem to have any direct connection with the nucleus.

*Nucleus.*—This is circular or oval, approximately central in position or sometimes nearer to one end and possesses a definite nuclear membrane. Its chromatin is diffusely spread within and much achromatic substance is present. The structure of the nucleus may best be described as vesicular. There does not appear to be a karyosome as described by James [**10**] in one of his forms of *Leucocytozoön canis*. In its general structure and behaviour towards stains, the nucleus of this parasite is very suggestive of that of *Trypanosoma rajæ*.

The nuclear membrane is definite. It has a somewhat beaded appearance in some stained preparations and that can also be seen in living material (Pl. XXXIX. figs. 2, 4, 6, 16). Extra-nuclear chromatin also occurs, for in favourably stained specimens, a chromatic cap can be distinguished at either end (Pl. XXXIX. fig. 15), and isolated granules also occur (Pl. XXXIX. fig. 8).

### (b) *The vermicules of* Hæmatopinus spinulosus.

The vermicules of the lice present the following appearance:—

Their ectoplasm is not well differentiated from the endoplasm, but indications of myonemes are present and are best seen at the ends of the organism.

The endoplasm is granular and much as in the trophozoites, but marked concentrations of granules do not occur.

The nucleus in some appears to lie in a vacuole, and in most specimens there is a clearer portion in the neighbourhood of the nucleus. Its chromatin is more abundant than in the blood-inhabiting forms, and the nuclear membrane is fairly distinct (Pl. XXXIX. figs. 23, 24).

These vermicules were about 8·8$\mu$ long and 1·4$\mu$ broad.

## VIII. Multiplication.

### (a) *Schizogony.*

Examination of bone-marrow showed the presence of small, oval cysts (cytocysts) about 13·1$\mu$ long by 8·9$\mu$ broad (Pl. XXXIX. fig. 20). These contained relatively few (about 12) but distinct, small forms with a definite vermicular or reniform contour. Each of these small vermicules was about 4·4 long by ·8$\mu$ broad (Pl. XXXIX. fig. 20). They are the merozoites, produced by the multiple or asexual fission of a schizont inside the cytocyst. The general protoplasm was granular. Remains of the nucleus of the leucocyte host were seen on the side of the cyst. Inside the cyst were also some remains of the residual protoplasm of the schizont. By the dehiscence of the cyst these merozoites are set free in the blood-plasma, where they become vermicules or young trophozoites.

### (b) *Possible Association of Trophozoites.*

Two parasites lying in one corpuscle were observed (Pl. XXXIX. fig. 21), or two which had just left the corpuscles (Pl. XXXIX. fig. 22). One such case, of two parasites lying in the remains of a leucocyte, suggested possible association (Pl. XXXIX. fig. 21). Here the two forms, partially free from the host-cell or leucocyte, came in contact with one another and became enveloped in a common cytocyst. The nucleus of one appeared to come nearer the area common to the two than the other, and a chromatin mass was seen in the common area of the couple. This suggested that transference of chromatin takes place from one parasite to the other. However, the formation of a definite zygote from these associated forms was, unfortunately, not seen.

Again, in Pl. XXXIX. fig. 22, those authorities who believe in differentiation into male and female forms, would see a female form (macrogametocyte) in the upper, broader and granular parasite, and a male form (microgametocyte) in the lower, longer and narrower form. I do not go quite so far personally, as I have doubts of sexual differentiation, preferring the series view (see page 707). However, in the present state of our knowledge, the suggestion of sexual forms is worthy of note.

## IX. Life-History.

Commencing with the free vermicule which may be either a sporozoite or a merozoite, the following sequence probably occurs. The parasite lives awhile in the plasma as a small, active form (Pl. XXXIX. fig. 13). This ultimately penetrates a leucocyte and grows actively there as an endoglobular trophozoite. A cytocyst may or may not form around it (Pl. XXXIX. figs. 15, 16, 17). After a time, it becomes free in the plasma, rupturing the host-cell as it issues, but leaving little or no trace of its presence behind. In the plasma it assumes the free trophozoite form. Association between trophozoites may perhaps occur (*cf.* Pl. XXXIX. figs. 21, 22), and the result of this is probably a zygote, which one would expect to find in the louse, on homology with the malarial parasite—but more definite information is lacking.

Other free forms may reach the bone-marrow. There encystment occurs, and a schizont, in a thin but distinct cytocyst, is produced. This schizont by multiple fission gives rise to relatively few but definite merozoites. By the rupture of the cyst, these are set free into the blood-stream where growth again occurs, leading to adult trophozoites. This is the schizogonic cycle of the parasite.

Ecto-parasitic on the mouse was the louse, *Hæmatopinus spinulosus*. By the bite of this louse infected blood passes from the mouse to the mouth and gut of the invertebrate host, and so we find the small, gregariniform vermicules shown in Pl. XXXIX. figs. 23, 24. These ultimately reach the saliva of the louse and by this insect are probably transferred to another mouse. Perhaps a sexual cycle of the Leucocytozoön occurs in the louse, but of this I have, unfortunately, no definite evidence. Probably the louse is merely a mechanical agent in spreading the infection.

## X. Affinities of the Parasite, and Summary.

### *Affinities of Parasite.*

The term Leucocytozoön was used by Danilewsky [**8**] in 1890 for vermiform parasites stated to occur in the leucocytes of certain birds. Danilewsky confined his observations to fresh preparations.

Similar parasites were afterwards studied by Berestneff, Sacharoff, Ziemann, and Laveran. The latter states that Danilewsky's parasites really occur in immature erythroblasts. The parasite was stated later by Schaudinn [**12**] in 1905 to be a stage in the life-history of a Spirochæte. The matter is fully discussed by James [**10**], and as it is very controversial, need not be dwelt on further here.

Bentley [**3**] and James [**10**] independently described a parasite from the leucocytes of pariah dogs in India in 1905. This was a true Leucocytozoön and is known as *L. canis*. A memoir by Christophers [**5**] on the same parasite appeared in 1906, and the following year he worked out the sexual cycle in the tick [**6**]. Other Leucocytozoa have been described in mammals by Patton [**11**] in the Indian palm-squirrel, *Funambulus pennantii*, under the name of *L. funambuli*; in Malay dogs by Gerrard [**9**] and Wenyon [**14**]; and in rats in various parts of the world by Balfour [**2**] from leucocytes of *Mus decumanus* at Khartoum, by Adie [**1**] from *Mus rattus* in the Punjaub (as *L. ratti*), and by Cleland [**7**] from rats in Perth, Western Australia. These parasites in rats are probably best known as *L. muris* (cf. page 704). A form known as *L. felis* has been described, I believe, from the Indian bazaar cat in Madras by Christophers and Patton.

Outside mammals, from other vertebrates, we have recorded *L. ranarum* from the Amphibian *Leptodactylus ocellatus* by Carini [**14**]; and quite recently *L. lovati*, a form from the leucocytes of grouse by Seligmann and Sambon [**13**].

These are, I think, all or nearly all the Leucocytozoa recorded to date (May, 1908). Whether they have any intimate connection with Flagellates, such as that suggested by Schaudinn [**12**] remains to be seen—probably they have not.

These parasites are all gregariniform. Those in mammals are much about the same size, and occur both free in the plasma or endoglobular in the leucocytes. Schizogony is known in the bone-marrow [**5**] and liver.

Laveran suggested that the Leucocytozoa should be included in the genus *Hæmogregarina*. However, as they occur in a non-hæmoglobin-containing host, viz. leucocytes, while strict Hæmogregarines are found in erythrocytes, I think the generic name *Leucocytozoön* should be retained. The name for the parasite described in this memoir for the first time in the leucocytes of the mouse is *L. musculi*.

*Summary.*

(1) The forms of *L. musculi* here described occur in the mononuclear and transitional leucocytes of white mice.

(2) The free trophozoites in the plasma are gregariniform or reniform vermicules, the average size being $10{\cdot}9\mu$ long and $5{\cdot}1\mu$ broad (*cf.* Pl. XXXIX. figs. 1–12).

(3) The free trophozoites sooner or later enter leucocytes of the host and grow at the expense of the nucleus of the leucocyte

(*cf. Karyolysus* among the Hæmogregarines). A thin cytocyst is formed probably by the host-cell around the parasite (Pl. XXXIX. figs. 16, 17).

(4) Endoglobular forms are on the average 8μ long by 5μ broad (*cf.* Pl. XXXIX. figs. 15, 16, 17).

(5) Schizogony takes place in the bone-marrow. An endoglobular trophozoite rounds itself off and becomes a schizont, breaking up into merozoites, each about 4·4μ long and ·8μ broad (Pl. XXXIX. fig. 20). This again suggests affinities with *Karyolysus*, judging by Labbé's figures of schizogony in *Karyolysus*.

(6) Two parasites may sometimes occur within one host-cell. Two such forms suggesting the beginning of association are shown in Pl. XXXIX. figs. 21, 22.

Differentiation into male and female forms could not be made out with certainty, though some parasites were shorter, broader, and more granular than others.

(7) Vermicules were found in the gut and Malpighian tubules of lice, ectoparasitic upon the mice, but unfortunately no evidence of a sexual cycle in the louse was obtainable. Perhaps the lice merely act as mechanical agents in the transfer of the parasites among the mice.

(8) The parasites are found in smears from the heart and liver in abundance. They are less numerous in spleen and kidney smears, also in the bone-marrow and peripheral circulation. They were not abundant in the latter.

(9) No Trypanosomes were seen in the infected mice.

(10) The movements of the vermicules or trophozoites of this parasite in the blood-plasma of its Vertebrate host are fully described in section VI. of this memoir.

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## XII. EXPLANATION OF PLATE XXXIX.

The figures on the Plate XXXIX. were outlined with camera lucida (Abbé), using Zeiss $\frac{1}{12}$ inch achromatic and 2 mm. apochromatic oil-immersion objectives with compensating oculars 4 and 8. Zeiss E objective was also used for fresh preparations.

Fig. 1. Shows a free trophozoite which is broad and short. Stained Giemsa. × 1700. Liver smear of 1st mouse.

Fig. 2. Free trophozoite, rather large. Shows one chromosome. Giemsa. × 1700. Liver smear of 2nd mouse.

Fig. 3. Smaller, possibly younger, form. It has one patch of chromatin. Giemsa. × 1700. Liver smear of 1st mouse.

Fig. 4. Form showing dotted nucleus, also dots along the nuclear membrane. Giemsa. × 1700. Heart smear of 1st mouse.

Fig. 5. Parasite showing central chromatin filaments. The Leucocytozoön is not so markedly granular as some. Giemsa. × 1700. Liver smear of 1st mouse.

Fig. 6. *Cf.* fig. 1. The nucleus is vesicular and chromatin is distributed round the nuclear membrane. Giemsa. × 1700. Liver smear of 2nd mouse.

Fig. 7. Shows pale, vesicular nucleus, also myonemes (*my*) are well seen. The ends are somewhat pointed. Giemsa. × 2250. Liver smear of 2nd mouse.

Fig. 8. Parasite in a clear cytocyst (*cy*). It has a patch of extra-nuclear chromatin in the endoplasm. Giemsa. × 1700. Liver smear of 1st mouse.

Fig. 9. Parasite in cytocyst. Caps of chromatin present. Giemsa. × 1700. Kidney smear of 1st mouse.

Fig. 10. Parasite in cytocyst with deeper staining nucleus; also very granular protoplasm. Giemsa. × 1700. Liver smear of 1st mouse.

Fig. 11. Shows pale-staining vesicular nucleus and definite myonemes (*my*). In cytocyst (*cy*). Giemsa. × 1700. Liver smear of 1st mouse.

Fig. 12. Broad parasite within cytocyst (*cy*), showing alveolar protoplasm. Giemsa. × 1700. Spleen smear of 1st mouse.

Fig. 13. Free forms in plasma. Methylene-blue. Peripheral blood of 3rd mouse.

Fig. 14. Free vermicule penetrating mononuclear leucocyte. Methylene-blue. × 1200. Peripheral blood of 3rd mouse.

Fig. 15. Young intra-corpuscular stage. Parasite has a chromatin cap at either end. Giemsa. × 1700. Liver smear of 2nd mouse.
Figs. 16, 17. Endoglobular parasites in mononuclear Leucocytes. Giemsa. × 1700. Liver smear of 1st mouse.
Fig. 18. Shows egress of parasite from its host-cell. Intra vitam staining with methylene-blue. × 1200. Peripheral blood of 3rd mouse.
Fig. 19. Egress of parasite shown in fig. 18 from leucocyte just completed, after rotation of leucocyte. Intra vitam. Methylene-blue. Peripheral blood of 3rd mouse.
Fig. 20. Schizont within cytocyst in bone-marrow. Twelve merozoites are present, together with residual protoplasm (*r.pl.*). Methylene-blue. × 1600. Bone-marrow of 2nd mouse.
Fig. 21. Possible association of the two Leucocytozoa. A common cytocyst is present. Chromatin is showing passing across from one to the other. One Leucocytozoön is not entirely free from its host-cell. Each of the couple has a vacuole. Giemsa. × 1700. Liver smear of 1st mouse.
Fig. 22. Possible association. Both of the Leucocytozoa are free from their host-cell or cells. Liver smear of 1st mouse. Giemsa. ×1700.
Figs. 23, 24. Vermicules from the midgut of *Hæmatopinus spinulosus*. Giemsa. × 1700.

## 8. Descriptions of African Micro-Lepidoptera. By E. Meyrick, B.A., F.R.S., F.Z.S.

[Received June 13, 1907.]

This paper is a contribution towards the knowledge of the Tortricina and Tineina of the African region, which are at present very little known. The material for it was received from various collectors, but for the greater part of it I am indebted to Mr. A. J. T. Janse, of Pretoria, whose specimens are also particularly notable for their fine condition. Mr. Janse further furnished notes on localities and time of appearance, based on additional examples retained by himself besides those which he sent me. In addition to some known species recorded from Africa for the first time, 108 species and 10 genera are described as new.

### Eucosmidæ.

Lobesia aeolopa Meyr.

This species, described from India and Ceylon (Journ. Bomb. N. H. Soc. xvii. p. 976), I possess also from Grahamstown, Cape Colony, and the island of Réunion.

Polychrosis harmonia, sp. n.

♂ ♀. 10–13 mm. Head, palpi, and thorax light ochreous, face whitish-suffused. Abdomen whitish-ochreous, sometimes suffused with grey. Fore wings elongate, slightly dilated posteriorly, costa slightly arched, apex obtuse, termen obliquely rounded; pale brownish-ochreous; markings deep yellow-ochreous; an inwardly oblique spot beneath fold before middle (representing lower portion of angle of a strongly angulated basal patch, of which remainder is obsolete); central fascia rather narrow, sometimes with a few black scales, posterior edge excavated near dorsum; a blotch before middle of termen, connected by a narrow projection with apex; three short oblique dark fuscous strigulæ on costa posteriorly, beneath first a small deep ochreous spot; a fine line of blackish scales along termen; cilia yellow-ochreous, on costa paler spotted with fuscous. Hind wings grey; cilia whitish-grey, with grey subbasal shade.

Transvaal, Pretoria district, from November to March (*Janse*); nine specimens.

Polychrosis scorpiodes, sp. n.

♂ ♀. 17–18 mm. Head whitish-ochreous, face more whitish. Palpi ochreous slightly sprinkled with dark fuscous, second joint whitish towards apex and beneath. Thorax light ochreous mixed with brown. Abdomen grey, anal tuft pale ochreous. Fore wings elongate, posteriorly dilated, costa slightly arched, apex obtuse, termen obliquely rounded; ochreous-whitish, with some scattered ochreous-brownish strigulæ, towards dorsum and posteriorly more or less marbled with pale bluish-silvery-grey; costa directly strigulated with blackish; a basal patch of suffused ochreous-brown strigulation, marked with black on fold, outer edge obtusely angulated below middle; central fascia ochreous-brown, irregular, broadly interrupted below middle so as to leave beneath only a triangular spot before tornus, marked in middle with several small irregular black spots, and followed beneath costa by a suffused blue-grey patch; a roundish ochreous-brown patch before middle of termen, marked with black on each side; a small ochreous-brown apical spot marked with black. Hind wings grey; cilia whitish-grey, with grey subbasal shade.

Transvaal, Pretoria district, Pietersburg, from August to December (*Janse*); two specimens.

## Eccopsis Z.

Assuming for the present that this genus is tenable, and distinguished by the peculiar *thickened* dorsal lobe of hind wings, then the following species is referable to it.

Eccopsis acrocosma, sp. n.

♂. 15 mm. Head and thorax fuscous irrorated with pale specks. Palpi rather long, porrected, second joint triangularly scaled, terminal joint moderately long, pointed; second joint with base and lower edge whitish, upper edge with a metallic-bluish stripe, intermediate space orange crossed by an oblique black line and edged beneath with blackish, terminal joint blackish with upper edge metallic-bluish. Abdomen fuscous. Fore wings elongate, posteriorly considerably dilated, costa gently arched, apex obtuse, termen sinuate, somewhat oblique; rather dark fuscous, tips of scales whitish, appearing to form a very fine and regular transverse striation; costa marked with very short oblique dark fuscous strigulæ, between and beneath which are some leaden-grey scales; a small irregular black spot in disc at $\frac{2}{3}$, irregularly centred with metallic-blue; a triangular orange apical spot, marked with three blue-leaden-metallic streaks, uppermost short, slender, two lower stronger and partly edged with black, converging to apex: cilia fuscous sprinkled with whitish, with darker subbasal shade. Hind wings rather dark fuscous; cilia fuscous.

Nyassa-land, Songwe Valley; one specimen.

The singular apparently corresponding coloration of the palpi and tips of fore wings has doubtless some explanation in local circumstances.

Argyroploce orthacta, sp. n.

♀. 18 mm. Head whitish-fuscous tinged with reddish, crown irrorated with blackish. Palpi moderate, porrected, triangularly scaled, ochreous-whitish tinged with fuscous. Thorax reddish-fuscous mixed with blackish. Abdomen grey. Fore wings elongate-triangular, costa gently arched, apex obtuse, termen rounded, somewhat oblique; greyish-olive, with irregular grey-whitish striæ rising from pairs of whitish strigulæ on costa; a large sharply-marked dark fuscous basal patch mixed with dark red-brown, outer edge straight, oblique, finely edged with white, reaching on dorsum to beyond middle; a round patch of ground-colour towards termen above middle outlined by pale striæ, and broadly suffused posteriorly with dark reddish-fuscous; a streak of reddish suffusion mixed with blackish along termen; cilia ochreous-grey irrorated with whitish, indistinctly barred with darker grey, and with a dark grey subbasal line. Hind wings fuscous, suffused with dark fuscous towards termen; cilia fuscous, paler towards tips.

Transvaal, Pretoria and Zoutpansberg districts, in September and from December to March (*Janse*); one specimen.

Pamplusia sardonia, sp. n.

♂ ♀. 15–18 mm. Head, palpi, and thorax pale grey, irrorated with grey-whitish, and more or less suffused with pale crimson, palpi rather long. Abdomen rather elongate, dark grey. Fore wings elongate, gradually dilated, costa slightly arched, apex obtuse, termen almost straight, oblique; dark leaden-grey, with numerous irregular dull crimson-reddish transverse strigæ, sometimes largely suffused together; costa obliquely strigulated with dark fuscous and whitish; cilia fuscous mixed with reddish, with a whitish basal line on termen, apical third light reddish. Hind wings dark fuscous; cilia fuscous, with dark fuscous subbasal shade, tips pale brownish round apex.

Transvaal, N.E. Pretoria district, in December and January (*Janse*); three specimens.

Enarmonia batrachopa, sp. n.

♂ ♀. 18–22 mm. Head pale ochreous, face and sides suffused with dark fuscous. Palpi dark fuscous. Thorax with double posterior crest, pale ochreous, broadly suffused laterally with dark fuscous, sometimes mixed with ferruginous. Abdomen rather dark fuscous, in ♂ with large expansible pale greyish-ochreous genital tuft. Posterior tibiæ in ♂ with very large dense brush of greyish-white hairs above, including a blackish-grey tuft towards apex. Fore wings elongate-triangular, costa moderately arched, apex obtuse, termen almost straight, somewhat oblique; in ♂ with rather strong dorsal scale-projections towards base and beyond middle; light brownish or brownish-ochreous, obscurely strigulated with whitish, especially in ♂ towards dorsum and termen; most of wing except dorsum and termen in ♂ irrorated with fuscous-crimson and strigulated with black, in ♀ largely suffused with dark fuscous sometimes mixed with dull crimson, posterior edge of this area in ♀ well-defined and forming a blunt wedge-shaped projection extending downwards from upper half to near termen before middle, in ♂ indicated but inconspicuous; costa marked with some pale strigulæ, and in ♂ with several small fuscous-crimson and black spots; sometimes a distinct pale greenish discal dot beyond middle; a semioval olive-greenish or dark reddish-fuscous patch mixed with black occupying anterior half of dorsum, its central area more or less suffused with whitish-ochreous, especially in ♂; an acute-triangular olive-greenish spot mixed with black on dorsum before tornus: cilia whitish-fuscous irrorated and barred on upper half of termen with ferruginous, on lower half with blackish. Hind wings in ♂ with a deep semicircular excavation on termen above tornus; dark fuscous, darker posteriorly; in ♂ vein 1 *b* clothed with rough whitish hairs; cilia whitish-grey, with grey subbasal shade.

Cape Colony, Eastern portion; Natal; Transvaal; Rhodesia; bred in July and August from larvæ feeding on citrous fruits, stone-fruits, and guavas, sometimes doing extensive damage (*Lounsbury*); four specimens.

Eucosma leucopetra, sp. n.

♂. 12–14 mm. Head whitish, sides of crown suffused with ochreous. Palpi moderate, porrected, second joint with long rough projecting scales above and beneath; white, second joint tinged with pale brownish-ochreous. Thorax whitish, irregularly tinged with brownish and spotted with dark fuscous. Abdomen fuscous, more or less suffused with yellowish or whitish towards base, anal tuft whitish-ochreous. Fore wings elongate, somewhat dilated posteriorly, costa slightly arched, fold extending to $\frac{2}{5}$, apex obtuse, termen slightly indented above middle, rather oblique; ferruginous-ochreous, often more or less suffused with fuscous, variably and irregularly strigulated with white and dark fuscous; posterior $\frac{3}{5}$ of costa with five pairs of oblique white strigulæ, whence proceed short irregular leaden-metallic strigæ; a large irregular suffused white median dorsal blotch, including several grey strigulæ; ocellus large, white, irregular, containing several pale metallic-grey spots in two transverse series, and two black dots between those; sometimes several other black dots scattered round this: cilia dark reddish-grey finely irrorated with white, on tornus with a white patch. Hind wings with 3 and 4 stalked; grey; cilia pale grey or whitish-grey, with faint darker subbasal line.

TRANSVAAL, Pretoria district, in December, January, and July (*Janse*); seven specimens.

CROCIDOSEMA PLEBEIANA Z.

TRANSVAAL, Pretoria, Pietersburg, January to May (*Janse*).

I take the opportunity of noting that *Steganoptycha obscura* E. Woll., described from St. Helena, is certainly a synonym of this species, which is now common in suitable localities in all quarters of the globe, doubtless artificially introduced with its food-plant in gardens. The genus is hardly worth separating from *Cydia*, the single species agreeing in all respects except the peculiar tuft of hind wings in ♂.

CYDIA TUMULATA, sp. n.

♀. 16 mm. Head and thorax pale brownish-ochreous, crown with a dark fuscous central stripe. Palpi pale brownish-ochreous sprinkled with fuscous. Abdomen grey. Fore wings elongate, posteriorly dilated, costa gently arched, apex obtuse, termen sinuate, little oblique; pale brownish-ochreous, irregularly mixed and spotted with grey, with scattered dark fuscous and black scales; costa strigulated with dark fuscous, between these whitish-tinged, posteriorly giving rise to three oblique brown strigæ alternating with leaden-grey strigæ; two dark fuscous spots on dorsum, first slightly oblique at $\frac{1}{3}$, second larger and somewhat elongate-triangular at $\frac{3}{4}$, space between these suffusedly striated with whitish; ocellus indistinctly margined with leaden-metallic a small brown apical spot; some minute black dots on termen: cilia brownish sprinkled with whitish, round apex and on upper half of termen suffused with blackish. Hind wings with 3 and 4 stalked; grey, dark posteriorly; cilia grey.

TRANSVAAL, Pretoria district, in December and January (*Janse*); one specimen.

CYDIA ISOGRAMMA, sp. n.

♂ ♀. 12–16 mm. Head fuscous, sides and face more or less mixed with ochreous. Palpi fuscous, second joint usually with a central ochreous spot. Thorax fuscous, patagia pale ochreous. Abdomen whitish-ochreous irrorated with grey. Fore wings elongate, slightly dilated posteriorly, costa gently arched, apex obtuse, termen sinuate-indented, little oblique; whitish-ochreous, becoming yellow-ochreous towards costa posteriorly and termen; margins of cell, internal veins, and veins between cell and termen more or less lined with blackish-fuscous or sometimes partially with pale leaden-grey, with some additional interneural lines, ground-colour more or less whitish-suffused between these; dorsal area marked with irregular pale leaden-grey lines, and some scattered blackish-fuscous marks, with a narrow blackish-fuscous patch or streak along dorsum from near base to about $\frac{2}{5}$, and a small irregular ill-defined blackish-fuscous dorsal spot at $\frac{2}{3}$; costa blackish-fuscous, with more or less paired silvery-whitish strigulæ throughout, on posterior $\frac{2}{3}$ emitting oblique silvery-grey strigæ; a slender ferruginous-ochreous streak runs from middle of costa through posterior margin of cell to posterior dorsal spot; a silvery mark along lower half of termen: cilia whitish-ochreous, with a dark grey bar marked with dark fuscous in middle of termen, and base more or less marked with dark fuscous round tornus and above apex. Hind wings with 3 and 4 connate; grey; cilia whitish, with grey subbasal line.

TRANSVAAL, Pretoria, in March (*Janse*); CEYLON, Patipola, Maskeliya, and Diyatalawa, from March to September (*Green, Pole, Alston, Fletcher*); eight specimens.

CYDIA PSAMMACTA, sp. n.

♂ ♀. 17–19 mm. Head whitish-ochreous. Palpi with long rough scales, pale fuscous, towards tip of second joint above ochreous-whitish. Thorax whitish-ochreous, partially tinged with brownish. Abdomen light fuscous. Fore wings elongate, costa gently arched, apex obtuse, termen somewhat indented-sinuate, rather oblique; whitish-ochreous, suffusedly strigulated with fuscous suffused with brownish-ochreous, except on a large clear space occupying most of dorsal area towards middle, posterior half suffused with brownish-ochreous; costa and dorsum shortly strigulated with blackish, posterior half of costa with five pairs of whitish strigulæ, whence proceed oblique leaden-grey strigæ; ocellus represented by an irregular silvery-grey whitish blotch, cut by a slender transverse streak of ground-colour containing several irregular black marks, and with some other scattered black marks before and above it: cilia pale ochreous irrorated with whitish, round apex and upper half of termen suffused with dark fuscous. Hind wings with 3 and 4 stalked; grey; cilia whitish-grey, with darker subbasal line.

TRANSVAAL, Pretoria district, in December and January (*Janse*); three specimens.

LASPEYRESIA DELINEANA Walk.

(*Grapholitha delineana* Walk. Cat. xxviii. 389; *G. apicatana, ib.* 390; *Laspeyresia isacma* Meyr. Journ. Bomb. N. H. Soc. xviii. 144.)

TRANSVAAL, Pretoria, in January (*Janse*); MAURITIUS, Port Louis, in May. Occurs also in India and China.

LASPEYRESIA TRICENTRA Meyr.

TRANSVAAL, Pretoria, Pietersburg, from December to February (*Janse*).

A common Indian species, probably imported into Africa with its food-plant (*Crotalaria*). African specimens show some individual variation, and the hind wings are generally rather lighter, but I can find no reliable distinction. In India there are several very closely allied species.

## TORTRICIDÆ.

CACOECIA HEDRASTIS, sp. n.

♂. 12–13 mm. Head whitish-ochreous. Palpi moderately long, whitish-ochreous irrorated with dark fuscous. Thorax whitish-ochreous irrorated with fuscous. Abdomen grey, anal tuft ochreous-whitish. Fore wings suboblong, anteriorly rather strongly, posteriorly slightly arched, apex obtuse, termen straight, rather oblique, costal fold narrow, extending from base to beyond $\frac{1}{3}$; whitish-ochreous, with some scattered fuscous scales; basal patch indicated by increased fuscous irroration but not defined, on costal fold dark fuscous; central fascia moderately broad, dark fuscous, lighter and more ill-defined on lower half of posterior edge; costal patch flattened-triangular, dark fuscous, its apex connected by a dark fuscous striga with tornus; a dark fuscous striga along upper part of termen; cilia whitish-ochreous. Hind wings grey; cilia ochreous-grey-whitish, with a grey shade.

TRANSVAAL, Pretoria district, from January to March (*Janse*); two specimens.

TORTRIX CEDROTA, sp. n.

♂. 12 mm. Head and thorax pale yellowish-ochreous. Palpi moderate, porrected, ochreous-yellowish, basal half of second joint irrorated with blackish. Abdomen grey, anal tuft pale yellowish. Fore wings elongate, posteriorly dilated, costa gently arched, apex obtuse, termen obliquely rounded; glossy whitish-ochreous; basal patch suffused with ochreous-yellowish, costal edge and dorsal half irrorated with black, outer edge obtusely angulated in middle; central fascia moderately broad, suffused with ochreous-yellowish and irrorated with blackish, anteriorly edged with ochreous-yellow; costal patch triangular, dark grey mixed with black, edged with ochreous-yellowish, and connected with tornus by an ochreous-yellow striga sprinkled with blackish; some yellowish strigulæ irrorated with blackish along termen: cilia whitish-yellowish. Hind wings grey; cilia yellowish-grey-whitish, with a grey line.

TRANSVAAL, Pretoria, in March (*Janse*); one specimen.

TORTRIX AFRICANA Wals.

(*Conchylis africana* Wals. Trans. Ent. Soc. Lond. 1881, 227, pl. x. 6.)

This species, which I have from the Transvaal and Natal, I refer here.

TORTRIX CAPENSANA Walk.

(*Teras capensana* Walk. Cat. xxviii. 295; *T. reciprocana*, ib. 295; *T. meridionana*, ib. 295; *Tortrix capitana* Feld. Reis. Nov. pl. cxxxix. 48, 49; *Cacoecia adustana* Wals. Trans. Ent. Soc. Lond. 1881, 222, pl. x. 1; *Lozotænia dorsiplagana*, ib. 223, pl. x. 2.)

I am of opinion that all these names represent only one variable species, which is common and generally distributed in Transvaal, Natal, and Cape Colony, and is a true *Tortrix*.

TORTRIX IOCOMA, sp. n.

♂. 18–22 mm. Head orange. Palpi moderate, porrected, ochreous-orange, sometimes sprinkled with fuscous. Thorax pale ochreous-yellowish, anteriorly suffused with orange. Abdomen light ochreous-yellowish. Fore wings elongate, hardly dilated, costa gently arched, apex obtuse, termen nearly straight, rather oblique; light ochreous-yellowish, costa slightly yellower: cilia pale yellowish. Hind wings very pale grey, suffused with whitish-yellowish towards costa and apex; cilia pale yellowish.

TRANSVAAL, N.E. Pretoria district, in December and January (*Janse*); four specimens.

TORTRIX AGROECA, sp. n.

♂. 20 mm. Head, palpi, and thorax brownish-ochreous, palp moderate, porrected. Abdomen dark grey, anal tuft light yellowish. Fore wings suboblong, slightly dilated posteriorly, costa gently arched near base, thence nearly straight, apex obtuse, termen nearly straight, rather oblique; brownish-ochreous: cilia light brownish-ochreous. Hind wings fuscous-grey finely irrorated with blackish; cilia pale brownish-ochreous.

TRANSVAAL, Pretoria district, in December (*Janse*); one specimen.

## GELECHIADÆ.

PALTODORA PSACASTA, sp. n.

♂ ♀. 12–14 mm. Head and thorax whitish-yellowish. Palpi yellow-whitish, lower half of second joint fuscous, tuft short, spreading. Antennæ fuscous. Abdomen yellow-whitish, in ♂ with a central black spot. Fore wings elongate, very narrow, costa gently arched, apex pointed, termen very obliquely rounded; whitish-yellow, with brassy reflections; plical and second discal stigmata black; some light brown suffusion, sometimes sprinkled with darker fuscous, forming usually a streak along basal $\frac{2}{5}$ of costa, a spot resting on plical stigma, a smaller spot obliquely above and beyond this, a small spot before tornus, a larger spot on costa at $\frac{2}{3}$, a patch between second discal stigma and termen, and an apical patch, but these vary somewhat in development: cilia whitish-yellowish, above apex with a fuscous spot, sometimes with two or three cloudy fuscous antemedian dots on termen.

Hind wings with 6 and 7 stalked; grey-whitish; cilia pale whitish-yellowish.

TRANSVAAL, Pretoria district, from November to February (*Janse*); five specimens.

ARISTOTELIA SIROTA, sp. n.

♂. 15 mm. Head and thorax ochreous-whitish sprinkled with brown. Palpi moderately long, rather thickened with scales, whitish, second joint light brownish. Antennæ whitish-ochreous. Abdomen light grey, three basal segments ochreous-yellowish. Fore wings elongate, narrow, costa gently arched, apex acute, termen extremely obliquely rounded; 6 out of 7 near base; ochreous-whitish, faintly streaked longitudinally with pale brownish-ochreous; some dark fuscous irroration tending to form indistinct streaks on veins; plical stigma small, fuscous, second discal formed by a small round spot of dark fuscous irroration: cilia whitish-ochreous tinged with brownish. Hind wings grey-whitish; cilia whitish-ochreous.

TRANSVAAL, Pretoria district, in August, September, and January (*Janse*); one specimen.

ARISTOTELIA ACRENA, sp. n.

♀. 12 mm. Head and thorax whitish-ochreous mixed with deep ochreous-yellow. Palpi moderately long, loosely scaled, whitish, second joint mixed with yellowish and sprinkled with dark fuscous, terminal joint sprinkled with ochreous. Antennæ pale ochreous. Abdomen ochreous-yellowish, mixed with dark fuscous on sides and posteriorly. Fore wings elongate, very narrow, costa slightly arched, apex acute, produced, termen extremely oblique, sinuate; 7 and 8 out of 6; whitish-ochreous somewhat sprinkled with fuscous; some deep ochreous-yellow suffusion forming streaks beneath costa and along submedian fold, and a broad patch occupying most of postmedian area except a narrow terminal fuscous fascia sprinkled with dark fuscous; a blackish dot at base of costa, two beneath costa at $\frac{1}{5}$ and $\frac{2}{5}$, two on fold obliquely beyond these respectively, one in disc beyond middle, and one at $\frac{2}{3}$: cilia ochreous-yellowish, round apex with a few dark fuscous specks. Hind wings grey; cilia whitish-ochreous tinged with grey.

TRANSVAAL, Pietersburg, in April (*Janse*); one specimen.

ARISTOTELIA PELTOSEMA Low.

TRANSVAAL, Pretoria, in August and January (*Janse*).

I imagine this wide-ranging species, which occurs in Ceylon and Australia, is attached to some garden plant.

EPHYSTERIS, n. g.

Head smooth; tongue developed. Antennæ $\frac{4}{5}$, in ♂ simple, basal joint moderately long, without pecten. Labial palpi moderately long, recurved, second joint beneath with rough projecting scales, terminal joint shorter than second, loosely scaled, acute. Maxillary palpi rudimentary. Posterior tibiæ clothed with long hairs above. Fore wings with 2–5 parallel, 7, 8, and 9 out of 6, 7 to costa, 11 from middle. Hind wings under 1, elongate-trapezoidal, apex strongly produced, termen emarginate, cilia 3; 3 and 4 connate or stalked, 5 rather approximated, 6 and 7 tolerably parallel.

Apparently a development of *Gnorimoschema*.

EPHYSTERIS CHERSÆA, sp. n.

♂ ♀. 10–12 mm. Head ochreous-whitish, more or less mixed with dark fuscous. Palpi whitish mixed with dark fuscous. Antennæ dark fuscous. Thorax light brownish-ochreous, more or less irrorated with dark fuscous. Abdomen dark grey, second and third segments more or less suffused with ochreous-yellowish dorsally. Fore wings lanceolate, apex produced, acute; brownish-ochreous more or less irrorated with dark fuscous; an indistinct dark fuscous spot on fold towards base; stigmata cloudy, dark fuscous, sometimes large, first discal little before middle, plical obliquely before first discal; sometimes an indistinct pale ochreous spot on costa at $\frac{2}{3}$: cilia grey, with some black specks. Hind wings rather dark grey; cilia grey.

TRANSVAAL, Pretoria, from September to November (*Janse*); four specimens.

GELECHIA AROTRIAS, sp. n.

♀. 21 mm. Head and palpi pale ochreous-yellowish, base of palpi fuscous, terminal joint almost as long as second. Antennæ dark fuscous. Thorax dark fuscous, with broad central pale ochreous-yellowish stripe. Abdomen fuscous. Fore wings elongate, rather narrow, costa gently arched, apex round-pointed, termen very obliquely rounded; dark purplish-fuscous, lighter and crimson-tinged towards base of costa, darkest above dorsal stripe; a pale ochreous-yellowish dorsal stripe from base to near tornus, rather broad towards middle but narrowed to extremities, before posterior extremity emitting an oblique bar to $\frac{2}{3}$ of disc; (cilia imperfect). Hind wings rather light fuscous, somewhat darker posteriorly; cilia pale fuscous.

NATAL, Weenen, in October (*Spiller*); one specimen.

GELECHIA TRISIGNIS, sp. n.

♀. 16 mm. Head ochreous-white, sides narrowly blackish-fuscous. Palpi white, from base to above middle of second joint dark fuscous, terminal joint as long as second. Antennæ black. Thorax dark bronzy-fuscous, with broad white central stripe. Abdomen grey. Fore wings elongate, narrow, costa gently arched, apex round-pointed, termen hardly rounded, very oblique; very dark bronzy-fuscous; a rather broad ochreous-whitish costal stripe from base to near apex, narrowed posteriorly; a rather narrower ochreous-white dorsal stripe from base to tornus, narrowed to extremities: cilia bronzy-fuscous, becoming whitish-fuscous towards tornus, on costal streak ochreous-white. Hind wings light grey; cilia whitish-fuscous, darker round apex.

TRANSVAAL, Pretoria district, from October to December (*Janse*); one specimen.

PHTHORIMÆA OPERCULELLA Zell.

TRANSVAAL, Pretoria and Pietersburg districts, from September to May (*Janse*); common.

This destructive potato-feeding species has not previously been recorded from South Africa, though now introduced into many other countries.

LECITHOCERA CHOLOPIS Meyr.

TRANSVAAL, Pretoria and Pietersburg districts, from September to April (*Janse*); NATAL; NYASSALAND, Fort Johnston. Widely distributed in India.

PTILOTHYRIS PURPUREA Wals.

The female, which is not described by Lord Walsingham, is without the white patch which characterises the hind wings of the male, these wings being wholly blackish.

## DRAGMATUCHA, n. g.

Head with appressed hairs; ocelli absent; tongue small. Antennæ $\frac{4}{5}$, basal joint moderately elongate, without pecten. Labial palpi very long, recurved, second joint thickened with dense scales, forming a loose spreading tuft towards apex beneath, terminal joint longer than second, slender, acute. Maxillary palpi rudimentary. Posterior tibiæ clothed with very long rough spreading hairs. Fore wings with 2 and 4 short-stalked from angle, 3 absent, 5 approximated, 7 to costa, 8 and 9 out of 7, 11 from beyond middle. Hind wings over 1, trapezoidal, apex obtuse, termen hardly sinuate, cilia $\frac{1}{2}$; 3 absent, 5 parallel, 6 and 7 stalked.

Apparently related to some extent to *Timyra*.

DRAGMATUCHA PROAULA, sp. n.

♀. 30 mm. Head dark fuscous, face and sides of crown ochreous-yellow. Palpi light ochreous-yellowish, second joint suffused with orange-yellow, terminal joint sprinkled with dark fuscous. Antennæ whitish-ochreous, basal joint and a short streak towards base above blackish. Thorax dark purplish-fuscous, posterior margin narrowly ochreous-yellowish. Abdomen fuscous, dorsally coppery-tinged, segmental margins and apex ochreous-yellow. Legs yellow banded with blackish, hairs of posterior tibiæ mixed with whitish. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen somewhat obliquely rounded; dark purplish-fuscous; a small irregular pale ochreous-yellow spot at base; two narrow irregular whitish-ochreous transverse fasciæ, dilated towards costa and becoming deep ochreous-yellow on costal edge, at about $\frac{2}{5}$ and $\frac{4}{5}$ respectively: cilia grey mixed with blackish, on upper half of termen ochreous-yellow. Hind wings rather dark grey; cilia ochreous-yellowish, at apex with a grey patch, towards middle of termen with an indistinct grey shade.

TRANSVAAL, Pietersburg, in September, October, and March (*Janse*); one specimen.

BRACHMIA MUSICOPA, sp. n.

♂ ♀. 13–14 mm. Head and thorax ochreous-whitish, patagia pale brownish. Palpi ochreous-whitish, second joint flatly compressed, loosely scaled beneath and with scales somewhat expanded towards apex above. Antennæ dark grey. Abdomen pale fuscous, suffused with whitish-ochreous above towards base, anal tuft pale yellowish. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 7 and 8 stalked, 7 to apex, 9 separate; purplish-grey, veins marked with well-defined lines of black and brown irroration; a fine costal streak from base to $\frac{4}{5}$, another subcostal from base to middle, and a more or less broad dorsal suffusion from base to $\frac{3}{4}$ ochreous-whitish, sometimes partially tinged with yellowish; second discal stigma represented by a round whitish-yellowish spot, marked beneath or almost wholly suffused with ochreous-brown, sometimes centred with dark fuscous: cilia purplish-fuscous finely irrorated with whitish, basal third dark fuscous spotted with ochreous-whitish. Hind wings whitish-grey; cilia yellow-whitish tinged with grey round apex, with a faint grey shade.

TRANSVAAL, Pretoria district, in January (*Janse*); two specimens.

BRACHMIA STERICTIS, sp. n.

♀. 15–16 mm. Head, thorax, and abdomen pale ochreous-yellowish. Palpi whitish-ochreous, second joint infuscated except towards apex. Antennæ whitish-ochreous, basal joint partly infuscated. Fore wings elongate, costa gently arched, apex obtuse, termen obliquely rounded; 7 and 8 stalked, 7 to apex, 9 separate; whitish-ochreous tinged with yellow-ochreous; extreme base of costa dark fuscous; stigmata small, blackish, plical obliquely before first discal, second discal larger; a row of ill-defined blackish dots immediately before termen and apical portion of costa: cilia whitish-ochreous tinged with yellow-ochreous. Hind wings pale whitish-grey; cilia pale whitish-ochreous tinged with grey.

TRANSVAAL, Pretoria district, in January and February (*Janse*); two specimens.

BRACHMIA SERIALIS, sp. n.

♀. 14 mm. Head and thorax greyish-ochreous mixed with fuscous. Palpi whitish-ochreous, second joint suffused with fuscous. Antennæ pale ochreous suffusedly ringed with fuscous. Abdomen fuscous. Fore wings elongate, costa gently arched, apex obtuse, termen rounded, rather oblique; 7 and 8 stalked, 7 to apex, 9 separate; pale ochreous suffusedly irrorated with fuscous; blackish basal dots on costa and in middle; stigmata blackish, plical rather obliquely before first discal; a row of undefined blackish dots immediately before termen and apical part of costa, terminating in a small suffused dark fuscous prætornal spot: cilia pale ochreous irrorated with fuscous. Hind wings grey; cilia light grey.

TRANSVAAL, Pretoria, in January (*Janse*); one specimen.

POLYHYMNO TROPÆA, sp. n.

♀. 8 mm. Head white, posterior edge of crown dark fuscous, collar white. Palpi white, terminal joint grey except apex. Antennæ white, with a blackish line above. Thorax white, patagia mixed with fuscous. Abdomen grey, apex white. Fore wings elongate, rather narrow, costa slightly arched, apex acute, produced, termen sinuate, rather strongly oblique; bronzy-fuscous irrorated with dark fuscous; markings white; a median longitudinal streak from base to middle, thence bent to meet at a very acute angle a narrow very oblique streak from middle of costa, the bent portion closely followed by a similar parallel streak meeting the same costal streak produced; two shorter less oblique costal streaks posteriorly, second mostly in cilia and edged with blackish; a narrow irregular streak along posterior part of fold; a narrow almost marginal streak along lower half of termen, extended round tornus: cilia grey, above apex with a white spot margined posteriorly by an oblique dark fuscous line, beneath apex with a white patch, above and below which are fragments of a black antemedian line. Hind wings grey; cilia light grey.

TRANSVAAL, Pretoria district, from September to November and in February (*Janse*); one specimen.

## XYLORYCTIDÆ.

EPORYCTA, n. g.

Head with appressed scales, side-tufts somewhat spreading; ocelli and tongue apparently absent. Antennæ $\frac{2}{3}$, in ♂ shortly unipectinated (1) and ciliated, basal joint moderate, without pecten. Labial palpi very long, recurved, second joint thickened with appressed scales, terminal as long as second, slender, acute. Maxillary palpi rudimentary. Posterior tibiæ clothed with hairs above. Fore wings with 2 from $\frac{2}{3}$, 3 from angle, 7 and 8 stalked, 7 to apex, 11 from middle. Hind wings over 1, trapezoidal-ovate, cilia $\frac{2}{5}$; 3 and 4 connate, 5 parallel, 6 and 7 short stalked.

Clearly related to the Australian genus *Xylorycta*.

Eporycta tarbalea, sp. n.

♂. 25 mm. Head, palpi, antennæ, thorax, and abdomen ochreous-whitish, palpi with second joint and anterior edge of terminal mixed with fuscous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen slightly rounded, rather strongly oblique; ochreous-white; costa, apex, and termen somewhat suffused narrowly with pale yellow-ochreous: cilia yellow-whitish. Hind wings pale whitish-grey, slightly ochreous-tinged; cilia ochreous-whitish.

Transvaal, N.E. Pretoria district, in January (*Janse*); one specimen.

Nephantis xystopala, sp. n.

♂. 24–26 mm. Head and thorax ochreous-whitish. Palpi whitish-ochreous, second joint white above towards apex. Antennæ dark fuscous, towards base white. Abdomen with ochreous-whitish scales overlying ferruginous-brown surface, which tends to appear in longitudinal lines. Fore wings elongate, costa moderately arched, apex tolerably pointed, termen rather sinuate, oblique; white; a narrow light brownish-ochreous stripe above middle from base to apex: cilia white. Hind wings light grey, paler and tinged with whitish-ochreous anteriorly; cilia whitish-ochreous, tips white.

Transvaal, Pretoria district, in December and January (*Janse*); eight specimens.

Odites citrantha, sp. n.

♂. 21 mm. Head dark fuscous, face pale yellowish. (Palpi broken.) Antennæ pale fuscous, ciliations $1\frac{1}{2}$. Thorax light yellow. Abdomen ochreous-yellowish. Fore wings elongate, costa gently arched, apex obtuse, termen rounded, hardly oblique; 2 from near angle; clear yellow; discal stigmata minute, blackish: cilia yellow. Hind wings ochreous-whitish; cilia whitish-yellowish.

Natal, Durban, in August (*Leigh*); one specimen.

Odites procellosa, sp. n.

♂ ♀. 17–18 mm. Head, palpi, antennæ, thorax, and abdomen whitish-ochreous tinged with yellowish; palpi with lower $\frac{2}{3}$ of second joint and base of terminal joint dark fuscous; antennal ciliations 2. Fore wings elongate, slightly dilated posteriorly, costa gently arched, faintly sinuate in middle, apex obtuse, termen rounded, hardly oblique; 2 from near angle; whitish-ochreous tinged with yellow, thinly and irregularly sprinkled with fuscous; towards base some fuscous suffusion sprinkled with dark fuscous, especially on costa and dorsum; stigmata dark fuscous, first discal enlarged into a round cloudy rather dark fuscous spot, obliquely above and before which is another dark fuscous dot, plical obliquely beyond first discal; a suffused fuscous spot on costa beyond middle; a curved posterior series of cloudy dots of fuscous and dark fuscous scales: cilia whitish-yellowish. Hind wings ochreous-whitish, faintly fuscous-tinged; cilia whitish-yellowish.

S. Nigeria, Wari, in May and August; three specimens.

Epimactis metazona, sp. n.

♀. 25–26 mm. Head and thorax white. Palpi white, lower half of second joint fuscous. Antennæ grey, base white. Abdomen light yellow-ochreous. Fore wings suboblong, costa moderately arched, apex obtuse, termen nearly straight, vertical; white; second discal stigma grey; a narrow silvery-grey fascia close before termen, dilated towards costa but not quite reaching it: cilia white. Hind wings and cilia white.

Sierra Leone; two specimens.

## Procometis Meyr.

To this genus should be referred *acutipennis* Wals., described under *Apiletria*, as well as the three following species. All four of these agree with the single known Indian species, *P. trochala*, and differ from all the Australian species (ten in number) in the character of the labial palpi, which in these have the second joint loosely haired above and the terminal joint relatively very short ($\frac{1}{2}$ or less), whilst in the Australian forms the second joint is clothed with appressed scales and the terminal joint is as long as second. Notwithstanding this distinction, the two groups are so obviously closely related in all other characters, structural and superficial, and connecting forms are so likely to be found eventually in intermediate regions (the differences being only comparative), that I think it best to treat them as congeneric; but the group to which the African and Indian species belong seems worthy of a subgeneric name, and I therefore give it the name of *Hyostola*.

Procometis oxypora, sp. n.

♂. 33 mm. Head, thorax, and abdomen pale ochreous. Palpi with second joint loosely haired above, terminal joint $\frac{1}{3}$ of second; pale brownish-ochreous mixed with whitish. Antennæ whitish. Fore wings elongate, rather narrow, costa moderately arched, apex very acute, produced, termen sinuate, extremely oblique; pale yellowish-ochreous, tinged with brown-reddish posteriorly; a broad very undefined streak of pale fuscous suffusion beneath costa from before middle to apex, and some undefined pale fuscous suffusion towards dorsum: cilia pale ochreous-yellowish. Hind wings narrower than fore wings, with very long tornal cilia, and large light ochreous-fuscous costal hair-pencil reaching to apex; grey, paler and whitish-tinged towards base; cilia light ochreous-fuscous, becoming light yellowish-ochreous towards tornus.

Natal, Weenen, in January; one specimen.

PROCOMETIS ACHARMA, sp. n.

♂. 32 mm., ♀ 46 mm. Head and thorax pale brownish-ochreous. Palpi with second joint loosely haired above, terminal joint $\frac{1}{3}$ of second; brownish-ochreous sprinkled with whitish. Antennæ ochreous-whitish indistinctly ringed with fuscous. Abdomen light greyish-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex in ♂ round-pointed, in ♀ obtuse, termen in ♂ straight, very oblique, in ♀ slightly rounded, rather strongly oblique; light fuscous suffusedly irrorated with whitish, suffused with pale brownish-ochreous towards costa anteriorly, with a few black scales on veins on costal half; discal stigmata faintly indicated, the white suffusion more pronounced on a longitudinal streak traversing these and towards dorsum: cilia whitish-yellowish, in ♀ sprinkled with whitish. Hind wings in ♂ narrower than fore wings, with very long tornal cilia, and grey costal hair-pencil reaching to $\frac{4}{5}$; grey, in ♀ somewhat lighter; cilia light grey mixed with whitish, in ♂ becoming pale ochreous-yellowish towards tornus, in ♀ with grey subbasal line.

NATAL, Weenen, in December; two specimens.

PROCOMETIS TERRENA, sp. n.

♀. 37 mm. Head, palpi, antennæ, and thorax rather dark fuscous; palpi with second joint loosely haired, terminal joint half second. Abdomen light fuscous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen rounded, oblique; rather dark ashy-fuscous, lighter posteriorly; a broad ochreous-brown median stripe from base, becoming suffused and obsolete beyond middle, edged above by groups of scattered black scales beyond $\frac{1}{4}$ and about middle, and followed by two minute black dots transversely placed at $\frac{2}{3}$: cilia fuscous. Hind wings light fuscous; cilia whitish-fuscous, with darker subbasal line.

NYASSALAND, Mpeta, on Loangwa River, in December; one specimen.

## ŒCOPHORIDÆ.

COESYRA BALANTIAS, sp. n.

♀. 20 mm. Head, palpi, and thorax bright yellow. Antennæ grey, becoming yellowish towards base. Abdomen ochreous-yellowish. Fore wings elongate, costa gently arched, apex obtuse, termen nearly straight, oblique; bright yellow; a triangular whitish-fuscous spot irrorated with dark fuscous on dorsum beyond middle, its apex sending an irregular outwardly oblique projection edged with white above to disc at $\frac{3}{5}$; two or three small fuscous dots in disc posteriorly, representing part of a curved series; several minute indistinct fuscous dots on termen and round apex: cilia yellow. Hind wings and cilia light ochreous-yellowish.

NATAL, Weenen, in February (*Spiller*); one specimen.

EPIPHRACTIS, n. g.

Head with appressed scales, side-tufts spreading; tongue developed. Antennæ $\frac{4}{5}$, basal joint moderately elongate, without pecten. Labial palpi very long, recurved, with appressed scales, terminal joint shorter than second, acute. Maxillary palpi rudimentary. Posterior tibiæ clothed with hairs above. Fore wings with 2 from angle, 7 and 8 stalked, 7 to termen, 11 from before middle. Hind wings 1, elongate-ovate, cilia $\frac{1}{2}$; 3 and 4 connate, 5–7 parallel, 7 connected with 8 by a bar beyond cell.

Probably allied to *Cryptolechia.*

EPIPHRACTIS PHŒNICIS, sp. n.

♀. 23 mm. Head and thorax light rosy-ochreous. Palpi whitish-ochreous. Antennæ pale ochreous tinged with crimson. Abdomen light grey, apex light ochreous. Fore wings elongate, somewhat dilated posteriorly, costa gently arched, apex obtuse, termen faintly sinuate, rather oblique; ochreous-crimson, deeper purplish-crimson towards dorsum, lighter and more ochreous towards costa; costal edge whitish except towards apex, extreme costal edge blackish towards base; second discal stigma represented by a small suffused dark grey spot: cilia rosy. Hind wings grey; cilia whitish-grey.

ANGOLA, Bihe; one specimen.

ETHMIA BALLISTIS, sp. n.

♀. 29–31 mm. Head and thorax shining grey irrorated with grey-whitish; head with a triangular blackish spot on back of crown, thorax with three black dots in a dorsal triangle, two others posterior, and two on shoulders. Palpi blackish-grey, towards base whitish. Antennæ blackish, whitish in front towards base, and on lower half of basal joint. Abdomen bright deep yellow, beneath blackish towards base of segments. Legs blackish ringed with white, posterior tibiæ yellow. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen rounded, rather oblique; bronzy-grey; base of costa blackish; two small black spots beneath costa near base, surrounded with some whitish suffusion; black dots on fold at base, near base, and at $\frac{1}{5}$; stigmata black, discal large, round, first little before middle, plical small, obliquely beyond first discal: cilia bronzy-grey. Hind wings bright deep yellow; a dark grey apical patch, covering about $\frac{1}{5}$ of wing; cilia yellow, round apex dark grey.

GERMAN EAST AFRICA, Dar-es-Salaam; two specimens.

BORKHAUSENIA GALACTÆA, sp. n.

♂. 16 mm. Head, palpi, antennæ, thorax, and abdomen ochreous-whitish; palpi with median bands of fuscous irroration on second and terminal joints; antennæ serrate. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen extremely obliquely rounded; ochreous-whitish; a small blackish dot beneath costa near base; stigmata black, plical obliquely beyond first discal; an almost marginal series of undefined dark fuscous dots round posterior third of costa and termen: cilia ochreous-whitish. Hind wings light grey; cilia ochreous-whitish.

TRANSVAAL, Pretoria district, in December and January (*Janse*); one specimen.

## ELACHISTIDÆ.

STATHMOPODA XANTHOPLITIS, sp. n.

♂. 15 mm. Head and thorax orange, face shining whitish-ochreous. Palpi whitish-ochreous. Antennæ grey, basal joint orange. Abdomen whitish-ochreous, base of segments golden-ferruginous. Fore wings narrow-lanceolate, very acutely pointed; pale greyish-ochreous; basal third orange: cilia pale yellowish-ochreous. Hind wings light grey; cilia pale yellowish-ochreous.

TRANSVAAL, Pretoria, from December to February (*Janse*); one specimen.

ELACHISTA CROCOGASTRA, sp. n.

♂. 6–7 mm. Head, palpi, antennæ, and thorax ochreous-whitish. Abdomen whitish, tinged and sometimes suffused with yellow. Fore wings lanceolate, ochreous-whitish: cilia whitish. Hind wings and cilia ochreous-whitish.

TRANSVAAL, Pretoria district, in August, December to February, and April (*Janse*); six specimens.

COSMOPTERYX BACTROPHORA, sp. n.

♀. 11 mm. Crown of head and thorax dark fuscous with three fine longitudinal white lines, face light fuscous. Palpi white, terminal joint with a black line on each side. Antennæ white lined with black. Abdomen rather dark grey, beneath pale ochreous. Fore wings narrow-lanceolate, apex very long-produced and acute; dark fuscous; an oblique series of three fine white longitudinal lines about $\frac{1}{4}$, first reaching base of costa, others detached; a broad ochreous-yellowish transverse fascia beyond middle, anterior edge somewhat oblique and marked with two small silvery-metallic spots, first followed by two or three black scales, and extended anteriorly on costa as a short fine white streak, posterior edge limited by two small silvery-metallic spots edged with dark fuscous anteriorly, between which the yellow colour forms a triangular median projection, whence proceeds a sinuate fine white line to apex: cilia dark fuscous, with a white bar on apical line. Hind wings and cilia dark grey.

TRANSVAAL, Pretoria, in February (*Janse*); one specimen.

COSMOPTERYX TABELLARIA, sp. n.

♂. 10 mm. Crown of head and thorax dark brown with three fine longitudinal white lines; face whitish-fuscous. Palpi whitish, terminal joint with a blackish line on each side. Antennæ white lined with black. Abdomen pale yellowish-ochreous. Fore wings narrow-lanceolate, apex very long-produced and acute; dark brown; an oblique series of three fine white longitudinal lines about $\frac{1}{4}$, first reaching base of costa, second reaching base and also connected with projection of postmedian band, third connected with same projection beneath; a broad ochreous-yellow transverse fascia beyond middle, anterior edge produced as a short white streak on costa, below middle with a triangular projection, above this marked with a round golden-metallic spot followed by a black dot, obliquely beyond this within fascia is a round golden-metallic spot near dorsum, posterior edge of fascia marked with two opposite pale golden-metallic spots, between which is an elongate projection of the yellow colouring, whence proceeds a sinuate white line to apex: cilia dark fuscous. Hind wings and cilia grey.

TRANSVAAL, Pretoria, in March (*Janse*); one specimen.

STAGMATOPHORA SEMNOSTOLA Meyr.

TRANSVAAL, Pretoria district, in August, September, and from December to April (*Janse*).

Described from Australia, where the larva feeds amongst spun leaflets of *Acacia decurrens*; I have not yet obtained the species from intermediate regions.

LIMNŒCIA ICHNOGRAPHA, sp. n.

♂. 17–18 mm. Head, palpi, and thorax blackish, sprinkled with white. Antennæ blackish. Abdomen dark grey, sides of back ochreous-whitish towards base, anal tuft whitish mixed with yellow. Fore wings elongate-lanceolate, acute; dark purplish-grey, suffusedly streaked longitudinally with black; a fine white line above fold from base to $\frac{2}{5}$, beneath which is another on posterior portion; a short white oblique mark from beneath costa at $\frac{1}{5}$; a white mark on middle of costa, beneath which are two or three small undefined white marks longitudinally arranged in disc and one on fold; a rather inwardly oblique white streak from costa beyond $\frac{3}{4}$, reaching half across wing; an irregular undefined line of more or less scattered white scales along dorsum from near base and lower half of termen: cilia dark grey, with a small basal spot of white scales beneath apex, and a faint median whitish shade on upper half of termen. Hind wings dark grey; cilia grey, basal line pale greyish-ochreous.

TRANSVAAL, Pretoria and Pietersburg districts, from September to January (*Janse*); two specimens.

## GRACILARIADÆ.

EPICEPHALA PYRRHOGASTRA, sp. n.

♂ ♀. 9–10 mm. Head white, somewhat mixed with grey on forehead. Palpi pale grey, becoming white towards apex.

Antennæ grey. Thorax grey, sometimes whitish-mixed. Abdomen light ochreous-reddish, dorsally suffused with grey, sides with series of oblique dark grey stripes. Fore wings narrowly elongate-lanceolate, apex blunt-pointed; ochreous-grey; three fine white very oblique streaks from costa at $\frac{1}{3}$, beyond middle, and at $\frac{3}{4}$, reaching nearly half across wing, dark-edged anteriorly, sometimes dilated on costa, between these are more or less distinct whitish marks beneath costa; an irregular white streak along dorsum throughout, above which is a short white oblique mark beneath middle of wing, and two approximated fine oblique white lines above tornus; a fine silvery-metallic curved transverse line at $\frac{5}{6}$; a small round black anteapical spot, above and beneath which are white wedge-shaped spots on margins: cilia white, towards tornus light ochreous-grey, elsewhere with a blackish subbasal line, on costa also with apical third blackish. Hind wings dark grey; cilia grey.

TRANSVAAL, Pretoria, from December to February (*Janse*); four specimens.

ACROCERCOPS DASMOPHORA, sp. n.

♀. 8–9 mm. Head and palpi shining white. Antennæ grey, beneath whitish. Thorax pale ochreous. Abdomen whitish-ochreous. Fore wings narrowly elongate-lanceolate; ochreous-orange; markings shining white, edged with rather dark fuscous; three semioval dorsal spots, first two large, first reaching base, second rather obliquely placed, third smaller; an elongate-triangular blotch extending along costa from near base to $\frac{2}{5}$, broadest posteriorly, posterior edge oblique, almost united with second dorsal spot; three wedge-shaped costal spots posteriorly, first oblique, elongate, almost united with third dorsal spot, second and third not dark-margined posteriorly, second extended as a narrow streak to termen, third small, anteapical, its apex almost touching this streak; a small elongate black apical spot: cilia white, on costa with three dark fuscous bars, round apex and termen with a dark fuscous subbasal line, and a dark fuscous bar beneath apex, beneath termen tinged with greyish-ochreous. Hind wings grey; cilia pale greyish-ochreous.

TRANSVAAL, Pretoria, in November, January, and February (*Janse*); two specimens.

MACAROSTOLA ONYCHOTA, sp. n.

♂ ♀. 8–9 mm. Head white, sides of crown fuscous-tinged. Palpi loosely scaled, white, lower $\frac{2}{3}$ of second joint and a median ring of terminal joint fuscous. Antennæ whitish ringed with fuscous. Thorax ochreous-bronze, with two white stripes. Abdomen grey. Fore wings elongate-lanceolate, acute; ochreous-bronze; markings white, edged with black irroration; four streaks from costa, reaching nearly half across wing, first three outwardly oblique, first at $\frac{2}{5}$, extended as a fine line along costa to near base, fourth inwardly oblique; four streaks from dorsum reaching half across wing, first three outwardly oblique, first from rather near base, fourth inwardly oblique: cilia white, with two posterior lines of black irroration, on costa grey with a white bar, at apex with a black hook, beneath this on basal half ochreous-grey speckled with black and barred with white, beneath tornus greyish. Hind wings and cilia grey.

TRANSVAAL, Pretoria, in January, February, and May (*Janse*); four specimens.

## PLUTELLIDÆ.

### IRIOTHYRSA, n. g.

Head with appressed hairs; ocelli absent; tongue short. Antennæ $\frac{5}{6}$, in ♂ simple, basal joint elongate, with pecten. Labial palpi very long, porrected, second joint very long, widely diverging, clothed with dense scales, projecting roughly above, terminal joint half second, bent inwardly at right angles to it, loosely scaled, acute. Maxillary palpi obsolete. (Posterior legs broken.) Fore wings with 2 from angle, 3 absent, 4 and 5 connate, 6 and 7 out of 8, 7 to termen, 9 out of 8 before 6, 10 from near end of cell, 11 from beyond middle. Hind wings $\frac{2}{3}$, narrow-lanceolate, cilia 3; 2 separate, 3 and 4 connate, 5 and 6 stalked, 7 separate.

Intermediate in character between *Plutella* and *Coleophora*.

IRIOTHYRSA MELANOGMA, sp. n.

♂. 21 mm. Head and thorax ochreous-whitish. Palpi whitish, second joint sprinkled outwardly with fuscous and blackish. Antennæ ochreous-whitish. Abdomen ochreous-whitish mixed with grey. Fore wings elongate-lanceolate, termen faintly sinuate; pale brownish-ochreous, suffusedly mixed with white, especially towards base; costal edge blackish towards base; some scattered black scales, and posterior $\frac{2}{3}$ suffusedly streaked longitudinally with fuscous suffusion irrorated with black: cilia whitish-ochreous. Hind wings rather dark grey, anteriorly pale greyish-ochreous towards costa; cilia whitish-ochreous.

TRANSVAAL, Pietersburg, in March (*Janse*); one specimen.

YPONOMEUTA GLAPHYROPIS, sp. n.

♂ ♀. 25–28 mm. Head white or whitish, with two black spots on crown and two or four on face. Palpi blackish, apex of all joints whitish. Antennæ light grey. Thorax grey-whitish, with two black marks on each shoulder, a dot on each patagium, and two on back. Abdomen dark grey or blackish-grey. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen nearly straight, oblique, cell very long, reaching to $\frac{7}{8}$ of wing; light grey or sometimes darker grey, with whitish reflections; usually some whitish suffusion on fold, especially on basal half; five or six black dots immediately beneath costa on basal $\frac{2}{5}$, a series of about six near costa from $\frac{1}{3}$ to apex, a series of about three from $\frac{4}{5}$ of disc to apex, a submedian series of eight or nine from near base to termen, and a subdorsal series of six to eight from near base to termen: cilia light grey. Hind wings with basal transparent fovea narrow, deep; blackish-grey; cilia dark grey.

NATAL, Weenen, from October to December; six specimens.

## TINEIDÆ.

BUCCULATRIX PORTHMIS, sp. n.

♂ ♀. 6 mm. Head and thorax yellow-ochreous. Antennæ pale ochreous, suffusedly ringed with dark fuscous. Abdomen rather dark grey. Fore wings rather broad-lanceolate, apex rather produced, acute; yellow-ochreous; an undefined patch of blackish irroration on costa beyond middle, appearing to be margined laterally by faint oblique marks of whitish suffusion; a patch of blackish irroration on dorsum slightly before costal: cilia grey, with basal and median lines of black irroration. Hind wings rather dark grey; cilia grey.

TRANSVAAL, Pretoria, in February (*Janse*); two specimens.

OPOGONA PHÆOCHALCA, sp. n.

♀. 12 mm. Head and palpi shining whitish-ochreous; back of crown and thorax purplish-bronzy-fuscous. Antennæ whitish-ochreous. Abdomen light grey. Fore wings lanceolate, acute; purplish-bronzy-fuscous: cilia bronzy-greyish-ochreous. Hind wings light grey, with very strong brassy reflections; cilia light bronzy-greyish-ochreous.

REUNION, St. Denis, in April; one specimen.

OPOGONA CHLOROPHANES, sp. n.

♂ ♀. 11-12 mm. Head, palpi, antennæ, thorax, and abdomen shining whitish-ochreous. Fore wings lanceolate, very acute; shining whitish-ochreous, with a brassy or bronzy tinge: cilia whitish-ochreous. Hind wings grey, with strong brassy reflections; cilia whitish-ochreous.

TRANSVAAL, N.E. Pretoria district, in August, December, and January (*Janse*); four specimens.

MONOPIS MEGALODELTA, sp. n.

♂. 13 mm. Head ochreous-whitish. Palpi ochreous-whitish, externally suffused with dark fuscous except at apex. Antennæ whitish-ochreous, above suffused with dark fuscous towards base, basal joint ochreous-whitish. Thorax dark brown mixed with blackish, shoulders with an ochreous-whitish spot. Abdomen brownish-ochreous. Fore wings elongate, costa gently arched, apex obtuse, termen obliquely rounded; 7 and 8 stalked, discal impression very large, thinly scaled but not transparent; ferruginous-brown irrorated with blackish, and strewn with small dark slaty-fuscous spots of more or less raised scales; a large triangular ochreous-whitish blotch extending on costa from $\frac{1}{4}$ to $\frac{3}{4}$, and reaching $\frac{3}{4}$ across wing; disc beyond this blotch more coppery-ferruginous: cilia ferruginous-fuscous irrorated with blackish. Hind wings grey, with golden reflections; cilia ochreous-whitish.

S. Nigeria, Ogrugu; one specimen.

### Malacyntis, n. g.

Head roughly tufted; ocelli absent; tongue obsolete. Antennæ over 1, in ♂ stout, simple, basal joint thick, concave beneath. Labial palpi moderate, porrected, second joint with dense scales projecting beneath at apex and two or three apical bristles, terminal joint moderate, densely scaled. Maxillary palpi obsolete. Posterior tibiæ clothed with long hairs above. Fore wings with 2 from towards angle, 7 and 9 stalked, 7 to costa, 8 absent, 11 from before middle. Hind wings under 1, elongate-ovate, cilia $\frac{4}{5}$; 2–7 tolerably parallel.

A development of *Tineola*.

Malacyntis stibarodes, sp. n.

♂. 15 mm. Head light yellow-ochreous. Palpi rather dark fuscous, beneath ochreous-suffused, apex whitish-ochreous. Antennæ whitish-ochreous. Thorax and abdomen pale brownish-ochreous. Fore wings elongate, costa moderately arched, apex obtuse, termen very obliquely rounded; pale brownish-ochreous; base of costa infuscated: cilia pale yellowish-ochreous, tips paler. Hind wings bronzy-grey; cilia light brownish-ochreous.

Sierra Leone; one specimen.

Tineola leucastis, sp. n.

♂. 24 mm. Head light ochreous-orange. Palpi moderate, whitish-ochreous. Antennæ grey. Thorax white. Abdomen ochreous-yellowish. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; white; costal edge finely blackish towards base, elsewhere pale ochreous-yellowish: cilia pale ochreous-yellowish. Hind wings light yellowish-grey; cilia whitish-ochreous.

Transvaal, N.E. Pretoria district and Pietersburg, in October, December, and March (*Janse*); one specimen.

Tineola xanthastis, sp. n.

♂. 19 mm. Head and thorax bright ochreous-yellow. Palpi moderate, grey, apex whitish-yellowish. Antennæ grey. Abdomen whitish-ochreous. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; bright ochreous-yellow; costal edge finely blackish towards base: cilia ochreous-yellow. Hind wings grey; cilia whitish-ochreous.

Transvaal, Pretoria, in December, January, and March (*Janse*); one specimen.

TINEOLA OCHROPSAMMA, sp. n.

♂. 18 mm. Head fulvous-ochreous. Palpi moderate, pale ochreous, second and terminal joints suffused with dark fuscous on basal half. Antennæ pale ochreous. Thorax and abdomen yellow-ochreous. Fore wings elongate, costa moderately arched, apex tolerably pointed, termen very oblique, almost straight; yellow-ochreous: cilia yellow-ochreous, paler towards tips. Hind wings purplish-grey suffused anteriorly with light brassy-ochreous; cilia as in fore wings.

NATAL, Durban, in September (*Leigh*); one specimen.

TINEOLA MARCESCENS, sp. n.

♂. 18 mm. Head brownish-ochreous. Palpi moderate, dark fuscous. Antennæ pale brownish-ochreous, infuscated at base. Thorax and abdomen light brownish-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; pale brownish-ochreous, somewhat more brownish-tinged anteriorly; costal edge dark fuscous towards base: cilia pale brownish-ochreous. Hind wings and cilia pale ochreous.

BRITISH EAST AFRICA, Mombasa, in October; one specimen.

TINEOLA HOLOPSAMMA, sp. n.

♂. 19 mm. Head ochreous-yellowish mixed with fuscous. Palpi moderate, ochreous-yellowish, terminal joint and base of second suffused with fuscous. Antennæ pale ochreous, base infuscated. Thorax and abdomen yellow-ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; yellow-ochreous; costal edge infuscated towards base: cilia yellow-ochreous. Hind wings light ochreous-grey; cilia whitish-ochreous, more ochreous towards base.

TRANSVAAL, Pietersburg, in September (*Janse*); one specimen.

TINEOLA MELANOSTOMA, sp. n.

♂. 19 mm. Head fulvous. Labial and maxillary palpi blackish, labial short, maxillary stout. Antennæ pale ochreous, becoming whitish towards apex. Thorax deep yellow-ochreous tinged with lilac. Abdomen golden-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; deep yellow-ochreous tinged with brownish and suffused with pale lilac; costal edge dark fuscous towards base: cilia concolorous. Hind wings grey with lilac-bronze reflections; cilia pale golden-ochreous.

BRITISH EAST AFRICA, Mombasa, in October; one specimen.

TINEOLA MERETRIX, sp. n.

♂. 15 mm. Head fuscous. Palpi moderate, whitish-ochreous, terminal joint fuscous. Antennæ stout, somewhat compressed laterally, ochreous-whitish. Thorax light ochreous. (Abdomen damaged.) Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; purple-brownish-ochreous: cilia ochreous sprinkled with purplish towards base. Hind wings grey, with purplish reflections; cilia pale yellowish-ochreous.

CAPE COLONY, Grahamstown; one specimen.

TINEOLA PHOCINA, sp. n.

♂. 12 mm. Head pale ochreous-yellowish. Palpi moderate, dark fuscous, apex ochreous-whitish. Antennæ pale greyish-ochreous, towards apex more whitish, towards base infuscated. Thorax bronzy-fuscous, dorsally purplish-tinged. Abdomen greyish-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; shining fuscous-bronze: cilia pale bronzy-ochreous. Hind wings grey; cilia whitish-ochreous, tips whitish.

TRANSVAAL, N.E. Pretoria district, in December (*Janse*); one specimen.

TINEOLA (?) CHLORISTIS, sp. n.

♂. 11 mm. Head ochreous-whitish. Palpi whitish-ochreous, infuscated above. Maxillary palpi apparently rudimentary. Antennæ, thorax, and abdomen whitish-ochreous. Fore wings elongate, costa moderately arched, apex obtuse, termen very obliquely rounded; 7 and 8 stalked; shining whitish-ochreous: cilia whitish-ochreous, more whitish towards tips. Hind wings and cilia pale whitish-ochreous, with a bronzy tinge.

TRANSVAAL, N.E. Pretoria district, in February (*Janse*); one specimen.

TINEA ŒNOPIS, sp. n.

♂. 17 mm. Head ochreous-yellowish. Palpi dark fuscous, apex paler. Antennæ 1, ochreous-whitish. Thorax dark purplish-fuscous. Abdomen light brownish-ochreous, segmental margins whitish-ochreous. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; rather dark purplish-bronzy-fuscous: cilia pale bronzy sprinkled with fuscous. Hind wings pale bronzy, with a pale grey terminal line; cilia pale grey.

TRANSVAAL, Pretoria, in December (*Janse*); one specimen.

TINEA PARAXENA, sp. n.

♂. 14 mm. Head bright yellow. Palpi pale ochreous, suffused above with dark fuscous. Antennæ 1, ochreous-whitish. Thorax and abdomen pale shining ochreous. Fore wings elongate, narrow, costa gently arched, apex round-pointed, termen extremely obliquely rounded; pale shining ochreous; costal edge blackish towards base: cilia pale ochreous, more whitish towards tips. Hind wings grey with bronzy reflections; cilia whitish-ochreous.

Transvaal, Pietersburg, in September (*Janse*); one specimen.

Distinguished from *T. tanystis* by the much narrower fore wings.

Tinea othello Meyr.

Transvaal, Pretoria and Pietersburg districts, from August to December (*Janse*): four specimens, apparently not differing from Indian examples.

Tinea homestia, sp. n.

♂. 12 mm. Head yellow-ochreous. Palpi whitish-ochreous, upper edge blackish except towards apex of joints. Antennæ 1, grey-whitish, greyer above, especially towards base. Thorax and abdomen pale ochreous. Fore wings elongate, rather narrow, costa gently arched, apex round-pointed, termen very obliquely rounded; pale ochreous, with a faint brownish tinge: cilia concolorous. Hind wings very pale greyish; cilia pale ochreous.

Transvaal, Pretoria, in January (*Janse*); one specimen.

Tinea tanystis, sp. n.

♂. 16–17 mm. Head bright yellow. Palpi pale ochreous, second joint mixed with blackish. Antennæ 1, stout, compressed, ochreous-whitish. Thorax light yellow-ochreous, anterior margin infuscated. Abdomen yellow-ochreous. Fore wings elongate, rather narrow, costa gently arched, apex round-pointed, termen very obliquely rounded; pale yellow-ochreous; costal edge blackish towards base: cilia pale yellow-ochreous. Hind wings grey, with a slight bronzy tinge; cilia whitish-ochreous.

Transvaal, Pretoria and Pietersburg districts, from September to February (*Janse*); five specimens.

## Pseudurgis, n. g.

Head rough-scaled; ocelli and tongue absent. Antennæ $\frac{2}{3}$, in ♂ unipectinated, apex simple. Labial palpi rather long, porrected, densely clothed throughout with loosely projecting scales, terminal joint moderate. Maxillary palpi absent. Posterior tibiæ loosely scaled. Fore wings with 2 from $\frac{4}{5}$, 3 from angle, 4 and 5 divergent, 7 to termen, 8–10 approximated at base, 11 from middle. Hind wings 1, elongate-ovate, cilia $\frac{2}{5}$; 2–7 tolerably parallel.

A development of *Melasina*, principally distinguished by the unipectinated antennæ, but of peculiar facies.

Pseudurgis tectonica, sp. n.

♂. 21–22 mm. Head light brown mixed with whitish and sprinkled with dark fuscous. Palpi brown sprinkled with dark fuscous. Antennæ whitish, stalk and pectinations lined with blackish, pectinations 6. Thorax brown mixed with whitish. Abdomen light brown mixed with whitish. Fore wings elongate, rather narrow, posteriorly somewhat dilated, costa nearly straight, slightly sinuate, apex obtuse, termen nearly straight, oblique; white, towards costa and dorsum more or less irregularly irrorated with fuscous and strigulated with dark fuscous and blackish; a dark fuscous spot marked with blackish on base of costa, one on middle of dorsum, and one in disc beyond middle; an elongate-transverse fuscous spot suffusedly mixed with blackish near termen, not reaching margins, terminal area beyond and beneath this mixed with light ferruginous and with some dark fuscous strigulæ; apical and terminal margins marked with small dark fuscous and black spots: cilia white, inner half irrorated with fuscous and limited by a line of dark fuscous irroration, outer half barred with dark fuscous suffusion. Hind wings grey; cilia whitish-grey.

TRANSVAAL, Pretoria, in November and December (*Janse*); two specimens.

STRUTHISCA OMICHLODES, sp. n.

♂ ♀. 15–20 mm. Head and thorax fuscous, face sometimes paler and whitish-tinged. Palpi very short, fuscous. Antennæ grey, pectinations in ♂ $2\frac{1}{2}$. Abdomen light greyish, rather hairy posteriorly, apex in ♀ whitish-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; 7 absent; light grey, very indistinctly strigulated with darker: cilia light grey. Hind wings thinly scaled, light grey; cilia whitish-grey.

TRANSVAAL, Pretoria, in August and September (*Janse*); three specimens.

In my original characterisation of this genus the absent vein of fore wings is stated to be 9; I am now of opinion that it is really 7 which is missing normally; in *S. hormotris*, described below, all veins of the fore wings are present, but 7 and 8 are stalked, and this species is therefore probably an early form, and indicates the true homology.

STRUTHISCA AREATA, sp. n.

♂. 17–19 mm. Head and thorax ochreous-fuscous. Palpi very short, fuscous. Antennæ fuscous, pectinations 4. Abdomen rather hairy, pale brownish-ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen rounded, rather strongly oblique; 7 absent; light brownish-ochreous: cilia concolorous. Hind wings and cilia very pale ochreous-grey.

TRANSVAAL, Pietersburg, in September (*Janse*); three specimens.

STRUTHISCA HORMOTRIS, sp. n.

♂. 16 mm. Head whitish-ochreous. (Palpi broken.) Antennæ fuscous, pectinations 4. Thorax and abdomen fuscous. Fore wings elongate, costa moderately arched, apex obtuse, termen very obliquely rounded; 7 and 8 stalked; grey-whitish, irregularly strigulated with fuscous; a patch of fuscous suffusion on base of costa; a moderate slightly incurved fuscous fascia from middle of dorsum, reaching $\frac{2}{3}$ across wing, darkest anteriorly; an undefined fuscous spot beneath costa at $\frac{3}{4}$: cilia pale whitish-ochreous. Hind wings grey; cilia whitish-ochreous-grey.

NYASSALAND, Zomba, 3000 feet, in December; one specimen.

### THRANITICA, n. g.

Head with loosely appressed scales; ocelli present; tongue absent. Antennæ $\frac{1}{2}$, in ♂ moderately biciliated. Labial palpi moderately long, subascending, with appressed scales, terminal joint moderate, obtuse. Maxillary palpi absent. Posterior tibiæ smooth-scaled. Fore wings with 2 from angle, 5 absent, 7 to apex, 8 absent, 11 from middle. Hind wings 1, ovate, cilia $\frac{1}{3}$; 4 absent, 2–7 nearly parallel.

THRANITICA HEMICOPA, sp. n.

♂. 20 mm. Head whitish-ochreous tinged with yellowish. Palpi fuscous. Antennæ whitish-ochreous. Thorax pale whitish-ochreous mixed anteriorly with brownish and dark fuscous. Abdomen whitish-ochreous. Fore wings elongate, moderately broad, costa moderately arched, apex rounded, termen obliquely rounded; pale whitish-ochreous, irregularly strewn with fuscous and dark fuscous strigulæ; base of costa dark fuscous; a narrow erect dark fuscous fascia from dorsum at $\frac{1}{3}$, reaching more than half across wing; a dark fuscous dot in disc at $\frac{2}{3}$; three very small dark fuscous spots on posterior half of costa: cilia whitish-ochreous. Hind wings and cilia pale whitish-ochreous.

NATAL; one specimen.

MELASINA HALIEUTIS, sp. n.

♂. 22 mm. Head and thorax white, partially fuscous-tinged. Palpi short, fuscous mixed with whitish, loosely haired. Antennæ whitish, pectinations 4. Abdomen hairy, ochreous-whitish. Fore wings elongate, somewhat dilated posteriorly, costa moderately arched, apex obtuse, termen obliquely rounded; 7 absent; whitish, irregularly strigulated throughout with fuscous; costa with several small darker fuscous spots; a suffused fuscous spot above middle at $\frac{3}{4}$: cilia whitish, outer half more or less brownish. Hind wings grey; cilia grey-whitish.

NATAL; one specimen.

MELASINA STELITIS, sp. n.

♂. 23 mm. Head and thorax grey mixed with white, forehead and upper edge of face white, rest of face dark grey. Palpi short, slender, loosely scaled, grey. Antennæ light grey, pectinations 5. Abdomen grey. Fore wings elongate, somewhat dilated posteriorly, costa moderately arched, apex obtuse, termen obliquely rounded; 7 absent; grey suffusedly mixed with white, and strigulated throughout with blackish; three small indistinct dark fuscous spots on posterior half of costa; absence of white suffusion and increase of dark strigulation forms an undefined narrow fascia from middle of dorsum reaching $\frac{2}{3}$ across wing: cilia pale fuscous mixed with whitish. Hind wings grey; cilia grey, towards tips whitish-tinged.

TRANSVAAL, N.E. Pretoria district, in January (*Janse*); one specimen.

MELASINA ÆDIFICA, sp. n.

♂. 20–24 mm. Head ochreous-yellowish, sometimes tinged with fulvous. Palpi moderate, densely scaled, ochreous-yellowish, basal half suffused with dark fuscous. Antennæ ochreous-whitish, pectinations 5. Thorax ochreous-whitish, anterior margin suffused with blackish-fuscous, tips of patagia and thoracic crest sometimes blackish. Abdomen pale greyish-ochreous, anal tuft yellowish. Fore wings elongate, moderate, costa gently arched, apex obtuse, termen obliquely rounded; all veins separate; whitish, with scattered small blackish-fuscous strigulæ; costal edge whitish-ochreous; irregular markings formed of confluent cloudy blackish-fuscous strigulæ, viz., a small, sometimes partially obsolete, basal patch, a moderate fascia from $\frac{1}{3}$ of costa to middle of dorsum, another from $\frac{3}{5}$ of costa to tornus, and a transverse spot from $\frac{5}{6}$ of costa, reaching half across wing: cilia whitish-ochreous, barred with fuscous and dark fuscous irroration. Hind wings ochreous-whitish, more or less tinged with grey: cilia whitish-ochreous, sometimes with a grey line.

TRANSVAAL, Pretoria, from November to January (*Janse*); five specimens.

MELASINA PARAPHRICTIS, sp. n.

♂. 18 mm. Head pale yellow-ochreous. Palpi moderate, densely scaled, pale ochreous-yellowish suffused with fuscous except towards base and apex. Antennæ fuscous mixed with ochreous-whitish, pectinations 5. Thorax fuscous, posteriorly suffused with whitish-ochreous. Abdomen fuscous, anal tuft ochreous-yellowish. Fore wings elongate, moderate, costa moderately arched, apex obtuse, termen obliquely rounded; all veins separate; light fuscous, suffusedly strigulated with dark fuscous; costal edge whitish-ochreous; indistinct markings outlined by cloudy blackish-fuscous partly confluent strigulæ, viz., an angulated fascia near base, a fascia from $\frac{1}{3}$ of costa to middle of dorsum, another from $\frac{3}{5}$ of costa to tornus, and a transverse spot from costa at $\frac{5}{6}$ reaching half across wing: cilia fuscous mixed with whitish-ochreous and dark fuscous. Hind wings dark fuscous; cilia whitish-fuscous, with darker fuscous subbasal shade.

TRANSVAAL, Pietersburg, in December (*Janse*); one specimen.

MELASINA MORBIDA, sp. n.

♂. 23 mm. Head whitish-ochreous with a few fuscous hairs. Palpi moderate, loosely scaled, ochreous-whitish mixed with dark fuscous except towards apex. Antennæ ochreous-whitish, pectinations 4. Thorax whitish, anteriorly mixed with dark fuscous. Abdomen whitish-brownish. Fore wings elongate, costa gently arched, apex obtuse, termen little rounded, oblique; all veins separate; white, rather closely strigulated with light fuscous, with a few blackish strigulæ; an irregular angulated blackish-fuscous transverse streak near base, not quite reaching dorsum; a rather large blackish-fuscous subquadrate spot beneath middle of disc, with undefined blackish strigulæ diverging from its upper angles; a series of blackish-fuscous strigulæ at about $\frac{5}{6}$ parallel to termen: cilia whitish tinged with fuscous, with fuscous antemedian line and broader apical interrupted fuscous shade. Hind wings fuscous-whitish, more fuscous-tinged posteriorly; cilia whitish, with light fuscous subbasal shade.

German East Africa, Dar-es-Salaam; one specimen.

Melasina sauropa, sp. n.

♂. 26–27 mm. Head, palpi, and thorax pale ochreous more or less mixed with dark fuscous; palpi moderate, loosely scaled. Antennæ whitish-ochreous somewhat sprinkled with dark fuscous, pectinations 5. Abdomen light ochreous sprinkled with fuscous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen rounded, rather strongly oblique; all veins separate; whitish-ochreous strewn with undefined dark fuscous strigulæ or suffusedly irrorated throughout with fuscous and dark fuscous; a dark fuscous spot on costa at $\frac{1}{3}$, and five on posterior half of costa, becoming smaller towards apex; a very undefined basal patch of dark fuscous suffusion; a thick irregular suffused dark fuscous streak proceeding from dorsum near base to $\frac{1}{3}$ of disc, whence it sends a branch to first costal spot, thence curved downwards beneath middle of disc to $\frac{2}{3}$, whence it sends a branch to tornus, and a longitudinal arm beneath costa which is connected more or less distinctly with all five posterior costal spots: cilia ochreous-whitish, broadly barred or almost wholly suffused with dark fuscous. Hind wings fuscous; cilia pale fuscous, with darker subbasal line and anteapical shade.

Nyassaland, Mpeta, on Loangwa River, in December; two specimens.

Melasina stabularia, sp. n.

♂. 13 mm. Head pale yellowish-ochreous. Palpi moderate, with dense projecting scales, whitish-ochreous, basal half suffused with fuscous. Antennæ whitish-ochreous, pectinations 5. Thorax pale yellowish-ochreous sprinkled with fuscous. Abdomen whitish-ochreous. Fore wings elongate, moderate, costa gently arched, apex obtuse, termen obliquely rounded; 9 absent; pale yellowish-ochreous sprinkled with fuscous, margins strigulated with fuscous; stigmata indicated by spots of fuscous suffusion, plical beyond first discal: cilia pale yellowish-ochreous, apical third paler and barred with fuscous irroration. Hind wings whitish-grey; cilia whitish-ochreous.

British East Africa, Mombasa, in October; one specimen.

Melasina cyclatma, sp. n.

♂. 28 mm. Head, palpi, and thorax fuscous sprinkled with whitish and dark fuscous; palpi rather short, densely scaled, pointed. Antennæ whitish-fuscous sprinkled with dark fuscous, pectinations 5. Abdomen grey, anal tuft greyish-ochreous. Fore wings elongate, costa moderately arched, apex obtuse, termen little rounded, rather strongly oblique; all veins separate; fuscous, somewhat sprinkled with whitish and irregularly and suffusedly irrorated with blackish-fuscous, the confluence of irroration forming several irregular broken longitudinal marks, and three or four spots on posterior half of costa; a rounded blotch of whitish suffusion on dorsum before middle, and an irregular streak of whitish suffusion along posterior third of dorsum and termen to apex: cilia pale fuscous, with a dark fuscous antemedian shade, outer half sprinkled with whitish and indistinctly barred with dark fuscous suffusion. Hind wings grey; cilia whitish-fuscous, with dark fuscous subbasal shade.

Transvaal, N.E. Pretoria district, from September to December (*Janse*); one specimen.

Melasina isospila, sp. n.

♂. 25 mm. Head pale ochreous. Palpi moderate, with appressed scales, pale ochreous mixed with fuscous. Antennæ ochreous-whitish spotted with dark fuscous, pectinations 6, lined with dark fuscous. Thorax fuscous mixed with dark fuscous and whitish. Abdomen grey. Fore wings elongate, costa moderately arched, apex obtuse, termen obliquely rounded; all veins separate; light fuscous, irregularly mixed with white and strigulated with dark fuscous; a series of irregular dark fuscous spots along costa, a larger suffused spot beneath middle of disc, and the confluence of dark strigulation appears to form other irregular markings, especially an angulated fascia from $\frac{3}{4}$ of costa to tornus, but these are hardly definable: cilia ochreous-whitish indistinctly barred with fuscous. Hind wings light fuscous; cilia whitish-fuscous.

Angola, Bihe; one specimen.

Melasina immanis, sp. n.

♂ 22–26 mm., ♀ 35 mm. Head light greyish-ochreous mixed with dark fuscous. Palpi moderate, densely scaled, tolerably pointed, whitish-ochreous mixed with dark fuscous. Antennæ whitish-ochreous sprinkled with dark fuscous, pectinations in ♂ 6. Thorax whitish-ochreous irrorated with dark fuscous. Abdomen light fuscous, anal tuft pale ochreous. Fore wings elongate, more so in ♀, costa gently arched, apex obtuse, termen obliquely rounded; all veins separate; whitish-ochreous, more or less irrorated with fuscous, and strigulated throughout with blackish-fuscous; second discal stigma distinct, moderate, dark fuscous; an elongate suffused dark fuscous mark beneath middle of disc, whence proceeds a slightly curved series of shorter similar marks to apex, sometimes obscured by the fuscous irroration which tends to form a cloudy patch or suffusion in posterior part of disc: cilia whitish-ochreous mixed with fuscous and indistinctly barred with dark fuscous suffusion. Hind wings whitish-ochreous suffusedly irrorated with fuscous except towards base; cilia whitish-ochreous, with a fuscous subbasal line.

S. Nigeria, Ogrugu; Gambia, Bathurst; thirteen specimens.

Melasina dissoluta, sp. n.

♂ 22–27 mm., ♀ 35–42 mm. Head light yellowish-ochreous, with a few dark fuscous hairs. Palpi moderate, densely scaled, pointed, pale ochreous sprinkled with dark fuscous. Antennæ whitish-ochreous sprinkled with dark fuscous, pectinations in ♂ 4. Thorax whitish-ochreous more or less suffused with fuscous and sprinkled with dark fuscous. Abdomen fuscous. Fore wings elongate, more so in ♀, costa gently arched, apex obtuse, termen obliquely rounded; all veins separate; whitish-ochreous, more or less wholly irrorated with fuscous and strigulated with blackish-fuscous; the confluence of dark strigulation produces irregular undefined markings, viz., a basal patch with angulated edge, a fascia from $\frac{1}{3}$ of costa to middle of dorsum, another from $\frac{3}{5}$ of costa to tornus, connected with preceding in disc, and an inwardly oblique patch from costa towards apex: cilia whitish-ochreous mixed with fuscous and indistinctly barred with dark fuscous suffusion. Hind wings fuscous, rather darker in ♂; cilia whitish-fuscous, with darker fuscous subbasal line.

Nyassaland, Zomba, 3000 feet, in December; six specimens.

Melasina inimica, sp. n.

♂. 25 mm. Head and palpi pale greyish-ochreous mixed with dark fuscous; palpi moderate, densely scaled. Antennæ pale greyish-ochreous, pectinations 6, lined with dark fuscous. Thorax fuscous mixed with dark fuscous. Abdomen fuscous. Fore wings elongate, moderately broad, costa moderately arched, apex obtuse, termen obliquely rounded; all veins separate; fuscous suffusedly strigulated with dark fuscous; obscure oblique median and postmedian fasciæ indicated by confluence of strigulation, former marked with a patch of darker suffusion about fold: cilia fuscous mixed with darker. Hind wings fuscous; cilia whitish-fuscous, with fuscous subbasal shade.

Angola, Bihe; one specimen.

An obscure species, but differs from *immanis* and its allies by the obviously broader fore wings.

Melasina systolæa, sp. n.

♂ 17–19 mm., ♀ 23–24 mm. Head pale fulvous; tongue very short. Palpi very long, densely scaled, pale ochreous suffused with blackish. Antennæ in ♂ ochreous-whitish spotted with dark fuscous, pectinations 5, lined with black, in ♀ shortly pectinated, wholly clothed with dense loose dark fuscous scales. Thorax brownish irrorated with blackish. Abdomen dark fuscous. Fore wings elongate, more so in ♀, costa gently arched, apex obtuse, termen obliquely rounded; all veins separate; fuscous sometimes somewhat mixed with whitish and bluish-grey, and sprinkled with blackish; costal edge whitish-ochreous; markings ochreous-brown irregularly irrorated with black, viz., an undefined basal patch, a fascia from $\frac{1}{3}$ of costa to middle of dorsum, another from $\frac{3}{5}$ of costa to tornus, and some undefined posterior streaks rising from small spots on costa: cilia dark fuscous, with several whitish-ochreous bars, sometimes partly obsolete. Hind wings blackish-fuscous; cilia dark purplish-bronzy-fuscous, with blackish subbasal line.

NATAL, Durban and Mooi R., in September and October (*Leigh*); seven specimens.

This and the following species, which possess a very short tongue (absent in the rest), are apparently primitive.

MELASINA AMICA, sp. n.

♂ 23 mm., ♀ 30–34 mm. Head and palpi light ochreous-orange, palpi short, rough-scaled; tongue very short. Antennæ light ochreous (in ♂ broken). Thorax yellow-ochreous. Abdomen light ochreous. Fore wings elongate, more so in ♀, costa gently arched, apex obtuse, termen obliquely rounded; all veins separate; yellow-ochreous: cilia light yellow-ochreous. Hind wings in ♂ light greyish-fulvous, in ♀ grey; cilia pale ochreous, with a faint fuscous subbasal line.

NYASSALAND, Zomba, 3000 feet, in December; three specimens.

MELASINA LIOCHRA, sp. n.

♂. 21–22 mm. Head and palpi light fulvous-ochreous; palpi moderate, densely scaled. Antennæ grey, pectinations $2\frac{1}{2}$, lined with black. Thorax pale ochreous, anteriorly tinged with fuscous. Abdomen pale yellowish-ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen slightly rounded, rather strongly oblique; all veins separate; light yellowish-ochreous; base of costa blackish; a blackish dot in disc at $\frac{3}{5}$: cilia light yellowish-ochreous. Hind wings dark grey; cilia whitish-ochreous tinged with fuscous.

TRANSVAAL, Pretoria, in October, December, and January (*Janse*); four specimens.

MELASINA MYLICA, sp. n.

♂. 22–23 mm. Head light yellowish-fulvous, face yellowish-white; tongue very short. Palpi moderate, densely scaled, yellowish-fulvous mixed with fuscous. Antennæ whitish-ochreous, pectinations 3, lined with dark fuscous. Thorax whitish irrorated with pale ochreous. Abdomen ochreous-whitish, anal tuft large, pale yellowish. Fore wings elongate, narrow, costa slightly arched, apex obtuse, termen very obliquely rounded; all veins separate; white, thinly and finely sprinkled with brown: cilia ochreous-whitish, finely sprinkled with brown. Hind wings whitish-ochreous-grey; cilia whitish-ochreous.

Transvaal, Pietersburg, in October and November (*Janse*); two specimens.

Melasina abacodes, sp. n.

♂. 20 mm. Head pale bright fulvous, face whitish-suffused; tongue very short. Palpi moderate, densely scaled, fulvous-yellowish, suffused with fuscous towards base. (Antennæ broken.) Thorax white, tinged with ochreous anteriorly. Abdomen whitish-ochreous, anal tuft large, expansible. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; all veins separate; white, with very numerous pale fuscous strigulæ or small spots arranged in longitudinal series between veins, obsolete in anterior half of cell and absent on anterior half of costal area; a dark fuscous dot on base of costa; costal edge ochreous-yellowish to origin of cilia: cilia whitish-yellowish, on termen with two rows of dark fuscous points. Hind wings grey; cilia whitish-yellowish.

Transvaal, N.E. Pretoria district, in November (*Janse*); one specimen.

Hapsifera pardalea, sp. n.

♂ ♀. 20–30 mm. Head and palpi pale yellowish-ochreous. Antennæ and abdomen pale ochreous. Thorax pale ochreous tinged with brownish and lilac, and mixed anteriorly with dark fuscous. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 9 absent; whitish-ochreous, irregularly strigulated with ferruginous, with scattered black strigulæ on margins, all these strigulæ more or less raised; larger tufts near base, and an antemedian fascia near dorsum; very indefinite markings of irregularly mixed ferruginous, lilac-fuscous, and black scales, forming a basal patch, an oblique fascia before middle, and a large posterior patch in disc almost reaching apex: cilia whitish-ochreous, with two indistinct fuscous lines. Hind wings pale grey tinged with whitish-ochreous; cilia whitish-ochreous, with more or less indistinct fuscous line.

Natal, Camperdown (2500 feet) and Northdene, in March and April (*Leigh*); ten specimens.

The only known species in which vein 9 is absent (coincident with 7 instead of stalked), but normal in all other respects.

Hapsifera ochroptila, sp. n.

♂ ♀. 23–27 mm. Head, palpi, and thorax ochreous-whitish. Antennæ and abdomen whitish-ochreous. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 9 out of 7; ochreous-whitish, sometimes strewn with small yellow-ochreous strigulæ slightly sprinkled with blackish, but these are often obsolete except on costa, where they are distinct; numerous undefined blackish strigulæ arranged in two or three longitudinal series in disc from near base to termen; strong yellow-ochreous tufts as follows, viz., one at base, two beneath fold, one in disc before middle, three in an oblique series beyond middle, one towards costa posteriorly, and a series of smaller ones round posterior part of costa and termen: cilia ochreous-whitish, sometimes tinged with yellow-ochreous. Hind wings ochreous-whitish; cilia whitish-ochreous.

Transvaal, Pretoria, from December to April (*Janse*); five specimens.

Hapsifera septica, sp. n.

♂. 21–23 mm. Head and antennæ ochreous-whitish. Palpi ochreous-whitish tinged with yellowish, terminal joint with a faint darker subapical ring. Thorax ochreous-whitish spotted with yellow-ochreous suffusion. Abdomen grey. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 2 and 3 short-stalked, 9 out of 7; whitish, with numerous yellow-ochreous strigulæ or small spots arranged in longitudinal series; on a submedian streak from near base to termen, continued along termen to apex, these spots or strigulæ are blackish-grey; strong yellow-ochreous tufts as follows, viz., one at base, two beneath fold, one in disc before middle, three in an oblique series beyond middle, one towards costa posteriorly, and a series of smaller ones round posterior part of costa and termen: cilia yellow-ochreous, mixed with whitish towards tips. Hind wings rather dark grey; cilia whitish-ochreous tinged with grey.

Nyassaland, Fort Johnston, in February; two specimens.

Hapsifera meliceris, sp. n.

♂. 25 mm. Head and palpi whitish-ochreous partially suffused with ochreous-yellowish. (Antennæ broken.) Thorax whitish-ochreous spotted with ochreous-yellowish suffusion and anteriorly with blackish. Abdomen light yellow-ochreous. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 9 out of 7; whitish-ochreous strigulated throughout with blackish; some irregular undefined streaks and patches of pale ochreous-orange suffusion; an ochreous-orange patch in disc before middle, and an oblique transverse patch beyond middle, containing raised scales; an ochreous-orange tuft at base, and two beneath fold; some small ochreous-orange spots round posterior part of costa and termen: cilia whitish-ochreous suffusedly barred with ochreous-orange, with a few dark fuscous scales. Hind wings blackish; cilia ochreous-yellowish.

Transvaal, N.E. Pretoria district; Natal; from January to March (*Janse*); one specimen.

HAPSIFERA GLEBATA, sp. n.

♂. 15–19 mm. Head pale greyish-ochreous, with a few dark fuscous scales. Palpi whitish-ochreous, basal $\frac{2}{3}$ of second joint and a median band of terminal joint suffused with dark fuscous. Antennæ pale greyish-ochreous, more whitish towards apex. Thorax pale greyish-ochreous, more or less suffused with dark fuscous anteriorly and at posterior extremity. Abdomen whitish-grey. Fore wings elongate, narrow, costa gently arched, apex obtuse, termen extremely obliquely rounded; 9 out of 7; pale greyish-ochreous, sprinkled and irregularly strigulated throughout with dark fuscous; six moderate dark fuscous costal spots; stigmata represented by small somewhat raised dark fuscous spots, plical slightly beyond first discal, second discal larger; a series of small dark fuscous spots round apex and termen: cilia whitish-ochreous sprinkled with dark fuscous. Hind wings pale grey; cilia whitish-ochreous tinged with grey.

TRANSVAAL, Pretoria (*Janse*); UGANDA, Kampala; from October to March; five specimens.

## PITHARCHA, n. g.

Head with dense loosely appressed scales; ocelli present; tongue absent. Antennæ $\frac{4}{5}$, in ♂ simple. Labial palpi moderately long, curved, ascending; second joint clothed with dense projecting scales beneath, forming a rough tuft, with two or three long bristles externally; terminal joint shorter, loosely scaled, obtuse. Maxillary palpi short, drooping, filiform. Posterior tibiæ clothed with very long dense hairs. Fore wings with tufts of scales on surface; 2 and 3 stalked, 7 and 8 stalked, 7 to apex, 11 from $\frac{1}{3}$. Hind wings 1, elongate-ovate, cilia $\frac{2}{3}$; 2–7 tolerably parallel.

PITHARCHA CHALINÆA, sp. n.

♂ ♀. 20–28 mm. Head pale greyish-ochreous. Palpi whitish-ochreous, second joint except towards apex, and sometimes two indistinct bands of terminal joint, suffusedly irrorated with dark fuscous. Antennæ pale ochreous suffusedly spotted with fuscous. Thorax pale greyish-ochreous more or less irrorated with fuscous and dark fuscous. Abdomen pale greyish-ochreous. Fore wings elongate, costa gently arched, apex rounded, termen obliquely rounded; pale whitish-ochreous, sometimes partially suffused with fuscous, irregularly and suffusedly strigulated with dark fuscous, more distinctly on margins; a narrow irregular blackish-fuscous streak from costa at $\frac{3}{5}$ obliquely outwards, sharply angulated in middle and not reaching dorsum: cilia pale whitish-ochreous sprinkled with dark fuscous. Hind wings in ♂ greyish-ochreous, in ♀ grey; cilia whitish-ochreous, in ♀ more or less tinged with fuscous.

S. NIGERIA, Wari; SIERRA LEONE; NYASSALAND, Zomba and Blantyre; in May, four specimens.

## Amydria Clem.

Head rough-haired; ocelli and tongue absent. Antennæ $\frac{3}{4}$, in ♂ stout, simple, basal joint without pecten. Labial palpi moderate, curved, ascending, second joint clothed with dense loose scales projecting beneath towards apex, with a row of long projecting bristles externally or sometimes with numerous spreading bristles beneath, terminal joint moderate or short, somewhat pointed. Maxillary palpi short. Posterior tibiæ loosely haired. Fore wings with 2 from towards angle, 7 to apex, 11 from before middle. Hind wings 1, elongate-ovate, cilia $\frac{1}{2}$; 2–7 tolerably parallel.

### Amydria optania, sp. n.

♂. 18 mm. Head, palpi, antennæ, and thorax deep yellow-ochreous; second joint of palpi with external bristles. Abdomen pale ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen obliquely rounded; deep yellow-ochreous, very faintly strigulated with brownish: cilia yellow-ochreous, tips blackish on termen. Hind wings light fuscous tinged with yellowish; cilia whitish-ochreous.

S. Nigeria, Ogrugu; two specimens.

### Amydria leontopa, sp. n.

♂ 17–18 mm. Head and thorax brownish-ochreous, head fulvous-tinged. Palpi pale ochreous, second joint and a median ring of terminal joint suffused with dark fuscous, second joint with external bristles. Antennæ greyish-ochreous, more or less ringed with dark fuscous. Abdomen pale ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; brownish-ochreous: cilia concolorous. Hind wings grey; cilia pale ochreous, more or less sprinkled with fuscous.

Transvaal, Pretoria, in October and November (*Janse*); three specimens.

### Amydria opifica, sp. n.

♂. 13 mm. Head and thorax greyish-ochreous mixed with dark fuscous. Palpi whitish-ochreous, second joint and median band of terminal joint suffused with dark fuscous, second joint with external bristles. Antennæ fuscous. Abdomen light grey. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; pale greyish-ochreous irrorated with fuscous and dark fuscous: cilia whitish-ochreous irrorated with dark fuscous. Hind wings light grey; cilia pale greyish-ochreous, sprinkled with grey.

Transvaal, Pietersburg, in September (*Janse*); one specimen.

Amydria percastis, sp. n.

♂ ♀. 17–21 mm. Head, palpi, antennæ, and thorax dark fuscous; second joint of palpi with numerous spreading bristles beneath and externally, apex of terminal joint whitish-ochreous. Abdomen in ♂ fuscous, in ♀ light greyish-ochreous. Fore wings elongate, narrow, costa gently arched, apex round-pointed, termen extremely obliquely rounded; bronzy-fuscous, suffusedly and indistinctly strigulated with dark fuscous: cilia greyish-ochreous mixed with dark fuscous. Hind wings light grey; cilia pale greyish-ochreous or greyish.

Transvaal, Pretoria, from August to October (*Janse*); three specimens.

Amydria trophias, sp. n.

♂. 19 mm. Head and thorax pale greyish-ochreous irrorated with dark fuscous. Palpi whitish-ochreous mixed with dark fuscous, second joint with numerous projecting bristles on both sides, terminal joint with basal and median dark fuscous bands. Antennæ pale fuscous suffusedly ringed with darker. Abdomen fuscous. Fore wings elongate, moderate, costa moderately arched, apex obtuse, termen obliquely rounded; whitish-ochreous suffused with pale fuscous and finely irrorated with dark fuscous, irregularly and coarsely strigulated with dark fuscous; plical and second discal stigmata forming suffused dark fuscous spots, preceded and followed by paler spaces; costal edge whitish-ochreous from $\frac{1}{4}$ to apex: cilia whitish-ochreous mixed with dark fuscous. Hind wings light fuscous; cilia whitish-ochreous with two fuscous shades.

Transvaal, Pietersburg and N.E. Pretoria district, from October to December (*Janse*); one specimen.

Scardia paracosma, sp. n.

♂. 16–17 mm. Head, palpi, and thorax whitish-ochreous, yellowish-tinged. Antennæ grey, blackish-sprinkled. Abdomen light grey, anal tuft whitish-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse-pointed, termen very obliquely rounded; 7 and 8 stalked; whitish-ochreous, slightly yellowish-tinged; base of costa slightly infuscated: cilia whitish-ochreous. Hind wings grey; cilia whitish-ochreous.

Transvaal, Pretoria, in December (*Janse*); two specimens.

## Hyoprora, n. g.

Head densely rough-haired; ocelli present; tongue absent. Antennæ $\frac{4}{5}$, in ♂ shortly ciliated, basal joint with pecten of long scales. Labial palpi moderately long, straight, porrected, second joint rough-scaled above and densely tufted beneath, terminal joint short, slender, pointed. Maxillary palpi absent. Posterior tibiæ clothed above with long hairs. Fore wings with 2 from towards angle, 7 absent, 11 from before middle. Hind wings somewhat under 1, ovate-lanceolate, cilia 1; 2–7 nearly parallel.

Hyoprora crymodes, sp. n.

♂. 13 mm. Head, palpi, and thorax white. Antennæ grey, base white. Abdomen pale yellow-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex pointed, termen extremely obliquely rounded; white, with a very few scattered slightly raised black specks; small undefined yellow spots arranged as under, viz., two beneath costa anteriorly, two on fold, one in disc before middle, one on costa before middle, one in disc at $\frac{2}{3}$, and a series of very indistinct ones round posterior part of costa and termen: cilia white. Hind wings pale whitish-grey with a faint yellowish tinge; cilia ochreous-white.

Transvaal, Pretoria, in January (*Janse*); one specimen.

## Adelidæ.

### Ceromitia Zell.

This genus differs essentially from *Nemophora* only in the maxillary palpi being short, loosely scaled, drooping, instead of long, filiform, folded.

Ceromitia spilodesma, sp. n.

♂. 15–18 mm. Hairs of crown white, face fuscous mixed with whitish. Palpi short, slender, fuscous. Antennæ whitish, towards base ringed with fuscous. Thorax white, shoulders fuscous. Abdomen rather dark fuscous, apex pale ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; 8 and 9 usually stalked; white, more or less mixed with pale fuscous, with some scattered dark fuscous strigulæ, especially towards costa; markings dark fuscous; an elongate-triangular spot along basal fifth of costa, broadest posteriorly; an elongate spot on costa about $\frac{1}{3}$, beneath which is an inwardly oblique bar in disc, indistinctly connected with it; a rather thick fascia from beyond middle of costa to $\frac{2}{3}$ of dorsum; a large transverse oval spot in disc at $\frac{3}{4}$; a series of small spots round posterior part of costa and termen: cilia whitish-ochreous. Hind wings grey; cilia whitish-ochreous.

Transvaal, Pretoria, from November to January (*Janse*); two specimens.

Ceromitia stathmodes, sp. n.

♂. 14 mm. Head white, hairs of crown brownish between antennæ. Palpi short, slender, fuscous mixed with white. Antennæ whitish, with fuscous rings becoming indistinct towards apex. Thorax whitish, shoulders fuscous. Abdomen rather dark fuscous, apex pale ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 8 and 9 separate; whitish, partially tinged with very pale fuscous, and sprinkled with dark fuscous; markings dark fuscous; an elongate spot along basal fifth of costa; three moderate undefined fasciæ, first from $\frac{1}{3}$ of costa to $\frac{1}{3}$ of dorsum, second from beyond middle of costa to $\frac{2}{3}$ of dorsum, third from $\frac{3}{4}$ of costa to tornus, indented beneath costa; a series of small spots round posterior part of costa and termen: cilia ochreous-whitish, basal half whitish barred with fuscous. Hind wings and cilia rather dark grey.

Transvaal, Pretoria, in January (*Janse*); one specimen.

Ceromitia libropis, sp. n.

♀. 14 mm. Head whitish, forehead suffused with brownish-ochreous. Palpi short, loosely scaled, whitish. Antennæ whitish, indistinctly ringed with fuscous. Thorax white, sprinkled with brownish. Abdomen grey. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; 8 and 9 stalked; light fuscous, suffusedly mixed with white, with a few scattered dark fuscous scales; an undefined spot of dark fuscous suffusion in middle of disc: cilia pale fuscous mixed with whitish. Hind wings grey; cilia whitish-grey.

Transvaal, Pretoria, in December (*Janse*); one specimen.

Ceromitia palyntis, sp. n.

♂. 16–17 mm. Head white, sides of face and a frontal bar dark fuscous. Palpi very short, loosely scaled, white. Antennæ whitish. Thorax white, shoulders fuscous. Abdomen fuscous, apex pale ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 8 and 9 separate; white, with a few scattered dark fuscous scales and strigulæ; a slender dark fuscous streak along basal fifth of costa; five dark fuscous dots or small spots, viz., two beneath fold at $\frac{1}{4}$ and middle, two in disc at $\frac{2}{5}$ and $\frac{4}{5}$, and one towards costa at $\frac{2}{3}$, and sometimes one or two small additional dots; a row of dark fuscous dots round posterior part of costa and termen: cilia ochreous-white. Hind wings grey; cilia grey, towards tips whitish-suffused.

Transvaal, Pretoria, from December to February (*Janse*); three specimens.

Ceromitia amphichroa, sp. n.

♂. 20 mm. Head ochreous-yellow, crown posteriorly whitish. Palpi short, whitish. Antennæ whitish. Thorax white; shoulders with a dark fuscous spot. Abdomen pale yellowish-ochreous. Fore wings elongate, rather narrow, costa moderately arched, apex obtuse, termen very obliquely rounded; 8 and 9 separate, white; a thick dark fuscous streak along basal fifth of costa, beneath which is a short subcostal line; three irregular dark fuscous dots longitudinally arranged in disc, three others nearer costa obliquely before them respectively, two on fold beneath the first two subcostal, one between second of these and second discal, and two or three other irregularly placed specks; an irregular submarginal series of small dark fuscous dots, and another series round posterior part of costa and termen: cilia ochreous-whitish. Hind wings grey; cilia whitish-ochreous.

Transvaal, Pretoria, in January (*Janse*); one specimen.

Ceromitia glandularis, sp. n.

♂. 19 mm. Head ochreous-yellowish. Palpi very short (defaced). Antennæ ochreous-whitish. Thorax ochreous-whitish, more ochreous anteriorly. Abdomen fuscous, apex pale ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 8 and 9 separate; ochreous-whitish, towards costa tinged with ochreous-yellowish; markings blackish; a slender streak along basal fifth of costa; five roundish small spots, viz., two beneath fold at $\frac{1}{4}$ and $\frac{1}{2}$, two in disc beyond these respectively, and one towards costa at $\frac{2}{3}$ in a line with the posterior pair; three or four smaller spots or dots between these and termen; a series of dots round posterior part of costa and termen: cilia whitish-ochreous, tips infuscated. Hind wings grey; cilia whitish-ochreous, tips infuscated.

Nyassaland, Zomba, in December; one specimen.

Ceromitia sporæa, sp. n.

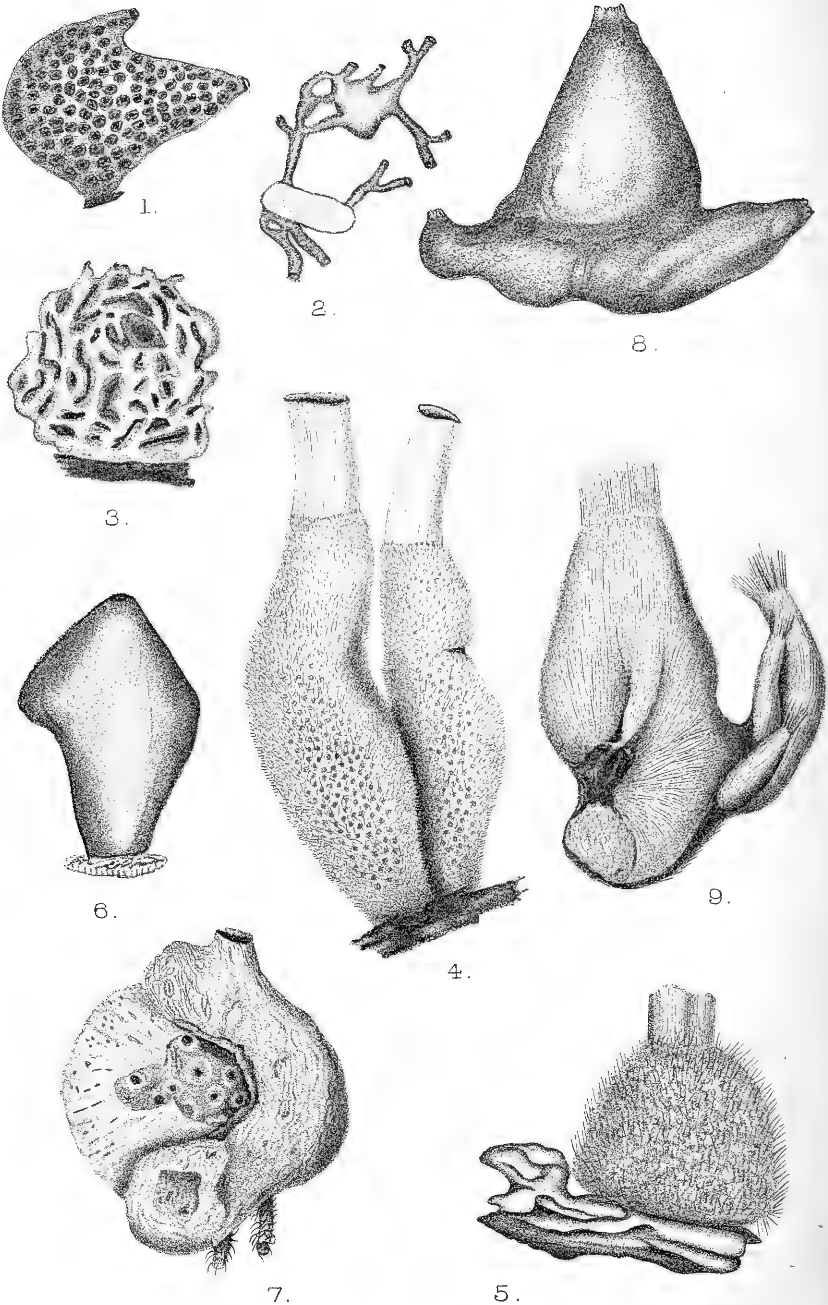
♂. 16 mm. Head white, between and round antennæ brown. Palpi short, white, with loose projecting scales. Antennæ whitish indistinctly ringed with pale fuscous. Thorax whitish, with pale brownish subdorsal and lateral stripes. Abdomen whitish-ochreous. Fore wings elongate, rather narrow, costa gently arched, apex obtuse-pointed, termen very obliquely rounded; 8 and 9 separate; pale brownish, suffusedly mixed with white, with a few scattered black scales; extreme costal edge blackish near base; an undefined subcostal line of black scales from base to about $\frac{1}{4}$; two or three undefined dots of black scales in disc before middle: cilia pale brownish mixed with whitish. Hind wings pale grey; cilia grey-whitish.

Transvaal, Pietersburg, in March (*Janse*); one specimen.

Ceromitia tyrochlora, sp. n.

♀. 14 mm. Head light yellow, lower part of face and back of crown whitish-suffused. Palpi short, yellow-whitish. Antennæ whitish. Thorax yellow-whitish, shoulders suffused with pale yellowish. Abdomen whitish-ochreous (partly defaced). Fore wings elongate, rather narrow, costa gently arched, apex obtuse, termen very obliquely rounded; 8 and 9 separate: pale whitish-ochreous tinged with yellowish: cilia concolorous. Hind wings pale grey; cilia pale whitish-ochreous.

Transvaal, Pretoria, in January (*Janse*); one specimen.




Huth lith. et imp.

CAPE VERDE ISLANDS CALCAREA.

## 9. On Collections of the Cape Verde Islands Fauna made by Cyril Crossland, M.A. (Cantab.), B.Sc. (Lond.), F.Z.S., (late of the Gatty Marine Laboratory, St. Andrews University), from July to September 1904.—The Calcareous Sponges. By A. G. Thacker, A.R.C.S. (Lond.), Research Scholar in Zoology at the Royal College of Science *.

[Received June 15, 1908.]

(Plate XL. † and Text-figures 155–166.)

It is somewhat remarkable that, although a considerable number of Calcareous Sponges has been described from the Azores and from the Canary Islands, only one species, *Grantia tuberosa*, dredged off St. Vincent by the 'Challenger,' has been hitherto recorded from the Cape Verde Islands. It was therefore to be expected that the dredging operations which were carried out by Mr. Crossland, with the aid of a grant from the Carnegie Trustees, in the summer of 1904, would yield some interesting results; and such has in fact been the case, for of the twelve species contained in the present collection, six are altogether new to science, and several of the remainder are of interest either from the zoögeographical or systematic point of view.

The twelve species are as follows:—

*Leucosolenia panis* (Haeckel).
*Leucosolenia atlantica*, sp. n.
*Leucosolenia canariensis* (Miklucho-Maclay).
*Sycon quadrangulatum* (Schmidt).
*Sycon caminatum*, sp. n.
*Grantia intermedia*, sp. n.
*Leucandra verdensis*, sp. n.
*Leucandra rudifera* (Poléjaeff).
*Leucandra sericata* (Ridley).
*Leucandra typica* (Poléjaeff).
*Leucandra crosslandi*, sp. n.
*Leucandra gemmipara*, sp. n.

Perhaps the most interesting of these species is the remarkable sponge, *Leucandra rudifera*, of which only a few fragments have been previously found and which is characterised by the possession of some curious and unique spicules in its gastral cortex.

Another fact, which is of some systematic interest and to which I would call attention, is the comprehensive sense in which I have been obliged to use the name *Leucosolenia canariensis*. From the great variability of certain characters in some of the Ascons in this collection, it seems probable that the characters by which certain sponges (notably *Leucosolenia nanseni* Breitfuss, and

* Communicated by Professor Arthur Dendy, D.Sc., F.R.S., F.Z.S., Sec.L.S.
† For explanation of the Plate see p. 782.

*Leucosolenia tenuipilosa* Dendy) have been supposed to be specifically distinguished from Haeckel's original *Ascaltis canariensis* are really quite inconstant and not of specific value. As used by me, therefore, the name *Leucosolenia canariensis* includes sponges which have been hitherto considered to be specifically distinct from each other, and in my description of this species I have endeavoured to give a detailed justification of this procedure.

The calcisponge fauna of the Cape Verde Islands shows distinct affinity with that of the western side of the Atlantic. In a letter to Professor Minchin, Mr. Crossland suggested that the distribution of these species might prove interesting because the Islands receive currents from the Gulf Stream. This forecast has been to some extent corroborated, for *Leucosolenia panis* has been recorded from the coast of Florida (immediately in the course of the Gulf Stream, of course), and *Leucandra typica* and *Leucandra rudifera* were dredged by the 'Challenger' off Bermuda (also not far from the Gulf Stream) on the same day and from the same spot. I think, therefore, that it is not impossible that the Gulf Stream may be a factor in the distribution of all three species; but it should not be forgotten that the North Equatorial Current, which takes its origin near the Cape Verde Islands and meets the Gulf Stream as the latter issues from the Gulf of Mexico, might produce precisely the same results by distributing the sponges in the opposite direction, that is, by carrying them westwards instead of eastwards. The distribution of *Leucandra typica* may not be of much value in estimating these factors of dispersal, because having been recorded from Australia it is evidently a widely distributed if somewhat uncommon species, but in the case of *L. panis* and of *L. rudifera*, each of which has only been found once before, the facts here stated are of greater significance. *Leucandra sericata* is a sponge inhabiting the Atlantic coast of South America. Of the remaining two species which are not new, *L. canariensis* has a very wide range and *Sycon quadrangulatum* has been recorded from the Arctic, from the eastern Atlantic, and from the Mediterranean.

Where it has been necessary in the following pages to refer to individual specimens, I have done so by the use of the Registered Number (*R.N.*) which I have attached to each specimen in the collection*. The numbers in square brackets—thus [**1**]—refer to the works given in the list of literature at the end. The list only includes such memoirs as I have had to refer to in the text.

Throughout this paper I have followed the classification of the Calcarea, set forth by Dendy in [**9**] and [**11**]. According to this system the genera *Leucosolenia* and *Leucandra* are very comprehensive, the former including all the Homocœla and the latter being extended to include species such as my *L. verdensis*, which

* The collection has been placed in the University Museum of Zoology at Cambridge.

has no oxeote spicules. In the case of these two genera the classification is to be regarded, I think, as the expression of a suspension of judgment. There can be little doubt that both *Leucosolenia* and *Leucandra* will eventually have to be split up into several distinct genera; but until this can be done with some reasonable likelihood of finality, it would seem wisest not to attempt the task.

I take this opportunity of expressing my gratitude to Professor A. Dendy, F.R.S., who placed the collection at my disposal for examination, and who has throughout the research given me invaluable assistance and advice. I have also to thank my friend Mr. F. J. Bridgman, Marshall Scholar in the Royal College of Science, who has very kindly sketched the external form of several of the Heterocœla (Pl. XL. figs. 4, 5, 7, and 9). And finally I must acknowledge my indebtedness to the authorities of the British Museum (Natural History), who gave me access to the National Collection of Calcarea and have afforded me special facilities for consulting the literature on the subject, much of which is not easily obtainable elsewhere.

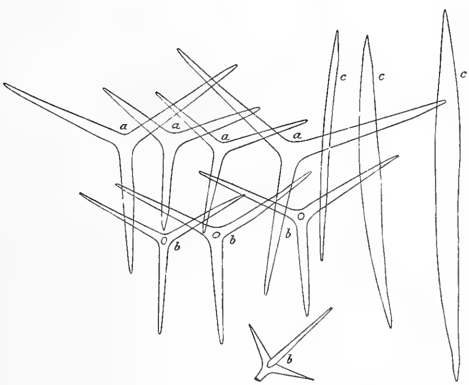
LEUCOSOLENIA PANIS (Haeckel). (Plate XL. fig. 1 & text-fig. 155.)

Synonymy:—

*Ascandra panis* Haeckel [14].

The collection contains three specimens of this beautiful little sponge, all dredged from a depth of 20 fathoms near North Point,

Text-fig. 155.




Spicules from *Leucosolenia panis*.

*a* = Triradiates. *b* = Quadriradiates. *c* = Oxeotes. All × 120.

Boa Vista Island. The external form and general characters of these agree with the description of the species given by Haeckel, but the largest of the three specimens is not more than one-sixth the size of that figured by him. The sponge is composed of a compact reticulum of Ascon-tubes, but there is no common investing skin or pseudoderm covering the whole colony and no endogastral network.

*Colour* (in alcohol) pale brown.

The *Skeleton*, which consists of all three kinds of spicules, shows only slight differences from Haeckel's description (text-fig. 155).

The triradiates are regular and fairly sharply pointed; they vary in length from 0·12 mm. to 0·18 mm. and in basal width from 0·011 mm. to 0·016 mm. The quadriradiates are less numerous than the triradiates and differ from them only by the presence of the fourth ray, which is the same length as the facial rays but only a little more than half as thick and is straight and sharply pointed. The oxeote spicules are somewhat smaller than those described by Haeckel; they vary in length from 0·35 mm. to 0·55 mm. and in maximum width from 0·025 mm. to 0·035 mm. They are either quite straight or very slightly curved and are sharply pointed, especially at one end. A few extremely fine hair-like oxea occur in my specimens; their presence is not to be regarded as of much systematic importance.

*Distribution.* Atlantic coast of North America; Florida (*Haeckel* [**14**]); Cape Verde Islands (*Crossland Collection*).

Leucosolenia atlantica, sp. n. (Plate XL. fig. 2 & text-fig. 156.)

The collection contains two specimens of this species, both dredged from a depth of 20 fathoms off North Point, Boa Vista Island. The sponge is composed of large Ascon-tubes which for the most part are much separated from each other, but which occasionally fuse together into a larger mass and then separate from each other again (Plate XL. fig. 2). There is of course no pseudoderm uniting the whole colony, and there is no endogastral network. The diameter of the Ascon-tubes varies from 0·8 mm. to 1·2 mm. and the thickness of the wall is 0·2 mm. The oscula have a diameter of about 0·7 mm. The colour (in alcohol) is straw-yellow.

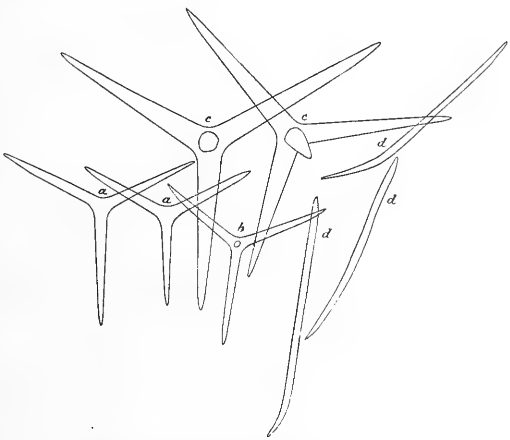
The *Skeleton* consists of middle-sized triradiates, of middle-sized quadriradiates, of large quadriradiates, and of oxeotes (text-fig. 156).

The triradiates are regular and have cylindrical, rather sharply pointed rays. The average size is: length 0·12 mm., width of rays at base 0·01 mm. These spicules do not vary much in size and are distributed without order in the thickness of the body-wall.

The middle-sized quadriradiates resemble the triradiates except for the presence of the fourth ray. The apical rays are feebly developed on these spicules, being thinner than the facial rays and not more than one quarter as long.

The large quadriradiates are also regular, have conical, fairly sharply pointed rays, and are distributed without order in the walls of the Ascon-tubes. The average length of their facial rays is 0·2 mm., and the thickness of the same at their bases is 0·035 mm. The apical rays are straight or slightly curved, are sharply pointed, are usually about half as long as the facial rays, and have a basal thickness of 0·025 mm. These spicules are quite numerous and do not vary much in size. The oxeote spicules are arranged transversely in the thickness of the sponge-wall, and their outer ends, which are slightly bent, project beyond the surface. They are fairly sharply pointed at both ends. Their average length is 0·3 mm. and their maximum thickness 0·009 mm. They are cylindrical, do not vary much in size, and are quite numerous.

Text-fig. 156.




Spicules from *Leucosolenia atlantica.*

*a* = Triradiates. *b* = Small quadriradiates. *c* = Large quadriradiates. *d* = Oxeotes. All × 120.

A few very fine hair-like, but not very long oxea are to be found in parts of the sponge. These are very probably young forms, but even if this is not the case I do not think they are to be considered of much systematic value.

This species appears to be more closely allied to *Leucosolenia laxa* Kirk [**15**], than to any other previously described Ascon. It is distinguished, however, from the New Zealand form (1) by having the quadriradiates differentiated into spicules of two distinct sizes, (2) by having oxea considerably thinner than those of *L. laxa*, and (3) by its looser external form.

*Distribution.* Cape Verde Islands (*Crossland Collection*).

Leucosolenia canariensis (Miklucho-Maclay). (Plate XL. fig. 3 & text-figs. 157–160.)

Synonymy:—

*Nardoa canariensis* Miklucho-Maclay.
*Nardoa sulphurea* Miklucho-Maclay.
*Nardoa rubra* Miklucho-Maclay.
*Tarroma canariense* Haeckel (Prodromus).
*Tarroma sulphureum* Haeckel (Prodromus).
*Tarroma rubrum* Haeckel (Prodromus).
*Ascaltis canariensis* Haeckel [**14**].
*Ascaltis compacta* Schuffner [**22**].
*Ascaltis canariensis* Lakschewitsch [**16**].
*Ascetta coriacea*, n. var. *Ascaltis coriacea* Fristedt [**13**].
*Leucosolenia nanseni* Breitfuss [**4**].
*Ascetta coriacea* Arnesen [**1**].
*Leucosolenia tenuipilosa* Dendy [**12**].

The examination of a number of Ascons in this collection has convinced me that I have to deal with a sponge that has been previously described under several different names and from various widely separated localities. The sponge in question is to be regarded as a close ally of *Leucosolenia coriacea*, one of the commonest of Homocœla, but it differs from the latter species in one essential character; some of the spicules develop a fourth ray, thus becoming quadriradiates.

In 1872, in his great monograph 'Die Kalkschwämme,' Haeckel described a sponge from the Canary Islands which was characterised by having small, completely regular triradiate and quadriradiate spicules with bluntly pointed rays; this sponge he called *Ascaltis canariensis*. The form had been previously described both by himself and by Miklucho-Maclay under three specific names, a misconception which arose owing to the supposed specific value of the different colours exhibited by different specimens of the species. This Ascon was similar to *L. coriacea*, but differed from the latter by the presence of quadriradiates and by the smaller size of its spicules.

Some thirteen years later Lakschewitsch [**16**] recorded the same species under the same name from Minorca.

In 1898, in describing a collection of Calcarea from Spitzbergen (a preliminary account of which he had issued two years previously [**3**]), Breitfuss [**4**] described a sponge which he considered new to science and which he named *Leucosolenia nanseni*. Having regard to the results of the present investigation, I think this form cannot be regarded as specifically distinct from Haeckel's *Ascaltis canariensis*, and indeed Breitfuss himself noticed the great similarity between the two forms, for at the end of his description of *L. nanseni* he says:—"Das Skelet von *Leucosolenia nanseni* erinnert etwas an *Leucosolenia* (*Ascaltis*) *canariensis* (M.-Mcl.), unterscheidet sich aber von dieser durch die Grösse der Nadeln, welche bei letzterer Species beinahe dreimal kleiner sind und nur eine Schenkellänge von 0·04–0·06 mm. bei einer Dicke von 0·003–0·005 mm. erreichen. Ausserdem ist die Innenseite der Röhren bei *L. nanseni* stets mit Papillen besetzt, dagegen bei *L. canariensis* nur bei der Varietat *papillata* H."

The measurements which he gives for the spicules of *L. nanseni* are: length of rays 0·113 to 0·145 mm., thickness at base 0·008 to 0·014 mm. This makes the spicules, as Breitfuss points out, nearly three times as large as in *L. canariensis*. I have found, however, a series of specimens which completely links up the two forms in this respect. There is one other slight difference between the two forms which Breitfuss does not mention in his comparison: in *L. canariensis*, Haeckel says that the apical rays of the quadriradiates are straight and are sometimes longer, sometimes shorter, than the facial rays; whereas in *L. nanseni* Breitfuss states that the apical rays are slightly curved and are usually only half the length of the other rays. In this character, too, I have found specimens intermediate between the two forms. Since papillæ were present on the inner surface of the Ascon-tubes in some of Haeckel's *Ascaltis canariensis*, the presence of these structures in *L. nanseni* is not a specific distinction between the two forms.

*L. nanseni* appears to me to resemble a sponge described by Schuffner [**22**] under the name of *Ascaltis compacta*, even more than it does the original *L. canariensis*. *A. compacta*, which was found off Mauritius, has regular triradiates and quadriradiates with rays reaching a maximum length of 0·12 mm. and a maximum thickness of 0·012 mm. The apical rays of the quadriradiates are 0·084 mm. long, have a basal thickness of 0·009 mm., and are sharply pointed and slightly bent at their extremities precisely as in *L. nanseni*. The ratio of the length to the thickness of the rays is slightly less than in *L. nanseni*, being usually less than 10 to 1 and sometimes as low as 7 to 1. Schuffner separated his sponge from Haeckel's *A. canariensis* because (1) it had no papillæ on the inner surfaces of the Ascon-tubes, and because (2) of the different shape of the apical rays of the quadriradiates. With regard to the latter point, I have, as stated above, found specimens intermediate between the two forms, and have also found much variation within the limits of the same specimen. And as for the papillæ, it is truly remarkable that whereas one of Schuffner's reasons for separating his sponge from *A. canariensis* was that it never had these structures, Breitfuss separated his sponges from *A. canariensis* partly on the ground that they always did have the papillæ. This affords a very good illustration of the kind of confusion which must necessarily arise if attempts are made to utilise structures, which are known to be indifferently present or absent within one species, as specific distinctions between that species and other members of the genus. It therefore appears that this *Ascaltis compacta* is not distinct from either *L. nanseni* or *A. canariensis*, and I include it in the species *L. canariensis*.

Finally, a sponge described by Dendy [12] three years ago from Ceylon under the name *Leucosolenia tenuipilosa* is to be regarded as a variety of this species and as standing in the same relationship to typical specimens of *L. canariensis* as *L. coriacea ceylonensis*, Dendy, does to the typical *L. coriacea*. This variety, *L. canariensis tenuipilosa*, has regular triradiates and quadriradiates with rays 0·1 mm. long by 0·012 mm. thick, the apical rays of the quadriradiates being very variable but usually longer than the facial rays. The distinguishing feature of the variety is the presence of hair-like oxea. Similar hair-like oxea occur in several of the Cape Verde Islands specimens under discussion.

The collection contains a considerable number of specimens which I consider belong to this species. They were dredged by Mr. Crossland from various localities, Boa Vista Island, Porto Praya, and elsewhere. The sponge forms rather massive colonies of reticulating Ascon-tubes (Plate XL. fig. 3). The exhalent openings are true oscula and there is no pseudoderm or endogastral network, but in examples where the tubes anastomose very closely more or less indefinite inter-canals are formed. Each colony is attached by a somewhat constricted base, and in several cases there is a short stalk. None of the colonies in my specimens is very large; the larger sponges have a diameter of from 1 cm. to 2 cm. The diameter of the Ascon-tubes varies considerably in different specimens and in different parts of the same specimen; this variation ranges from 0·15 to 0·4 mm. The walls of the tubes are from 0·02 to 0·035 mm. thick. The colour (in alcohol) is brown.

The *Skeleton* consists of regular triradiates, and of quadriradiates which differ from the triradiates only in the presence of the fourth ray; some of the triradiates possess a knob evidently representing an incipient fourth ray. The rays are usually fairly bluntly pointed (though there is some variation in this respect) and are nearly cylindrical. The apical rays of the quadriradiates project at right angles to the facial rays. There is not much variation in the size of the spicules in the same individual, but much difference between the spicules of different specimens. The measurements of the spicules of the following series of five specimens show how completely this series links up *L. canariensis* on the one hand and *L. tenuipilosa* and *L. nanseni* on the other the sizes of the spicules of these sponges having been given above:—

*Specimen R.N.* 6.—Length of rays, 0·06–0·07 mm.
Thickness of rays, 0·006–0·007 mm.
Apical rays of quadriradiates straight and equal or nearly equal in length to facial rays.

*Specimen R.N.* 8.—Length of rays, 0·08–0·09 mm.
Thickness of rays, 0·007–0·008 mm.
Apical rays of quadriradiates straight and from one-half to two-thirds the length of the facial rays.

*Specimen R.N.* 9.—Length of rays, 0·1–0·11 mm.
Thickness of rays, 0·009–0·01 mm.

Apical rays of quadriradiates straight but variable in form; sometimes half as thick and nearly as long as the facial rays; sometimes equally thick but not much more than half as long as the facial rays.

*Specimen R.N.* 14.—Length of rays, 0·12–0·15 mm.
Thickness of rays, 0·013–0·016 mm.

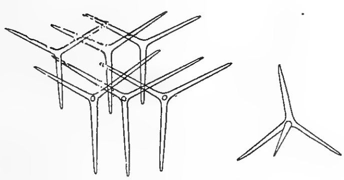
Apical rays of quadriradiates either straight or bent at their extremities, and from two-thirds to equal length of the facial rays.

*Specimen R.N.* 16.—Length of rays, 0·15–0·19 mm.
Thickness of rays, 0·014–0·016 mm.

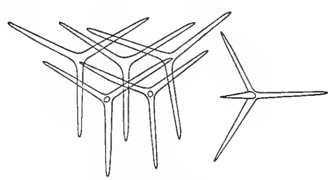
Apical rays of the quadriradiates very variable; either straight or bent at their extremities; either nearly as thick and half as long as the facial rays, or else much thinner but longer than the facial rays.

It will be noted that the rays in the first specimen are only very slightly larger than in Haeckel's *L. canariensis*, that in the second and third specimens the size is intermediate between

Text-fig. 157.

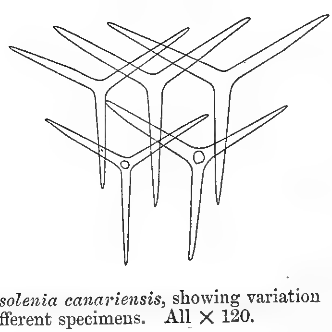


Text-fig. 158.



Text-fig. 159.

Text-fig. 160.



Spicules from four specimens of *Leucosolenia canariensis*, showing variation in the size of the spicules in different specimens. All × 120.

*L. canariensis* and *L. nanseni*, that in the fourth specimen the size is almost the same as in *L. nanseni*, and finally that in the fifth specimen the spicules are larger than in Breitfuss's Ascons. All the specimens contain some triradiates with knobs representing incipient fourth rays. As has been already stated, several specimens contain some thin hair-like oxea, and in some examples these are quite numerous but in others very scarce; the latter specimens obviously form connecting links between the typical form of the species and the variety *L. canariensis tenuipilosa*. These spicules have a thickness of 0·0015 to 0·003 mm., and vary in length from 0·05 to 0·3 mm.; they are sharply pointed.

I found no papillæ on the inner surface of the Ascon-tubes; as these structures were present in some and absent in other specimens of Haeckel's *L. canariensis* (and absent in those described by Lakschewitsch), this character is manifestly not to be considered as of specific value.

It remains to discuss the relationship between *L. coriacea* and *L. canariensis*. As previously remarked, the only essential difference between them is that *L. canariensis* has quadriradiate spicules; but in the Cape Verde Islands examples there appears to be every gradation between specimens in which the quadriradiates are very numerous (quite 50 °/₀ of all the spicules) and other specimens in which they are very scarce, and it is obvious that the latter approach very nearly to *L. coriacea*. Nor is this all, for Ascons having a few quadriradiate spicules have been identified and described as *L. coriacea*. Breitfuss mentions [**4**] that his *L. nanseni* is very like a sponge described as *Ascetta coriacea* (n. var. *Ascaltis coriacea*) by Fristedt [**13**] in 1887. Fristedt gives only an incomplete description of this sponge and gives no measurements of the spicules, but he says that the apical rays of the quadriradiates are more slender than the facial rays and are slightly curved. He says that he was doubtful at first as to whether he should identify the sponge as *Ascaltis canariensis*, but did not do so because (1) of the different shape of the apical rays, and (2) of the wide separation of the localities where the respective specimens were found—his sponges being arctic.

Again, in the year 1900 Arnesen [**1**] described some sponges from Norway which he called *Ascetta coriacea*, but which had some quadriradiate spicules.

It must therefore, I think, remain more or less a matter of opinion whether *L. coriacea* and *L. canariensis* should be maintained as separate species; but if they are to be so maintained it is quite certain that these sponges of Fristedt and Arnesen should be called *L. canariensis*.

*Distribution.* Canary Islands (*Haeckel* [**14**]); Cape Verde Islands (*Crossland Collection*); Minorca (*Lakschewitsch* [**16**]); Ceylon (*Dendy* [**12**]); Mauritius (*Schuffner* [**22**]); N. Atlantic and Arctic Oceans, and the White Sea (*Fristedt* [**13**], *Arnesen* [**1**], *Breitfuss* [**4**] [**5**]).

SYCON QUADRANGULATUM (Schmidt).

Synonymy:—

*Syconella quadrangulata* O. Schmidt [**21**].
*Sycortis quadrangulata* Haeckel [**14**].

*Sycortis quadrangulata* Bowerbank (Norman) [**2**].
*Sycandra quadrangulata* Lendenfeld [**17**].
*Sycon quadrangulatum* Breitfuss [**7**].

The collection contains one small specimen of this well-known species. The length of the specimen is 3·5 mm. and its width 1 mm. It was dredged from a depth of 10 fathoms.

*Distribution.* Mediterranean, Straits of Gibraltar, coasts of Portugal and Brittany (*Schmidt* [**21**], *Haeckel* [**14**], and *Lendenfeld* [**17**]); Guernsey (*Bowerbank* [**2**]); the White Sea (*Breitfuss* [**7**]); the Cape Verde Islands (*Crossland Collection*).

Sycon caminatum, sp. n. (Plate XL. fig. 4 & text-fig. 161.)

Mr. Crossland collected ten specimens of this new sponge, several of which are quite young individuals. The general form assumed by this Sycon is shown in Plate XL. fig. 4. It grows erect, either singly or in groups, and its greatest diameter is about one quarter its height. The largest specimen has a length (excluding the proboscis or peristome) of 14 mm. and its greatest width is 4 mm. The terminal osculum in this specimen has a diameter of 1·8 mm. A very characteristic and well-developed peristome or proboscis is present in all cases, and from this structure I have derived the specific name. The length of this peristome is variable; in one specimen it reaches as much as 4 mm., the length of the body of the sponge being only 8 mm. There is no true oscular crown.

The general structure of the sponge and the character of the body-wall are typical of the genus *Sycon*. There are radial chambers stretching through the whole thickness of the body-wall, crowned by tufts of oxea, and flanked by definite incurrent canals. There is a well-developed gastral cortex. The body of the sponge is nearly circular in transverse section. The thickness of the body-wall in the middle of the sponge, and therefore the length of the radial chambers, is 1 mm. The breadth of the radial chambers at their distal ends is 0·16 mm., and at their proximal ends 0·1 mm.; they are either spherical or somewhat ellipsoid in cross-section. The inter-canals open widely on to the exterior at their distal ends, are irregularly ellipsoid or nearly circular in cross-section, and have about the same diameter as the radial chambers; their length is equal to the thickness of the wall, 1 mm. The arrangement of the radial chambers, and the manner in which their crowning tufts of oxea project from the surface, are so regular that under an ordinary hand-lens the surface of the sponge gives an appearance of almost chess-board regularity. The distance which divides these crowning tufts from each other is, in the middle portion of the sponge, about 0·16 mm.

*Colour* (in alcohol) light brown.

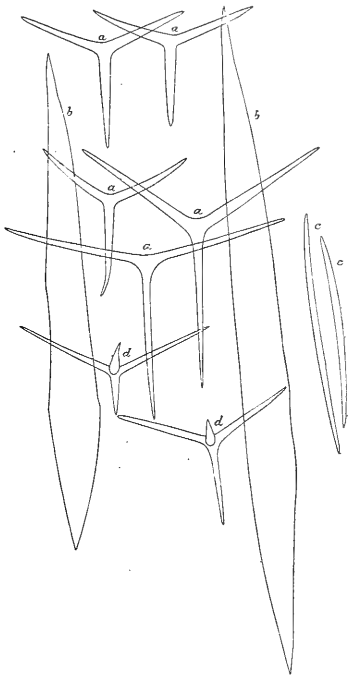
The *Skeleton* consists of triradiates, quadriradiates, and oxea, and may be said to consist of four divisions: (1) that of the radial chambers, (2) that of the tufts of spicules at the ends of the radial chambers, (3) that of the gastral cortex, and (4) that of the peristome.

The tubar skeleton consists almost exclusively of triradiate spicules. The majority of these spicules are markedly sagittal but there is much variation in this respect, some spicules being almost equiangular and equiradiate, whilst others have an angle amounting nearly to 180° and the other two angles only a little more than 90° each. In typical spicules the sagittal form is due both to this difference of angles and to the greater length which is attained by the basal ray. All the rays are usually straight; but sometimes the paired rays are slightly curved throughout their lengths, in which case they always have their convex sides, never the concave, towards the basal ray; and sometimes the basal ray is curved at its extremity. In a few cases the basal ray is shorter than the paired rays. The size of an average triradiate of the tubar skeleton is as follows:—Length of paired rays, 0·09 mm.; width at base of rays, 0·012 mm. Length of basal ray, 0·11 mm.; width at base, 0·012 mm. The great majority of the spicules are of this size or very close to it, but the rays are occasionally considerably longer, although never much wider. A few quadriradiate spicules, with facial rays resembling the rays of the triradiates and with short apical rays, occur in the proximal portions of the radial canals; they are, however, very scarce and are probably of little systematic importance.

The crowning tufts at the ends of the radial chambers are composed of oxea of three sizes. The largest of these (text-fig. 161, *b*) reach a length of 0·8 mm. and a maximum thickness of 0·05 mm. They are usually sharply pointed at both ends, but they taper to the point more gradually at one (the projecting) end than at the other, the thickest part of the spicule not being in the middle of its length; this character is very marked in some spicules, but in others it is scarcely noticeable. These spicules are somewhat flattened, are straight or nearly straight, and have about one-third of their lengths projecting beyond the surface of the sponge. The tufts also consist in part of much smaller straight or somewhat curved, sharply pointed oxea (text-fig. 161, *c*), of a diameter only about equal to that of the rays of the triradiates; these reach a length of 0·25 mm. and have a maximum thickness of 0·01 mm. In addition to these there are a number of very fine hair-like oxea which may perhaps be young spicules.

The gastral cortex, which is well developed and is four or five layers of spicules thick, consists of triradiates and quadriradiates, the apical rays of the latter projecting freely into the gastral cavity. As in the tubar skeleton, there exists considerable variation in the spicules; the triradiates are typically somewhat longer and narrower than those of the radial canals, but otherwise there is little difference between the triradiates of the two regions. The average length of the rays is 0·12 mm., and their width at base 0·008 mm. One angle is frequently greater than the other two, thus making the spicules sagittal. The facial rays of the quadriradiates resemble the rays of the triradiates; the apical rays are short and stout and sharply pointed; they are either straight or slightly curved at their extremities; their average length is 0·05 mm. and their width at base 0·011 mm. The majority of the quadriradiates, like the triradiates, are sagittal.

Text-fig. 161.




Spicules from *Sycon caminatum*.

*a* = Tubar triradiates. *b* = Large oxeotes. *c* = Small oxeotes. *d* = Gastral quadriradiates. All × 120.

The peristome consists of an irregular and complicated network of spicules similar to those which occur in the other regions of the sponge. There are large and small oxea like those crowning the distal ends of the radial chambers, there are triradiates like those of the tubar skeleton, and also triradiates and quadriradiates resembling those of the gastral cortex. Some of the sagittal triradiates in this region have the concave curve of the paired rays towards the basal ray. The very minute hair-like oxea which project from the ends of the chambers do not occur in the peristomal region.

This Sycon is most nearly allied to *Sycandra* (*Sycon*) *helleri* Lendenfeld, a sponge found in the Adriatic Sea [**17**]. The species differ, however, in a number of points, perhaps the most important of which is the presence in my species of the remarkably well-developed peristome. There is also never an oscular fringe of spicules in *S. caminatum*, a structure which is often present in *S. helleri*. *S. caminatum* is further distinguished by the presence of more than one kind of oxea at the distal ends of the radial chambers, by the absence from the radial chambers of sagittal triradiates with the concave curves of their paired rays turned towards the basal rays, and lastly by the merely sporadic occurrence of quadriradiates in the tubar skeleton, these spicules being numerous in that region in *S. helleri*.

*Distribution.* Cape Verde Islands (*Crossland Collection*).

GRANTIA INTERMEDIA, sp. n. (Plate XL. fig. 5 & text-fig. 162.)

Mr. Crossland collected a single specimen of this interesting new species. This is an egg-shaped sponge (Plate XL. fig. 5) 6 mm. high and 5 mm. broad. The outer surface is coarsely hispid, large oxeote spicules projecting in every direction, and there is a conspicuous osculum at the top (diameter 1 mm.) with a well-developed oscular fringe, 1·5 mm. high. The specimen was dredged from a depth of 20 fathoms off North Point, Boa Vista Island. Its colour (in alcohol) is pale brown. The dermal cortex is 0·16 mm. thick, the chamber-layer is 1·4 mm. thick, and there is a feebly developed gastral cortex, making the total thickness of the body-wall about 1·6 mm. The diameter of the gastral cavity (at its widest part) is 1·7 mm.

The specimen is not sufficiently well preserved to enable one to make out the structure of the canal-system in any very great detail; but the exhalent canals are well developed, and the chambers are very much branched. The canal-system is really intermediate between the form typical of the genus *Grantia* on the one hand and that of the genus *Leucandra* on the other; in short, it is of the "sylleibid" type. The tubar skeleton is, however, articulate and only shows slight signs of becoming scattered, and for this reason I place the species in *Grantia*, not in *Leucandra*.

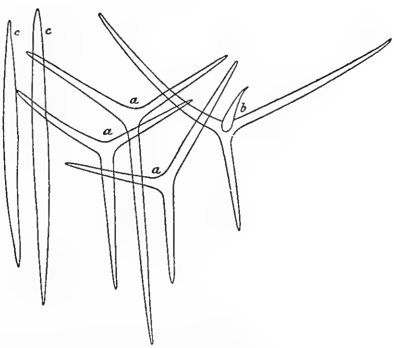
The *Skeleton* consists of all three forms of spicules.

The tubar skeleton is composed of both triradiates and quadriradiates. The former are very variable in shape and are usually very irregular. Their rays are sometimes straight, sometimes curved, and all three angles are frequently unequal (text-fig. 162, *a*). The rays vary in length from 0·12 mm. to 0·24 mm. and in thickness from 0·011 mm. to 0·014 mm. Some of the triradiates in the tubar skeleton show a strong tendency to become sagittal, and it is the basal rays of these that attain the greatest length. There are a few, but only a very few, quadriradiates in the tubar skeleton; the apical rays of these are the same thickness as, but shorter than, the facial rays and are curved at their extremities. The facial rays resemble the rays of the triradiates. None of the rays of either triradiate or quadriradiate spicules is very sharply pointed.

The dermal cortex consists of a compact mass of spicules resembling those of the tubar skeleton; the vast majority of the spicules are triradiate, but there are a few quadriradiates as well. Both triradiates and quadriradiates are sometimes sagittal, and in this case they have their basal rays pointing towards the base of the sponge, as is usual in the genus.

The gastral cortex is 0·07 mm. thick, and is composed of triradiate and quadriradiate spicules similar to those occurring in the tubar and dermal cortical skeleton, but in this portion of the sponge the quadriradiates form a much larger percentage of the whole number of spicules than they do in the tubar skeleton or dermal cortex. The apical rays of the quadriradiates project into the gastral cavity. There are sagittal triradiates and sagittal quadriradiates with basal rays pointing towards the base of the sponge.

Text-fig. 162.




Spicules from *Grantia intermedia*.

*a* = Triradiates × 120. *b* = Quadriradiates × 120. *c* = Oxeotes × 24.

There are also some "sub-gastral sagittal triradiates," viz., triradiates just buried within the gastral cortex and having a basal ray pointing horizontally outwards towards the dermal surface—in the same direction as the basal rays of the irregularly sagittal triradiates of the tubar skeleton point; the sagittal triradiates in this position closely resemble the sagittal triradiates in other situations.

There are some enormous oxeote spicules projecting from the surface of the sponge. These are not arranged in groups, but emerge from the surface without definite order and either at right angles to the surface or more or less obliquely. Their proximal ends are buried more or less deeply in the tubar layer of the body-wall. The spicules are spindle-shaped, are rather bluntly pointed at both ends, reach a length of 2 mm., and have a maximum thickness of 0·06 mm. (text-fig. 162, *c*).

The oscular fringe is composed of very long and very fine oxeote spicules. These reach a length of 3 mm. and have a maximum thickness of 0·008 mm.

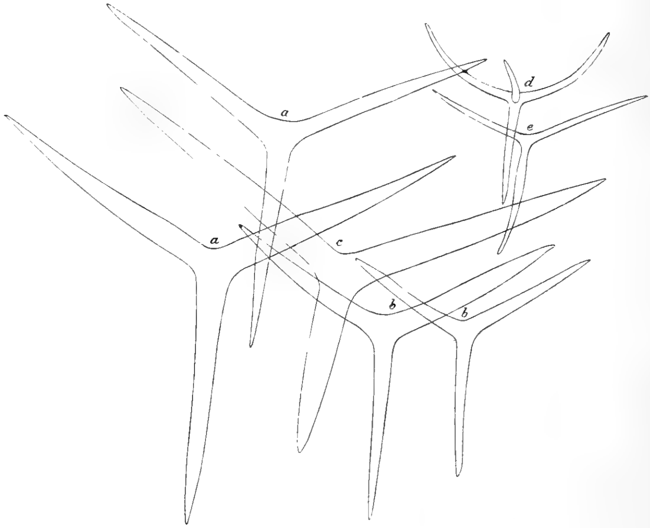
*Distribution.* Cape Verde Islands (*Crossland Collection*).

LEUCANDRA VERDENSIS, sp. n. (Plate XL. fig. 6 & text-fig. 163.)

The collection contains only a single specimen of this species. It was dredged from a depth of 10 fathoms and is a single Leucon person of sac-like form, nearly cylindrical in shape (Plate XL. fig. 6).

The length of the specimen is 6 mm. and its maximum width 3 mm. There is a terminal osculum which is naked and the surface of the body is smooth. The thickness of the body-wall is about 1 mm. and the diameter of the central gastral cavity is about the same. The colour of the sponge (in spirit) is brown.

Text-fig. 163.




Spicules from *Leucandra verdensis*.

*a* = Parenchymal triradiates. *b* = Regular triradiates of dermal cortex. *c* = Sagittal triradiate of dermal cortex. *d* = Gastral quadriradiate. *e* = Gastral triradiate. All × 120.

The canal-system is typically leuconoid; the flagellate chambers, which are scattered about in the parenchyma between the dermal and gastral cortices, are spherical or sac-shaped and have a maximum diameter of about 0·06 mm.

The dermal cortex, which is pierced by passages leading into large inhalent canals, is only about 0·02 mm. thick; and the gastral cortex, which is similarly pierced by apertures leading from the exhalent canals, is of about the same thickness.

The *Skeleton* consists of triradiates and quadriradiates. There are no oxeote spicules.

The main mass of the skeleton, that of the chamber-layer, consists of numerous large, irregularly arranged, regular or subregular triradiate spicules (text-fig. 163, *a*). They do not vary much in size; the average length of their rays is 0·3 mm. and the thickness at base is 0·04 mm.

The skeleton of the dermal cortex consists of three kinds of spicules:—(1) Regular or sub-regular triradiates similar to those of the chamber-layer but smaller; average size 0·2 × 0·025 mm. (2) Sagittal triradiates: basal ray pointing towards the base of the sponge; these vary up to a maximum size of—paired rays 0·3 × 0·04 mm., basal ray 0·2 × 0·04 mm.; the basal ray is always shorter than the other two. (3) Sagittal quadriradiates, similar to the sagittal triradiates except for the presence of a straight apical ray, about one quarter the length of and three quarters the thickness of the paired rays; these spicules do not appear to reach such a large size as the sagittal triradiates.

The gastral cortex consists of small quadriradiates and triradiates; the former are mostly sagittal with curved paired rays, a long straight basal ray, and a rather short curved apical ray (text-fig. 163, *d*). The length of the paired rays in these spicules is on the average 0·15 mm. and the width 0·015 mm.; the basal ray is rather longer and the size of the apical ray is 0·05 × 0·009 mm. The quadriradiates are sometimes irregular, sometimes nearly regular in shape, but they vary very little in size. The triradiates (text-fig. 163, *e*) of the gastral cortex also vary in shape, but are usually rather irregular; the average size of their rays is 0·15 × 0·015 mm.

*Distribution.* Cape Verde Islands (*Crossland Collection*).

LEUCANDRA RUDIFERA (Poléjaeff). (Plate XL. fig. 7 & text-fig. 164.)

Synonymy:—

*Leuconia rudifera* Poléjaeff [**19**].

A few fragments of this species, which is characterised by the possession of very peculiar minute oxeote spicules in the gastral cortex, were collected off Bermuda by the 'Challenger' and were described by Poléjaeff. Mr. Crossland dredged three specimens, all of which are complete, so that I am fortunately able to add the description of the external form to that of the skeleton which was given by Poléjaeff.

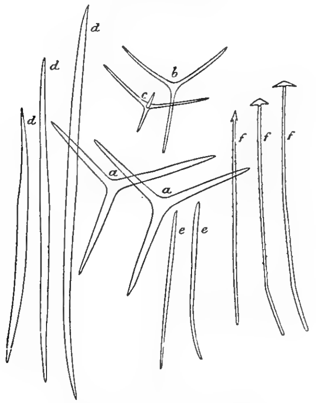
The sponge (Plate XL. fig. 7) is composed of an irregularly massive bulbous Leucon individual, and in the largest specimen reaches a height of 2 cm. and a maximum width of 1·7 mm. The smallest specimen is egg-shaped; no doubt this is the young form and the irregularly massive appearance is acquired with growth. There is a large circular osculum at the top; there is a peristome, and two of the specimens possess oscular crowns. The thickness of the body-wall varies very much: in the largest specimen it is as thick as 8 mm. in one place and as thin as 2 mm. in another. The maximum diameter of the central gastral cavity is 6 mm. The external surface is only slightly hispid, for the large oxea either do not project at all or project only slightly. The internal surface is rough owing to the projection of the apical rays of the gastral quadriradiates.

The canal-system is typically leuconoid; the flagellated chambers are spherical and have a diameter of from 0·03 to 0·05 mm. Many of the incurrent and excurrent canals are very wide; they attain a diameter of 1 mm. and in some cases of even more.

The *Skeleton* consists of the following elements:—(1) Large triradiates of the parenchyma. (2) Triradiates of the dermal cortex. (3) Sagittal quadriradiates and triradiates of the gastral cortex. (4) Large oxeotes, only slightly thicker than the large triradiates. (5) Minute oxea. (6) Minute spined grapnel-like oxea of the gastral cortex; these latter form the main distinguishing character of the species. Finally, the two smaller specimens have oscular fringes consisting of long fine smooth oxea.

The large triradiates of the parenchyma (text-fig. 164, *a*), which make up the main mass of the skeleton, are more constant in shape than those in Poléjaeff's specimens. They are regular or very nearly regular and have sharp-pointed rays. The average size, from which there is not much variation, is—length 0·45 mm., basal width 0·045 mm. A small minority of the spicules depart from the regular form and are sagittal or irregular in shape, both rays and angles being unequal.

Text-fig. 164.




Spicules from *Leucandra rudifera*.

*a* = Parenchymal triradiates × 24. *b* = Dermal triradiate × 24. *c* = Gastral quadriradiate × 24. *d* = Large oxeotes × 24. *e* = Small oxeotes (of dermal cortex etc.) × 120. *f* = Minute spined grapnel-like oxeotes of gastral cortex × 500.

The triradiates of the dermal cortex are variable in shape, being either sagittal or irregular; the thickness of their rays is about half that of those of the parenchymal triradiates, being on the average 0·022 mm.; the rays are frequently slightly curved, are fairly sharply pointed, and reach a length of 0·35 mm. (text-fig. 164, *b*).

The gastral cortex consists almost entirely of quadriradiates (text-fig. 164, *c*). These are sagittal and resemble those described by Poléjaeff. Lateral rays 0·35 mm. long, basal ray 0·2 mm. long; apical ray varies in length from 0·05 to 0·12 mm., usually slightly curved. All rays of the same basal diameter, 0·015 mm. There are a few triradiates in the gastral cortex; these only differ from the quadriradiates by the absence of the apical ray. As in the case of Poléjaeff's specimens, these quadriradiates also occur in small numbers in the walls of the exhalent canals.

Some large oxeote spicules are scattered about in the parenchyma; the greatest thickness of these is 0·055 mm. and they reach a maximum length of 2 mm., but usually do not exceed 1·5 mm. Many of these spicules do not project beyond the dermal cortex at all, and over the greater part of the surface of the sponge they never have more than one-third of their length projecting; near the osculum, however, they extend much further beyond the surface. The spicules are spindle-shaped and sharply pointed at both ends (text-fig. 164, *d*). They are not numerous.

There are also some very small oxea; these are either straight or slightly curved, and are fairly sharply pointed at both ends. They are shorter than those described by Poléjaeff; I found none longer than 0·25 mm. and they are usually only 0·15 mm. long. Their thickness is 0·003 mm. They occur either singly or in small bundles in or just beneath the dermal cortex, beyond which they often project. They are not numerous.

The minute and very peculiar spined grapnel-like oxea (text-fig. 164, *f*) of the gastral cortex form the main specific character of this Leucon. It is these spicules which Poléjaeff describes as "verticillate" oxea, but this term does not appear to be quite accurate, for the spines are not really arranged in verticils, but project on each side of the spicule alternately down the length of the shaft. These oxea reach a length of 0·06 mm. and their thickness varies from 0·0007 to 0·0011 mm. They are sometimes quite straight and sometimes curved throughout their length, but usually the spicule is straight in its distal and bent in its proximal part, which also seems to be slightly flattened and is slightly wider than the distal half, but I have not found any spicules so much expanded in this region as that figured by Poléjaeff in plate vii. fig. 3 *a*, III. [**19**]. In a few of the spicules the spiked head is much reduced, these spicules being evidently intermediate between those with large heads and ordinary spindle-shaped oxea.

Two of the specimens possess oscular fringes composed of spicules of the usual form—long, very fine oxea of maximum length 1·3 mm. and width 0·0025 mm. There is of course nothing remarkable in the presence of oscular fringes in two of the specimens and its absence in the third, for there are many Calcarea in which this structure is indifferently present or absent.

There is a peristome, and this structure is best developed on the specimen without an oscular fringe. It is composed of a complex network of spicules of all those types which occur in other regions of the body—large triradiates, small triradiates, small sagittal quadriradiates, large and small oxea, and minute grapnel-like oxea.

*Colour* (in alcohol) white.

*Distribution.* Bermuda (*Poléjaeff*); Cape Verde Islands (*Crossland Collection*).

Leucandra sericata (Ridley).

Synonymy:—

*Aphroceras sericatum* Ridley [**20**].

*Leuconia sericatum* Breitfuss [**8**] [**6**].

Mr. Crossland collected two specimens of this species. One of these is a solitary pear-shaped Leucon person 11 mm. high and with a maximum width of 5 mm.; the other specimen consists of three Leucon persons united at a common base, the central and largest of the three individuals being 2 cm. high and having a maximum width of 8 mm. The terminal oscula are protected by well-developed oscular fringes; the osculum of the largest individual is 2·5 mm. in diameter. The scattered flagellate chambers are usually somewhat elongated, occasionally being four times as long as broad; their width varies very little and is about 0·045 mm. The primary incurrent canals have a diameter of 0·2 mm. and the ultimate excurrent canals are about the same size.

The *Skeleton* agrees with the description given by Ridley. Many of the spicules of the gastral cortex lack apical rays, and are therefore of course triradiates.

*Colour* (in alcohol). One specimen is dirty white and the other brown.

*Distribution.* S.E. coast of Brazil (*Ridley*); Straits of Magellan (*Breitfuss*); Cape Verde Islands (*Crossland Collection*).

There is no doubt that this sponge is very closely allied to the much commoner species, *L. aspera*. It is to be distinguished from the latter however, (1) by the inferior ratio of the thickness of the large oxea to that of the parenchymal triradiates, and (2) by the size and shape of these triradiates themselves, which are larger than the corresponding spicules in *L. aspera* and are constantly sagittal. The presence in *L. sericata* of an oscular crown composed of special oxeotes, which is given by Ridley as a difference between the two forms, is a distinction which will not hold good, as this structure also occurs in many specimens of *L. aspera*.

Leucandra typica (Poléjaeff).

Synonymy:—

*Leuconia typica*, var. *massa* Poléjaeff [**19**].

„ „ var. *tuba* Poléjaeff [**19**].

*Leucandra typica*, var. *tuba* Lendenfeld [**18**].

*Leucandra typica* Dendy [**10**].

*Leuconia typica* Breitfuss [**6**].

Mr. Crossland dredged five specimens of this widely distributed species. One specimen consists of a mass of very wide, very short, united Leucon persons, and therefore is of the shape typical of the var. *massa*; the total width of this specimen is 2·3 cm. and its height is much less. Another specimen, which consists of a single Leucon person, is elongated and has the form typical of the var. *tuba*; its height is 10 mm. and its maximum width 4 mm. The other three specimens are intermediate in size and shape between the foregoing specimens, and consequently are of a form intermediate between the two varieties of the species which were established by Poléjaeff.

The general anatomy and skeleton of my specimens agree with the descriptions given by Poléjaeff and v. Lendenfeld; the only peculiarity is in the oxeote spicules. The majority of these resemble the corresponding spicules of the specimens hitherto described, *i. e.*, they are small spindle-shaped or rather cylindrical, sharply pointed, straight or slightly curved, and very variable in size, reaching a maximum length of 0·3 mm. and a maximum diameter of 0·005 mm. A minority of the oxea are, however, peculiar in that they are shorter and wider in proportion to their length than are the ordinary spicules, and are also markedly flattened and more or less arrow-headed; the arrow-head is sometimes very conspicuous.

The characters by which Poléjaeff endeavoured to divide this species into two varieties, *tuba* and *massa*, do not appear to be constant. In external form I have, as stated above, three specimens which are intermediate between the varieties. The other two characters on which Poléjaeff established his varieties are as follows :—

(*a*) Apical rays of gastric quadriradiates not longer than 0·06 mm. in *tuba*, but reaching 0·1 mm. in *massa*.

(*b*) Oxeote spicules not longer than 0·15 mm. in *massa*, but reaching 0·3 mm. in *tuba*.

Now with regard to (*a*) I find that in my specimen, which is of the *tuba* external form, the apical rays in question reach a length of 0·1 mm., and this is not exceeded in any of the other specimens. Whilst with regard to (*b*) the oxea reach much the same maximum length in all the specimens—viz. about 0·3 mm.—and are if anything rather shorter in my specimen of *tuba* than in the others. For these reasons I do not think it desirable to retain the two varietal names.

*Distribution.* Bermuda (*Poléjaeff*); East coast of Australia (*v. Lendenfeld*); Cape Verde Islands (*Crossland Collection*).

LEUCANDRA CROSSLANDI, sp. n. (Plate XL. fig. 8 & text-fig. 165.)

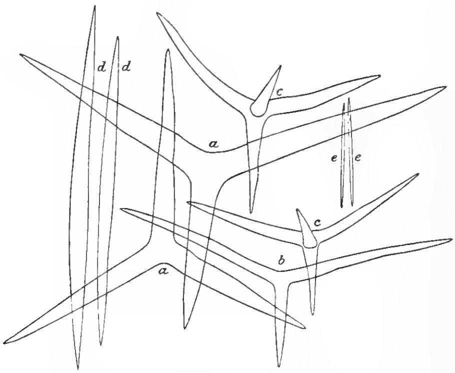
A large number of fragments and several complete specimens of this species were dredged by Mr. Crossland from a depth of 15 to 20 fathoms near Boa Vista Island.

The sponge (Plate XL. fig. 8) is pear-shaped, is from twice to three times as long as it is broad, and usually several Leucon individuals grow together attached to one another at a common base. The individuals grow to a size of 1·5 cm. by 0·8 cm. Both external and internal surfaces of the body are rough. On large specimens the oscula have a diameter of 1·5 mm.; there is never a true oscular crown, but an oscular rim or peristome is present; this varies very much in size, in some specimens being as short as 1 mm., or even less, whilst in others it reaches the enormous length of 7 mm. The thickness of the body-wall varies from 1 to 2·5 mm., and the maximum diameter of the central gastral cavity is 3 mm. The canal-system is of the form usual in the genus; the flagellate chambers are spherical or sac-shaped and are rather large, having a maximum diameter of 0·09 mm. The incurrent and excurrent canals have a maximum width of 0·25 mm. The width of the dermal cortex is 0·1 mm. and that of the gastral cortex 0·06 mm.

The *Skeleton* consists of the following elements:—(1) of middle-sized triradiates of the parenchyma, (2) of small triradiates of the dermal cortex, (3) of gastral quadriradiates, (4) of large oxea, three times as wide as the parenchymal triradiates, and (5) of minute oxea.

The main mass of the skeleton is made up by the middle-sized triradiates of the parenchyma (text-fig. 165, *a*). These vary somewhat in shape and size, but are usually sub-regular with rays 0·25 by 0·035 mm. Not infrequently they are slightly sagittal with the basal ray shorter than the lateral rays. The rays are sharply pointed.

Text-fig. 165.




Spicules from *Leucandra crosslandi*.

*a* = Parenchymal triradiates × 120. *b* = Dermal triradiates × 120. *c* = Gastral quadriradiates × 120. *d* = Large oxeotes × 24. *e* = Minute oxeotes × 120.

The dermal cortex consists of a mass of slender-rayed sagittal triradiates; the lateral rays spread widely at an angle of from 140° to 160°, and are from twice to three times as long as the basal ray (text-fig. 165, *b*). A typical spicule of this kind gave the following measurements:—Length of lateral rays 0·18 mm.; length of basal ray 0·07 mm.; thickness of all rays at base 0·012 mm. The rays are sometimes considerably more slender than this.

The skeleton of the gastral cortex consists of sagittal quadriradiates (text-fig. 165, *c*). Similar spicules line the exhalent canals. The lateral rays are rather stout and are slightly curved; they are somewhat longer than the basal ray, which is straight. The apical ray is from one-third to one-half the length of the lateral rays. The average length of the lateral rays is 0·15 mm.; the average thickness of the facial rays at their bases is 0·02 mm. The apical rays are less thick at their bases and are sometimes curved at their extremities.

The large oxeote spicules are slightly spindle-shaped, are slightly curved, and are from twice to three times as thick as the parenchymal triradiates (text-fig. 165, *d*). They are completely buried in the parenchyma or project slightly beyond the dermal surface or project much beyond. They are sharply pointed at both ends. In length they vary from 1 mm. to 1·5 mm. and in width from 0·08 mm. to 0·1 mm.

Minute oxea (text-fig. 165, *e*) are to be found in all parts of the sponge, but are most numerous in the dermal cortex, from which they sometimes project beyond the surface of the sponge. They are pointed at both ends and are quite or nearly straight. Their average length is 0·15 mm., and their average maximum thickness 0·0035 mm. They vary considerably in length but very little in thickness.

The peristome consists as usual of a network of spicules of all the types which occur in other parts of the sponge.

*Colour* (in alcohol) white.

This Leucon, which I have much pleasure in naming after Mr. Crossland, appears to be more nearly allied to *Leucandra crambessa* Haeckel, than to any other previously described species. It differs from this species, however, by the presence of the minute oxea, by the larger size of the parenchymal triradiates—these being about twice the size of those in *L. crambessa*—and in sundry minor details of anatomy.

*Distribution.* Cape Verde Islands (*Crossland Collection*).

LEUCANDRA GEMMIPARA, sp. n. (Plate XL. fig. 9 & text-fig. 166.)

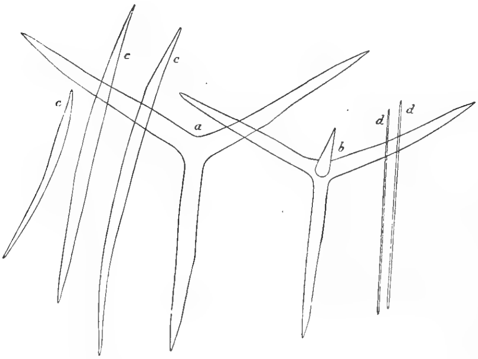
Mr. Crossland collected a considerable number of specimens of this species. The sponge (Plate XL. fig. 9) is elongated and somewhat flattened, and forms proliferous groups of incompletely separated Leucon individuals. The individuals grow to a height of 1–2 cm. and a width of 4 mm. Both external and internal surfaces of the body are fairly hispid. On the larger specimens the oscula have a diameter of 1·5 mm.; all the specimens have oscular fringes spicules, but on young individuals it is only feebly developed. The thickness of the body-wall varies very little; it is about 1 mm. or slightly less, whilst the maximum diameter of the central gastral cavity is 2 mm. The canal-system is typically leuconoid; the flagellated chambers are spherical or sac-shaped and are rather large, having a maximum diameter of 0·1 mm. The maximum diameter of the excurrent canals is only 0·15 mm., and of the incurrent canals even less. The thickness of the dermal cortex is 0·12 mm., and that of the gastral cortex 0·07 mm.

The *Skeleton* consists of the following elements:—(1) Rather small triradiates of the parenchyma; (2) small dermal triradiates; (3) gastral quadriradiates and triradiates; (4) large oxea, four times as thick as the parenchymal triradiates; (5) minute oxea; and (6) long slender oxea of the oscular fringe.

The main mass of the skeleton is composed of parenchymal triradiates (text-fig. 166, *a*). These are subregular in shape and their rays are almost always undulated; the length of the rays varies from 0·12 mm. to 0·22 mm., and the maximum thickness from 0·015 to 0·024 mm. They are sharply pointed. A few of these spicules sometimes develop apical rays of variable size and shape, thus becoming quadriradiates.

The dermal triradiates are similar to those of the parenchyma, but are smaller; they rarely exceed 0·1 mm. in length or 0·01 mm. in diameter.

Text-fig. 166.




Spicules from *Leucandra gemmipara*.

*a* = Parenchymal triradiate × 120. *b* = Gastral quadriradiate × 120.
*c* = Large oxeotes × 24. *d* = Small oxeotes × 120.

The central gastral cavity and a great part of the canal-system are lined by sagittal quadriradiates and triradiates (text-fig. 166, *b*). The wide-spreading lateral rays are usually slightly shorter than the basal ray, and are either straight or slightly curved; all the rays are sharply pointed. The apical ray is curved at its extremity. A typical quadriradiate gave the following measurements:—Length of lateral rays 0·12 mm.; length of basal ray 0·15 mm.; length of apical ray 0·06 mm.; maximum thickness of facial rays 0·012 mm., and of the apical ray somewhat less. There are some triradiate spicules of similar form.

Numerous large oxea project from the outer surface of the sponge. They issue from the dermal cortex at a very acute angle with the surface and their projecting ends all point towards the osculum. They are spindle-shaped and are slightly curved, and gradually but sharply pointed at both ends (text-fig. 166, *c*). Fully half the length of the spicule is usually projecting beyond the surface. These oxea reach a length of 2 mm., and their maximum thickness when full grown is from 0·07 mm. to 0·08 mm.

In the dermal cortex there are bundles of very small oxea, many of which project from the surface at various angles. These spicules (text-fig. 166, *d*) are more or less spindle-shaped and are nearly or quite straight; their diameter is 0·002 mm., and they reach a maximum length of 0·25 mm. They occur almost exclusively in the dermal cortex, but an occasional isolated spicule is to be found in the parenchyma.

The oscular fringe is composed of very long thin oxea. They reach a length of from 1 mm. to 2 mm., and their maximum diameter is 0·004 mm.

In addition to the fringe there is, as usual, a short peristome encircling each osculum.

*Colour* (in alcohol) yellowish-white.

This sponge bears a distinct resemblance to the well-known *Leucandra aspera* (Schmidt). It differs from this species, however, by the presence of minute oxea in the dermal cortex. *Leucandra gemmipara* is also not unlike the above described *L. crosslandi*, but it is to be distinguished from the latter (1) by the almost complete confinement of the small oxea to the dermal cortex, (2) by having much more slender parenchymal triradiates, and (3) by having smaller and different shaped dermal triradiates. In addition to these and certain other minor differences, I may mention that there is an oscular fringe present on all my specimens of *L. gemmipara*, but that this structure is not to be found on any of the specimens of *L. crosslandi*. I hesitate, however, to include this among the characters of specific value.

*Distribution.* Cape Verde Islands (*Crossland Collection*).

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## EXPLANATION OF PLATE XL.

Fig. 1. External form of *Leucosolenia panis*, × 3.
2. " " *Leucosolenia atlantica*, × 2.
3. " " *Leucosolenia canariensis*, × 4.
4. " " *Sycon caminatum*, × 4.
5. " " *Grantia intermedia*, × 4.
6. " " *Leucandra verdensis*, × 4.
7. " " *Leucandra rudifera*, × 2.
8. " " *Leucandra crosslandi*, × 3.
9. " " *Leucandra gemmipara*, × 4.

No. 57.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

April 28th, 1908.

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

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The SECRETARY read a Report on the additions that had been made to the Society's Menagerie during the month of March 1908.

Mr. C. TATE REGAN, M.A., F.Z.S., exhibited a specimen of an Australian Cat-fish (*Cnidoglanis megastoma* Richards.), and pointed out that the so-called second dorsal fin was in reality a procurrent portion of the caudal, differing from the dorsal and anal fins in the absence of basal supports.

Mr. HENRY SCHERREN, F.Z.S., exhibited on behalf of Mr. WALTER BURTON, F.Z.S., and briefly described some melanistic and black Leopard-skins from Abyssinia.

Prof. D'ARCY W. THOMPSON, F.Z.S., gave an explanation, illustrated by models, of his suggestion that the shapes of eggs were due to physical causes, being determined by the peristaltic pressure of the oviduct on liquid bodies contained in flexible membranes.

Mr. C. TATE REGAN, M.A., F.Z.S., read a paper entitled "A Revision of the Sharks of the Family *Orectolobidæ*." Twenty-one species were described and were referred to eight genera. Attention was called to the great differences in form, coloration, &c. among the members of the family, corresponding to differences in habits and environment.

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* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; 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. F. E. Beddard, F.R.S., F.Z.S., Prosector to the Society, gave an account of his identification of an Oligochæte Worm obtained in considerable numbers from a well near Cambridge, England. He described the worm as a new species of the genus *Phreatothrix*, the only other species of which had been described thirty years ago from the underground waters of Prague.

A Memoir by Mrs. E. W. Sexton, entitled "On the Amphipod Genus *Trischizostoma*," and communicated to the Society by Dr. W. T. Calman, F.Z.S., was based on a rich material obtained by the steamer of the Marine Biological Association in the Bay of Biscay, and by the steamer of the Irish Department of Agriculture off the west coast of Ireland.

A short paper was read by Mr. Henry Scherren, F.Z.S., on "Certain Errors respecting George the Fourth's Giraffe." The Author adduced evidence to show that the time the animal lived at Windsor had been much understated, and added details as to its life in confinement, the presentation of the skin and skeleton to the Museum of the Society, and the notes made by R. B. Davis while painting a picture of the animal at Windsor.

Mr. C. L. Boulenger, F.Z.S., communicated observations on the breeding-habits of a Cichlid Fish (*Tilapia nilotica*) which he had been able to make in the course of a visit last year to Lake Qurun in the Fayûm province of Egypt.

A memoir entitled "A Revision of the Oriental Pelobatid Batrachians (Genus *Megalophrys*)" was read by Mr. Beddard, F.R.S., in the absence of the Author, Mr. G. A. Boulenger, F.R.S., Vice-President of the Society.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 12th May, 1908, at half-past Eight o'clock p.m., when the following communications will be made:—

1. C. F. Jenkin.—The C. Crossland Collection of Calcarea from Zanzibar and Wasin (British East Africa).

2. R. E. Turner, F.Z.S.—Notes on the Australian Fossorial Wasps of the Family *Sphegidæ*, with Descriptions of new Species.

3. J. T. Cunningham, M.A., F.Z.S.—The Heredity of Secondary Sexual Characters in relation to Hormones: a Contribution to the Theory of Heredity.

The following communications have been received :—

1. Oldfield Thomas, F.R.S., F.Z.S., and R. C. Wroughton, F.Z.S.—The Rudd Exploration of S. Africa.—X. List of Mammals collected by Mr. Grant near Tette, Zambesia.

2. The Rev. T. R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Isopoda Terrestria.

3. F. E. Beddard, M.A., F.R.S.—On the Anatomy of *Antechinomys* and some other Marsupials, with especial reference to the Intestinal Tract and Mesenteries of these and other Mammals.

4. Prof. H. G. Seeley, F.R.S., F.Z.S.—The Armour of the Extinct Reptiles of the Genus *Pareiasaurus*.

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Communications intended for the Scientific Meetings of the Zoological Society of London should be addressed to

P. CHALMERS MITCHELL,

*Secretary*.

3 Hanover Square, London, W.

*May* 5*th*, 1908.

No. 58.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

**May 12th, 1908.**

F. DuCane Godman, Esq., D.C.L., F.R.S., Vice-President, in the Chair.

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The Secretary read a Report on the additions that had been made to the Society's Menagerie during the month of April 1908.

Mr. W. Woodland, F.Z.S., exhibited preparations of a new gland he had found in certain teleostean fishes, and made the following remarks:—"This new gland is diffuse in form and is intermingled with the veins and arteries which subdivide to form the numerous parallel capillaries of the rete mirabile found in connection with all teleost 'red bodies.' It is quite distinct from the gas-gland, and consists of rows of huge columnar cells, which are situated in close connection with the blood-vessels, which possess large nuclei and nucleoli and are packed with numerous large spherical granules derived from the red-corpuscle disintegration concerned in the generation of the oxygen contained in the swim-bladder. These granules, thus abstracted by the gland-cells from the blood, are carried away by special ducts appertaining to the gland. The discovery of this important gland confirms Jæger's view as to the mode of generation of the bladder oxygen. This gland exists in *Gobius*, *Syngnathus*, *Peristedion*, *Box*, and some other genera."

Mr. T. A. Coward, F.Z.S., exhibited a specimen of a Petrel, *Œstrelata neglecta* Schleg., which was the property of Mr. Arthur Newstead, of Cheshire, and had been picked up dead, yet in a

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quite fresh condition, at Tarporley in Cheshire, on April 1st, 1908. This bird is a native of the Southern Pacific, and has almost certainly never been recorded from the northern hemisphere, and certainly never from Europe before.

The Secretary, on behalf of Mr. R. Lydekker, F.R.S., F.Z.S., exhibited the tanned skin of a Wild Cat, obtained by The Hon. Mason Mitchell, of the American Consular Service, in Sze-chuen. Mr. Lydekker had compared it with a light-coloured skin of *Felis temmincki* from Sikkim, and described it as a new local race of that species.

Mr. C. Davies Sherborn, F.Z.S., exhibited a specimen of chert from the Middle Culm-measures (Carboniferous) of Christon Down, near Doddiscombe Leigh, Devonshire, showing numerous large and well-preserved Radiolaria.

A memoir by Mr. C. F. Jenkin, entitled "The Cyril Crossland Collection of Calcarea from Zanzibar and Wasin (British East Africa)," was communicated by Prof. A. Dendy, F.R.S., F.Z.S.

Mr. R. E. Turner, F.Z.S., read a paper entitled "Notes on the Australian Fossorial Wasps of the Family *Sphegidæ*, with Descriptions of new Species." Eighty species were described as new; and the absence of the genera *Oxybelus* and *Philanthus*, otherwise of world-wide range, from Australia was commented on.

Mr. J. T. Cunningham, M.A., F.Z.S., communicated a paper entitled "The Heredity of Secondary Sexual Characters in Relation to Hormones, a Contribution to the Theory of Heredity." The paper contained an examination and criticism of the most important recent investigations and theories on the subject by evolutionists of various schools, namely the theory which attributes such characters to constitutional causes such as male katabolism, Prof. Karl Pearson's biometrical investigation of sexual selection in man, Castle's Mendelian theory of the heredity of sex, and Geoffrey Smith's views on dimorphism of males and parasitic castration in Crustacea. The author maintained that all these contributions were more or less inconsistent with the known facts concerning the connection between the development of secondary sexual characters and the functional activity of the primary gonads. He drew attention to the recent discovery and experimental proof on the part of physiologists that the development of the characters was due to the stimulus of a chemical substance or hormone produced by the testis or ovary, and passed into the blood, and suggested that conversely hormones from parts of the soma might affect the gametes in the gonads. In this way the hypertrophy of a part of the body due to external stimulation might modify the corresponding determinants in the gametes so as to produce some hereditary effect in succeeding generations. Mr. Cunningham added that his theory was an interpretation in terms of modern physiology of Darwin's theory of pangenesis.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 26th May, 1908, at half-past Eight o'clock P.M., when the following communications will be made :—

1. OLDFIELD THOMAS, F.R.S., F.Z.S., and R. C. WROUGHTON, F.Z.S.—The Rudd Exploration of S. Africa.—X. List of Mammals collected by Mr. Grant near Tette, Zambesia.

2. The Rev. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Isopoda Terrestria.

3. F. E. BEDDARD, M.A., F.R.S.—On the Anatomy of *Antechinomys* and some other Marsupials, with especial reference to the Intestinal Tract and Mesenteries of these and other Mammals.

4. Prof. H. G. SEELEY, F.R.S., F.Z.S.—The Armour of the Extinct Reptiles of the Genus *Pareiasaurus*.

5. The Hon. N. CHARLES ROTHSCHILD, M.A., F.Z.S.—New Siphonaptera.

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The following communications have been received :—

1. OLDFIELD THOMAS, F.R.S., F.Z.S.—The Duke of Bedford's Zoological Exploration of Eastern Asia.—X. List of Mammals from the Provinces of Chili-li and Shan-si, N. China.

2. JAMES RITCHIE, M.A., B.Sc., and D. C. MCINTOSH, M.A., B.Sc., F.R.S.E.—On a Case of Imperfect Development in *Echinus esculentus*.

3. Prof. E. A. MINCHIN, M.A., V.P.Z.S., and D. J. REID, M.B., C.M., F.Z.S.—Observations on the Minute Structure of the Spicules of Calcareous Sponges.

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Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary*.

3 HANOVER SQUARE, LONDON, W.

*May* 19*th*, 1908.

No. 59.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

**May 26th, 1908.**

Professor E. A. Minchin, M.A., Vice-President, in the Chair.

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A paper was read by Messrs. Oldfield Thomas, F.R.S., F.Z.S., and R. C. Wroughton, F.Z.S., on Mammals collected by Mr. C. H. B. Grant near Tette, Zambesia, being the tenth and last of the series of papers on Mr. C. D. Rudd's Exploration of South Africa.

The importance of this collection was due to the fact that Tette was the place where Dr. Peters obtained most of the specimens on which his 'Säugethiere von Mossambique' (1852) was based, and the specimens now collected were therefore topotypes of his species and in consequence of great value in working out S. African Mammals in general.

104 specimens were referred to, belonging to 32 species.

A *résumé* was then given of the papers which had been published on the collections presented to the National Museum by Mr. Rudd, both those of the present series and others based more or less directly upon his specimens.

The exploration had lasted five years, and its results formed the largest and most complete collection that the Museum had ever received from any one source. Besides duplicates, 1541 specimens had been registered in the Museum, a large number of new species and subspecies had been discovered and described, and many more old and inexactly described species were now represented by good series of well-prepared skins and skulls.

The collection had, in fact, revolutionized our knowledge of S. African Mammalogy, and it was impossible to exaggerate the

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benefit that such an exploration was to Zoology in general, and to the National Museum in particular.

Great credit was also due to Mr. C. H. B. Grant for the manner in which he had carried out the mission entrusted to him by Mr. Rudd.

The Rev. T. R. R. Stebbing, M.A., F.R.S., F.Z.S., reported that the small collection of terrestrial Isopoda made by Dr. Cunnington on the Third Tanganyika Expedition consisted of four species. For two of these he instituted the new genus *Anchiphiloscia*, distinguished by more penicils on the mandibles and a different cleavage of the second maxillæ from *Philoscia* as founded by Latreille in 1804. The paper insisted on the need of some enthusiast able and willing thoroughly to revise all the forms which had clustered under and about the generic name *Philoscia.*

Mr. F. E. Beddard, M.A., F.R.S., F.Z.S., Prosector to the Society, gave an account of a communication on the anatomy of *Antechinomys* and some other Marsupials, with special reference to the intestinal tract and mesenteries of these and other Mammals. With the aid of a series of diagrams, the author described four grades or types into which he divided the modes of suspension of the mammalian intestinal tract.

Prof. H. G. Seeley, F.R.S., F.Z.S., read a paper on the dermal armour of the extinct reptiles of the genus *Pareiasaurus*. The existence of a dermal armour in *Pareisaurus* had been doubted by some authors, but Prof. Seeley was able to exhibit some actual specimens of scutes which had been obtained by Mr. J. Van Renen, south of Fraserberg, Cape Colony.

Prof. Seeley also exhibited the skull of an extinct reptile of the genus *Diademodon*, on which he proposed to found a new species, and gave an account of the further evidence which it afforded of the structure and dentition of these South African reptiles.

A communication from the Hon. N. Charles Rothschild, M.A., F.Z.S., contained descriptions of many new species of Siphonaptera.

*Addition to Abstract*, No. 58, May 12th, 1908.

Mr. Lydekker described under the name *Felis temmincki mitchelli* the Wild Cat which had been obtained by the Hon. Mason Mitchell in Sze-chuen, and stated that it differed from a light-coloured skin of *F. temmincki* from Sikkim by the much lighter colour of the upper parts, which were golden tawny, with a comparatively narrow dorsal streak of light rufous, and by its tail being golden rufous above.

The next Meeting of the Society for Scientific Business (closing the Session 1907–08) will be held on Tuesday, the 16th June, 1908, at half-past Eight o'clock P.M., when the following communications will be made:—

1. OLDFIELD THOMAS, F.R.S., F.Z.S.—The Duke of Bedford's Zoological Exploration of Eastern Asia.—X. List of Mammals from the Provinces of Chili-li and Shan-si, N. China.

2. JAMES RITCHIE, M.A., B.Sc., and D. C. MCINTOSH, M.A., B.Sc., F.R.S.E.—On a Case of Imperfect Development in *Echinus esculentus*.

3. Prof. E. A. MINCHIN, M.A., V.P.Z.S., and D. J. REID, M.B., C.M., F.Z.S.—Observations on the Minute Structure of the Spicules of Calcareous Sponges.

4. T. A. CHAPMAN, M.D., F.Z.S.—Two new Genera and a new Species of Indian *Lycænidæ*.

5. F. E. BEDDARD, M.A., F.R.S., F.Z.S.—A Contribution to the Knowledge of *Rhinoderma darwini*.

6. F. E. BEDDARD, M.A., F.R.S., F.Z.S.—Some Notes upon the Anatomy of *Chiromys madagascariensis*, with references to other Lemurs.

7. Miss ANNIE PORTER, B.Sc.—*Leucocytozoön musculi*, sp. n., a Parasitic Protozoön from the Blood of White Mice.

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Communications intended for the Scientific Meetings of the ZOOLOGICAL SOCIETY OF LONDON should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 HANOVER SQUARE, LONDON, W.

*June 2nd*, 1908.

No. 60.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

**June 16th, 1908.**

Dr. Henry Woodward, F.R.S., Vice-President, in the Chair.

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The Secretary read a Report on the additions that had been made to the Society's Menagerie during the month of May 1908.

Dr. A. Smith Woodward, F.R.S., F.Z.S., exhibited photographs and fragments of skin and bone of a Mammoth and a Rhinoceros discovered in an ozokerite mine at Starunia, Galicia. The carcases of these animals appeared to have found their way into an old marsh saturated with petroleum, which had completely preserved them. The photographs and specimens had been received from Dr. George von Kaufmann, who intended to present them to the British Museum.

Dr. C. I. Forsyth Major, F.R.S., F.Z.S., exhibited the lower jaw of a young Canadian Beaver in which there was present on each side a small conical tooth anterior to the deciduous premolar. He considered the supernumerary premolar to be a case of atavism.

Dr. Forsyth Major exhibited a set of drawings made from examples of two species of *Castor* from the East Runton Forest-bed, and remarked that truly Forest-bed species were found in association with Pliocene species. He discussed incidentally the numerous species of recent European Beavers admitted by Professor Matschie.

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Dr. Forsyth Major also exhibited photographs of Pliocene *Bovinæ* from specimens in the Florence Museum, stating that these unpublished figures showed the great variability of the Pliocene *Bovinæ*. He added that he endorsed Falconer's opinion that these Pliocene *Bovinæ* were nearly related to the primitive Buffaloes from the Siwaliks.

Mr. Oldfield Thomas, F.R.S., F.Z.S., read a paper on Mammals from the Provinces of Chih-li and Shan-si, N. China, collected by Mr. M. P. Anderson, being the tenth of the series of papers on the results of the Duke of Bedford's Zoological Exploration of Eastern Asia.

Very little material had hitherto existed from this part of Northern China, although a certain number of specimens had been sent to Paris by Père David, and it was therefore of great importance to have a series representing the species he discovered for comparison with mammals from other regions.

The present collection consisted of about 100 specimens, belonging to 20 species, of which several are new, the most notable being

Capreolus bedfordi, sp. n.

Size rather larger than in *C. capreolus*, much smaller than in *C. pygargus*. General colour in winter pelage more or less rufous, quite unlike the grey-brown of *C. capreolus*. Antlers small and slender.

Condylo-basal length of a male skull 207 mm.

*Hab.* Chao-Cheng-Shan, Shan-si, 8000′.

*Type.* Old female. Original number 1615.

The collection had, as before, been presented to the National Museum by the Society's President, the Duke of Bedford, K.G.

Dr. F. A. Bather, F.Z.S., communicated a paper by Messrs. James Ritchie, M.A., B.Sc., and D. C. McIntosh, M.A., B.Sc., F.R.S.E., entitled "On a Case of Imperfect Development in *Echinus esculentus*."

Professor E. A. Minchin, V.P.Z.S., and Dr. D. J. Reid, F.Z.S., read a paper on the minute structure of Calcareous Sponge-spicules. The primary object of this investigation was to demonstrate, by means of photo-micrographs, certain structures, the existence of which had been strenuously denied by some of the most competent of previous investigators: namely, the presence, after the spicules had been cautiously decalcified, of a residue in the form of an axial filament which could be stained and rendered evident by certain dyes, in addition to the sheath universally acknowledged to exist. The axial filament was found to be very distinct in the spicules of *Clathrinidæ*, but much less so in those of *Leucosoleniidæ* and *Heterocœla*. Incidentally the study of the axial filaments led to some interesting conclusions regarding the comparative morphology of the two principal types of spicules, monaxon and triradiate, occurring in calcareous sponges.

Dr. T. A. Chapman, F.Z.S., F.E.S., read a paper pointing out that *Cyaniris chennellii* of de Niceville was not a *Cyaniris* (*Celastrina* Tutt), but belonged to a new genus near to *Everes*; and that a specimen in Col. Bingham's collection placed with *chennellii* was a species almost entitled to be placed in *Cyaniris*, for which he proposed new generic and specific names. Another specimen of the latter species was in the Tring Museum. It was suggested that de Niceville had both these species together in dealing with *chennellii*, and unfortunately selected as his type the one that was not a *Cyaniris*. The two forms probably fly together and are therefore mimetic.

Mr. F. E. Beddard, F.R.S., F.Z.S., gave an account of two communications, entitled respectively, "A Contribution to Knowledge of the Batrachian *Rhinoderma darwini*" and "Some Notes upon the Anatomy of *Chiromys madagascariensis*, with references to other Lemurs."

Miss Annie Porter, B.Sc., read a paper, communicated by Mr. H. B. Fantham, F.Z.S., on "*Leucocytozoön musculi*, sp. n., a Parasitic Protozoön from the Blood of White Mice." The parasites occur in mononuclear and transitional leucocytes and free in the plasma. The free trophozoites are gregariniform vermicules, their average size being 10·9 $\mu$ long by 5·1 $\mu$ broad. Small free forms enter leucocytes and grow partly at the expense of the nucleus. A cytocyst is formed. The endoglobular parasites average 8 $\mu$ long by 5 $\mu$ broad. Schizogony occurs in the bone marrow. A schizont produces about twelve merozoites, each 4·4 $\mu$ by 0·8 $\mu$. Two parasites were sometimes seen in one host cell, suggesting association, and in one case possible exchange of chromatin occurred. Positive evidence of male and female forms was not obtained. Vermicules were found in the gut and Malpighian tubules of lice, ectoparasitic on the mice, but no sexual cycle in the louse was observed. Perhaps the lice serve merely as mechanical agents in the spread of infection.

In a memoir from Mr. E. Meyrick, B.A., F.R.S., F.Z.S., entitled "Descriptions of African Micro-Lepidoptera," 108 species and 11 genera of *Tortricina* and *Tineina* from the African Region (especially the Transvaal) were described as new.

Prof. A. Dendy, F.R.S., F.Z.S., communicated a paper by Mr. A. G. Thacker, A.R.C.S.(Lond.), on a collection of Calcareous Sponges made by Mr. Cyril Crossland in the Cape Verde Islands.

This Meeting closes the Session 1907–1908. The next Session (1908–1909) will begin on November 3rd next.

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Communications intended for the Scientific Meetings of the Zoological Society of London should be addressed to

P. CHALMERS MITCHELL,
*Secretary.*

3 Hanover Square, London, W.
*June 23rd*, 1908.

June 16, 1908.

# LIST OF PLATES.

1908, pp. 431–782.



## NOTICE.


The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1908, p. . . . The Distribution is as follows:—

Papers read in January and February, issued in June.
„ „ March and April, „ „ August.
„ „ May and June, „ „ October.
„ „ November and December, „ „ April.

'Proceedings,' 1908, pp. 127–430, were published on Sept. 17th, 1908.

**The Abstracts of the papers read at the Scientific Meetings in May and June are contained in this Part.**

# PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

# ZOOLOGICAL SOCIETY

# OF LONDON.

## 1908.

Pages 783–983.

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PART IV. CONTAINING PAPERS READ IN

NOVEMBER AND DECEMBER.

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# LIST OF CONTENTS.

## 1908, pp. 783–983.

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### November 3, 1908.



### November 17, 1908.



*Contents continued on page 3 of Wrapper.*

# THE 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.

## COUNCIL.

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 the collection of living animals at Regent's Park, by its Library at 3, Hanover Square, W., and by its scientific publications.

The Office of the Society (3, Hanover Square), where all communications should be sent, addressed to "The Secretary," is open from Ten till Five, except on Saturdays, when it closes at Two P.M.

The Library, under the superintendence of Mr. F. H. Waterhouse, is open daily at the above hours, except in September.

The Meetings of the Society for General Business are held at the Office on the Thursday following the third Wednesday in every month of the year, except in September and October, at Four P.M. Commencing on January 20th, 1909, these Meetings will be held on the third Wednesday of the month at 5 P.M.

The Meetings for Scientific Business are held at the Office twice a month on Tuesdays, except in July, August, September, and October, at half-past Eight o'clock P.M.

The Anniversary Meeting is held on the 29th. of April, or the nearest convenient day, at Four P.M.

The Gardens in the Regent's Park are open daily from Nine o'clock until Sunset. Mr. R. I. Pocock, F.L.S., is the resident Superintendent. The Prosectorium for Anatomical and Pathological work at the Gardens is under the charge of Mr. Frank E. Beddard, M.A., F.R.S., Prosector, assisted by Mr. H. G. Plimmer, 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 after the 31st. of August are not liable for the Subscription for the year in which they are elected.

## PRIVILEGES OF FELLOWS.

Fellows have Personal Admission to the Gardens with Two Companions daily, upon signing their names in the book at the entrance gate.

The Wife or Husband of a Fellow can exercise these privileges in the absence of the Fellow.

Every Fellow is entitled to receive annually 60 undated Green Cards, and, when no specific instructions are received, the supply will be sent in this form. If preferred, however, 20 Green Cards may be exchanged for a book containing 2 Orders for each Saturday * throughout the year. A similar book of Sunday Orders may also be obtained in lieu of 20 Green Cards. A Green Card may also be exchanged for 2 Buff Cards for the use of Children under 12 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.

Green and Buff Tickets may be used on any day and in any year, but in no case can two Children be admitted with one Adult Ticket, or an Adult be admitted with two Children's Tickets.

The annual supply of Tickets will be sent to each Fellow on the 1st. of January in every year, upon filling up and returning the form of Standing Order supplied to Fellows.

Fellows are not allowed to pass in friends on their written Order or on presentation of their Visiting Cards.

Fellows are exempt from payment of the fee for Painting, Sketching, and Photographing in the Society's Gardens.

Fellows have the privilege of receiving the Society's ordinary Publications issued during the year upon payment of the 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

* The Saturday Orders are not available if the Fellow introduces friends personally on that day.

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 one year or more, may, upon giving to the Secretary notice in *writing*, have his or her name placed upon the "dormant list," and will be thereupon exempt from the payment of the annual contribution during such absence.

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 undersigned.

P. CHALMERS MITCHELL,
*Secretary.*

3 Hanover Square, London, W.,
April 1st, 1909.

# MEETINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON

FOR

## SCIENTIFIC BUSINESS.

(AT 3 HANOVER SQUARE, W.)

**1909.**

| | | | |
|---|---|---|---|
| Tuesday, April .. | 6 and 27 | Tuesday, November | 9 and 23 |
| " May .... | 11 and 25 | " December | 14 |
| " June .... | 15 | | |

*The Chair will be taken at half-past Eight o'clock in the Evening precisely.*

# LIST OF THE PUBLICATIONS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.

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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, on the first of the months of June, August, October, and April, the part published in April completing the volume for the last half of the preceding year. From January 1901 they have been issued as two half-yearly volumes.

The "Transactions" contain such of the more important 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 in each year, 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 for them 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 Annual Volume of the Zoological Record for a sum of 30*s.* (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.

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P. CHALMERS MITCHELL,

*Secretary.*

3, Hanover Square, London, W.,
April 1st, 1909.

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# ZOOLOGICAL SOCIETY OF LONDON.

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The Zoological Record having been amalgamated with the International Catalogue of Scientific Literature, Zoology, Volumes from 43 onwards can only be obtained now from Messrs. Harrison & Sons, except when purchasing complete sets from the Zoological Society.

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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, 10*s.*

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| XIII. | Insecta | 12 | 0 | ,, |
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P. CHALMERS MITCHELL,
*Secretary.*

3 Hanover Square, London, W.
*April* 1*st*, 1909.

November 3, 1908.

Frederick Gillett, Esq., Vice-President, in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the months of June, July, August, and September, 1908:—

## June.

The registered additions to the Society's Menagerie during the month of June were 141 in number. Of these 115 were acquired by presentation, 9 by purchase, 6 were received on deposit, 5 by exchange, and 6 were born in the Gardens. The total number of departures during the month, by death and removals, was 144.

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

One Dent's Cercopitheque (*Cercopithecus denti*), from the Ituri Forest, new to the Collection, received in exchange on June 19th.

One Markhoor (*Capra megaceros*), ♂, born in the Menagerie on June 6th.

Two Somali Ostriches (*Struthio molybdophanes*), ♂ ♀, from Somaliland, purchased on June 15th.

The special Collection of Australian Animals reached the Gardens on June 9th, the total number of arrivals being 603, viz., Mammals 164, Birds 332, and Reptiles 107. Of these 200 were acquired by presentation, 193 by purchase, 6 were received on deposit, and 204 by exchange.

The following were reported as being new to the Society's Menagerie:—

### Mammals.

| | |
|---|---|
| 1 Broad-faced Rat Kangaroo. | *Potorous platyops.* |
| 1 Long-nosed Bandicoot. | *Perameles nasuta.* |
| 2 Pouched Mice. | *Phascogale flavipes.* |
| 2 Hairy Echidnas. | *Echidna setosa.* |

### Birds.

| | |
|---|---|
| 3 Blue Wrens. | *Malurus cyaneus.* |
| 2 Black-and-white Fantails. | *Rhipidura tricolor.* |
| 1 Tree Runner. | *Climacteris scandens*? |
| 1 Cuckoo Shrike. | *Graucalis mentalis.* |
| 1 Australian Oriole. | *Spectotheres australis*? |
| 4 Japanese Hawfinches. | *Coccothraustes robustus.* |
| 1 Harmonious Shrike-Thrush. | *Collyriocincla harmonica.* |
| 4 Spiny-cheeked Honey-eaters. | *Acanthogenys rufigularis.* |
| 1 Spine-bill Honey-eater. | *Acanthorhynchus tenuirostris.* |

| | |
|---|---|
| 5 New-Holland Honey-eaters. | *Meliphaga novæ-hollandiæ.* |
| 3 Lewin's Honey-eaters. | *Ptilotis chrysotis.* |
| 8 White-plumed Honey-eaters. | ,, *penicillatus.* |
| 4 White-eared Honey-eaters. | ,, *leucotis.* |
| 1 Yellow-faced Honey-eater. | ,, *chrysops.* |
| 6 Yellow-throated Honey-eaters. | *Myzantha flavigula.* |
| 1 Fulvous-fronted Honey-eater. | *Glyciphila fulvifrons?* |
| 2 Shoveller Ducks. | *Spatula rhynchotus.* |

REPTILES.

| | |
|---|---|
| 1 Swan River Lizard. | *Amphibolurus decresii.* |
| 3 Naked-toed Lizards. | *Gymnodactylus miliusi.* |
| 2 Diademed Snakes. | *Pseudelaps diadema.* |

JULY.

The registered additions to the Society's Menagerie during the month of July were 276 in number. Of these 170 were acquired by presentation, 19 by purchase, 51 were received on deposit, 10 by exchange, and 26 were born in the Gardens. The total number of departures during the month, by death and removals, was 183.

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

A Swan-Island Capromys (*Capromys thoracatus*), new to the Collection, presented by Dr. Percy R. Lowe on July 17th.

Two Arabian Hyraxes (*Procavia syriaca*), new to the Collection, presented by H.H. The Sultan of Muscat on July 2nd.

A male Grévy's Zebra (*Equus grevyi*), born in the Menagerie on July 24th.

A Great Anteater (*Myrmecophaga jubata*), presented by J. S. da Costa, Esq., on July 25th.

A magnificent Collection of 30 Birds of Paradise belonging to six species, new to the Collection, obtained in co-operation with Sir William Ingram, Bt., on July 3rd.

AUGUST.

The registered additions to the Society's Menagerie during the month of August were 130 in number. Of these 82 were acquired by presentation, 4 by purchase, 16 were received on deposit, 4 by exchange, and 24 were born in the Gardens. The total number of departures during the month, by death and removals, was 203.

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

A Kiang (*Equus hemionus*), ♂, from Tibet, deposited on Aug. 6th.

A Barasingha Deer (*Cervus duvaucelli*), ♂, born in the Menagerie on Aug. 8th.

A Martial Hawk-Eagle (*Spizaëtus bellicosus*), from S. Africa, presented by R. P. Burra, Esq., on Aug. 11th.

A Tiger-Bittern (*Tigrisoma brasiliense*), from Manãos, Brazil, presented by Col. Don Pedro Suarez, on Aug. 13th.

SEPTEMBER.

The registered additions to the Society's Menagerie during the month of September were 197 in number. Of these 91 were acquired by presentation, 10 by purchase, 34 were received on deposit, 3 by exchange, and 59 were born in the Gardens. The total number of departures during the month, by death and removals, was 161.

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

Two Aye-Ayes (*Chiromys madagascariensis*), from Madagascar purchased on Sept. 12th.

One Tiger (*Felis tigris sondaica*), ♂, from Deli, Sumatra, deposited on Sept. 11th.

One Jaguar (*Felis onca*), from Marajo, presented by G. L. Andrews, Esq., on Sept. 4th.

One Black-rumped Duiker (*Cephalophus melanorheus*), new to the Collection, from Benguela, presented by H. F. Varian, Esq., on Sept. 12th.

Six White-throated Pigeons (*Columba albigularis*), from the Moluccas, deposited on Sept. 24th.

Two South-American Mudfish (*Lepidosiren paradoxa*), from Para, new to the Collection, presented by the Goeldi Museum on Sept. 4th.

---

Professor E. A. Minchin, M.A., V.P.Z.S., exhibited some drawings of trypanosomes and trypanoplasms of freshwater fishes (pike, tench, bream, perch, and eel) studied by him at Sutton Broad Laboratory. After some remarks upon methods of obtaining and studying these blood-parasites, he pointed out that there were many problems connected with them still unsolved, particularly those relating to their transmission from fish to fish. It was generally believed that the infection of fish was effected by the intermediary of leeches. A great obstacle to the study of these questions was the lack of any monographs dealing with leeches in a general way, no such work having been published since that of Moquin-Tandon in 1846, and the hope was expressed that some zoologist would produce a handbook or monograph of the British leeches. Such a work would be of the greatest assistance to those studying fish-trypanosomes, a group of parasites which might one day become of great economic importance.

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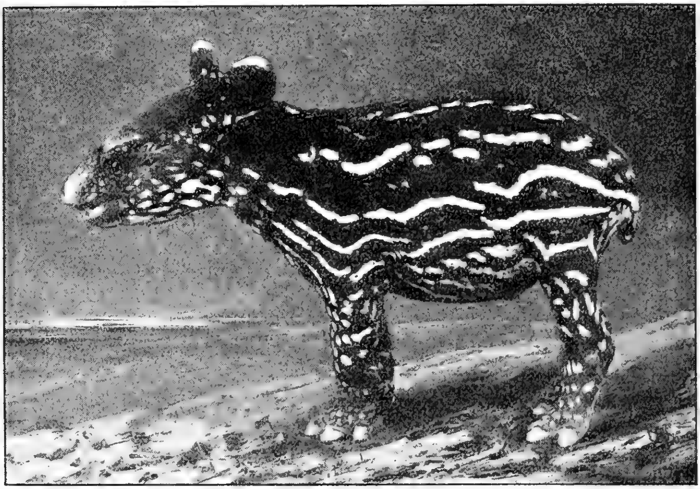
The Secretary exhibited a photograph (text-fig. 167) of a young Malayan Tapir, and remarked that he had been unable to find accurate drawings of the young of this species. The photograph had been given to him by the Right Hon. Sir Cecil Clementi Smith, P.C., G.C.M.G., M.A., Honorary Member of the Society, and had been taken from a living example which had been a pet in his house.

Text-fig. 167.



Young Malayan Tapir, photographed from a living example.

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The following papers were read :—

## 1. Description of a new Species of Toad from Sumatra. By Geoffrey Meade-Waldo, B.A.*

(Plate XLI.)

Bufo valhallæ, sp. n.

Head once and a third to once and a half as broad as long; snout as long as diameter of the orbit, short and blunt. Nostrils nearer the eyes than the tip of the snout; the eyes equidistant between snout and the angles of the jaws; interorbital space flat, its width about equal to that of the upper eyelid, and slightly greater than that between the nostrils.

* Communicated by E. G. B. Meade-Waldo, F.Z.S.

1.

2.

J. Green del. et Chromo lith

BUFO VALHALLÆ, Sp. nov.

*1. Upper surface of head. 2. Underside of foot.*

Tympanum two-thirds to three-fourths diameter of the eye, very distinct: cleft of the mouth extending back to the posterior border of the eye.

Fingers short, blunt; 3rd longest, and the 1st rather longer than 2nd and 4th, which are about equal in length; subarticular tubercles single; two moderate carpal tubercles, the inner quite twice as large as the outer, both elliptical in shape.

Hind limb moderately elongate, tibia as long as femur; a conspicuous gland on each calf; the tarso-metatarsal articulation reaches the eye. Toes moderately long, about one-half webbed; subarticular tubercles small and single; two small metatarsal tubercles, the inner more prominent than the outer. No tarsal fold.

Upper surface covered with anastomosing wrinkles, and with pores, very conspicuous and different in size. A large prominent elliptical or oval parotoid gland behind the eye on each side, the length of this gland contained once and a half in the length of the head. The lower surface granular, granules of uniform size and evenly distributed.

Olive-brown above, with a few slight traces of darker markings, in one specimen a distinct black line along the inner margin of the parotoid glands. Iris bright yellow, towards the corners thickly vermiculated with black.

Length 82 mm. from snout to vent.

Two females from Pulo Weh Island, off N. Sumatra.

I propose that the name *Bufo valhallæ* be given to the species, as I was travelling on Lord Crawford's yacht 'Valhalla' when the specimens were obtained.

There seem to be several species very nearly allied to this toad. I have compared the living examples with specimens of *Bufo olivaceus* Blanford, *Bufo stomaticus* Lütken, and *Bufo andersonii* Blgr., in the collection of the British Museum (Natural History), with the kind help of Mr. G. A. Boulenger, F.R.S.

The extreme prominence of the parotoid glands seems to be the most marked characteristic, and in this it differs considerably from *B. olivaceus*, in which these glands are depressed. Another difference between these two species is to be found in the skin of the upper surface; in *Bufo olivaceus* it is nearly smooth, in *B. valhallæ*, on the contrary, it is wrinkle-covered and of a porous consistency.

*B. stomaticus* closely resembles it, but may be distinguished from it by the toes being three-fourths webbed, whereas *B. valhallæ* has them only one-half webbed. The parotoid glands in *B. stomaticus* are only nearly as long as their distance from the end of the snout.

*B. andersonii* can be distinguished by the presence of a tarsal fold.

No specimen of *Bufo sumatranus* Peters, was available for comparison, but in that species the tympanum is only one-fourth the width of the eye, and it is also the possessor of a tarsal fold.

Another characteristic of *B. valhallæ* is the presence of a considerable glandular swelling on the calf of the hind limb; in none of the above-mentioned species does this occur; it is, however, conspicuous in the British species *B. calamita*.

*B. valhallæ* is capable of jumping along at a good pace, and is very active in catching any insect, however fast; I have frequently seen them jump quite 6 inches from the ground to catch a moth running up the side of their cage.

## 2. On Mammals from Inkerman, North Queensland, presented to the National Museum by Sir William Ingram, Bt., and the Hon. John Forrest. By OLDFIELD THOMAS, F.R.S., F.Z.S., and GUY DOLLMAN, B.A.

[Received August 7, 1908.]

(Plate XLII.)

After he had made the interesting collection of mammals from Alexandria, Northern Territory, of which an account was given two years ago*, Mr. W. Stalker was sent by the same generous donors to Inkerman, their station on the Burdekin River, near Townsville, in the southern part of North Queensland, and he has there formed the very fine collection of which we now give a list.

This region was hitherto almost entirely unrepresented in the National Collection, such of the few Queensland specimens as we possessed being either from the far north, on the Cape York peninsula, or from near Brisbane; and the present collection therefore, including as it does admirable series of all the local mammals, is of exceeding value to the Museum, while its general scientific interest also proves to be very great.

A study of the collection shows clearly that this part of Queensland belongs to the northern fauna, the species being all either those of North Australia, or nearly related to them, while such southern forms as are represented are generally subspecifically separable from their allies of New South Wales and South Queensland. The new Wallaby (*Macropus ualabatus ingrami*) and the Water Rat (*Hydromys chrysogaster reginæ*) may be quoted as instances of such subspecific differences; while the presence of *Isoodon torosus* instead of *obesulus*, of *Dasyurus hallucatus*, *Macropus agilis* and many others, are evidence of the essentially northern relations of the Townsville region.

Altogether this is one of the most important Australian collections that the Museum has ever received, and we are therefore very deeply indebted to Sir William Ingram and the Hon. John Forrest, the donors of this most valuable addition to our National Collections.

* P. Z. S. 1906, p. 536.

J. Smit del. West, Newman imp.

MACROPUS UALABATUS INGRAMI.

1. Pteropus gouldi Peters.

♂. 458. ♀. 466.
♂. 509. Mt. Elliot, Townsville.

2. Pteropus scapulatus Peters.

♂. 457, 462, 463, 489, 499, 500, 501, 502
♀. 320, 464, 490, 491.

3. Chalinolobus gouldi Gray.

♀. 496.

4. Scoteinus greyi Gray.

♀. 492, 493, 497.

5. Miniopterus schreibersi Kuhl.

♀. 354, 356.
Forearm 47 mm.

6. Miniopterus australis Tomes.

♂. 494. ♀. 355.
Forearm 38 mm.

7. Nyctinomus planiceps Peters.

♂. 495.

The skull of this specimen is not so flattened as those of other examples in the Museum, being rather intermediate in this respect between *N. planiceps* and *N. norfolcensis*.

8. Canis dingo Blumenb.

One specimen.

9. Hydromys chrysogaster reginæ, subsp. nov.

♂. 391, 394, 396, 419, 420, 423, 487, 506. ♀. 308, 393, 398, 400, 422, 505.

In general appearance and size like true *H. chrysogaster*, only very much greyer in colour, especially on the upper surface. General colour of back dark greyish, between "olive" and "sepia" of Ridgway, slightly darker in the middle line. Under surface white, tinged with buff, though not nearly so rich a buff as in the other Eastern forms. Tail blackish brown proximally, the terminal three or four inches white.

Dimensions of type (measured in the flesh):—

Head and body 336 mm.; tail 320; hind foot 66; ear 19.

Skull—basal length 54·7 mm.; basilar length 52·2; zygomatic breadth 31·7; length of nasals 20·5; palatilar length 28·5; palatal foramina 6·7; upper molar series 9.

*Type.* Adult male. B.M. No. 8.8.8.23. Original number 396. Collected 11th July, 1907.

From all the described East Australian *Hydromys*, whether the New South Wales "*lutrilla*"* is or is not distinct from the Tasmanian "*chrysogaster*," this Queensland Water-Rat is separable by its darker colour, less suffused with yellowish or buffy. Mr. Stalker's series is remarkably uniform in this respect.

Geoffroy's *Hydromys leucogaster* was also from Tasmania, and probably represents a partially albinistic phase of *H. chrysogaster*.

Gould's *H. fulvolavatus* is more buffy throughout. Its name may prove to be tenable for the South Australian representative of the genus.

Jourdan's *H. fulvo-venter* †, a name hitherto entirely overlooked, was based on a specimen believed to be from Swan River, but the description is wholly inapplicable to any W. Australian specimen, and there can be little doubt that the type was an example of *H. chrysogaster*, which, coming to M. Jourdan with his specimen of *Macropus irma*, was erroneously supposed to have come from the same place.

10. MUS CULMORUM, sp. n.

♂. 296, 297, 298, 299, 300, 321, 324, 327, 329, 445, 481.

♀. 278, 295, 301, 303, 304, 305, 306, 322, 323, 325, 326, 330, 361, 381, 434, 445, 447, 449, 450.

One ♀ in spirit.

Heath Island, Burdekin R.; Beach Mount; Mt. Abbot.

A coarse or spiny-haired fulvous Rat with a whitish belly, allied to *M. tunneyi*. Size about as in *Mus rattus*, or rather smaller. Fur sparse and coarse, more or less mixed with flattened spines. General colour above brownish fulvous, varying considerably according to the degree of spinousness. Sides more buffy. Under surface whitish, often with a tinge of yellow, the hairs pale slaty basally on the belly, whitish throughout on the throat and sometimes on the inguinal region. Ears rather short, practically naked. Upper surface of hands and feet white. Tail of medium length, longer than in *M. tunneyi*, its rings (at base) averaging about 10 to the centimetre, thinly haired, dull brownish, little lighter below. Mammæ, as usual in this group, 2—3=10.

Skull of somewhat the peculiar short broad shape of that of *M. tunneyi*, to which there is no doubt the species is most nearly allied, but its characters are not so extreme. Its bullæ, although much larger than those of *M. assimilis*, *greyi*, and *terræ-reginæ*, are not so large as those of *M. tunneyi*, and the molars not quite so broad. The interorbital region is narrower, and not so heavily ridged.

Dimensions of the type (measured in the flesh):—

Head and body 150 mm.; tail 135; hind foot 29; ear 17.

Skull—greatest length 35·5 mm.; basilar length 30; greatest breadth 19; length of nasals 12·2; interorbital breadth 4·8; palatilar length 16·7; diastema 9·7; palatal foramina 7·5; greatest diameter of bullæ 9; length of upper molar series 7·1.

* "*Hydromys lutrilla*, Macleay" Gould, Mamm. Austr. i. Introd. p. xxxvi, 1863.
† Ann. Sci. Nat. (2) viii. p. 372, 1837.

*Type.* Adult female from Beach Mount. B.M. No. 7.9.15.21. Original number 330. Collected 5th May, 1907.

This Rat would appear to be the commonest species of Central Queensland, and it is probable that some of the specimens that have been referred to *M. greyi*, *M. assimilis*, *M. terræ-reginæ*, and other species really belong to it. The types of all the latter are in the British Museum, and we have been able to assure ourselves of its distinctness from them.

Its only near relative as yet described is *M. tunneyi* of the Northern Territory, and from this it is distinguishable by its longer tail, rather smaller size, and smaller bullæ.

Among the series obtained by Mr. Stalker, there is a good deal of variation in the breadth of the teeth, the extremes being so far apart as to suggest specific distinctness. No external characters corresponding to the tooth differences can be found, however, and we prefer for the present to put the whole series under one heading.

11. Mus sp.

♀. 437.

An intermediate species not at present determinable.

12. Mus patrius, sp. n.

♂. 406, 411. ♀. 407, 408, 409, 410.
♂ & ♀ in spirit.

A Mouse of the *forresti-delicatulus* group, of about the size of *hermannsburgensis*.

Size medium within the group, decidedly larger than *M. delicatulus*. General colour above pale wood-brown, becoming slightly more buffy on the sides. Belly greyish white, fairly sharply defined, the bases of the hairs slaty, their tips white. Ears of medium size, practically naked, their few fine hairs buffy. Hands and feet white; sole-pads 6, rather larger and less sharply defined than in *M. delicatulus*, the sole between the pads naked. Tail slightly longer than head and body, finely haired, brown above, whitish on sides and below. Mammæ 0—2 = 4.

Skull in size and shape agreeing with that of *M. hermannsburgensis*, but the bullæ of the normal small size, those of Prof. Spencer's species being unusually large.

Molars with the laminæ obliquely twisted, as already described in *Mus forresti*, although not so much as in that species. A well-marked anterior supplementary cusp present on $m^1$.

Dimensions of the type (measured in the flesh):—

Head and body 65 mm. (range up to 70); tail 66 (range to 71); hind foot 18; ear 12.

Skull—greatest length 22·7 mm.; basilar length 17·2; nasals 8·2; interorbital breadth 3·2; breadth of brain-case 10·5; palatilar length 10·1; diastema 6; palatal foramina 4·2; length of upper molar series 4·2.

*Type.* Adult female. B.M. No. 7.8.9.44. Original number 408. Collected 27th July, 1907.

This species may be distinguished from *M. delicatulus* by its larger and from *M. forresti* by its smaller size, and from *M. hermannsburgensis* by its comparatively small bullæ. *M. novæ-hollandiæ* Waterh., which is somewhat similar externally, is not a member of this group, having normal molars without supplementary anterior cusps.

Mr. Stalker states that he dug these mice out of holes, in each of which he found one male and two females.

13. Mus musculus L.

A number of the introduced House-Mouse.

14. Macropus giganteus Zimm.

♂. 349, 353, 362, 376, 415, 471, 472. ♀. 279, 428.

15. Macropus robustus erubescens Sclat.

♂. 346, 369, 379, 403, 431. ♀. 338, 368, 390, 474, 488.

16. Macropus ualabatus ingrami, subsp. nov. (Plate XLII.)

♀. 425, 465, 468, 469. Inkerman.

Most nearly related to *M. u. apicalis* Günth., but smaller and much greyer in colour.

General colour of back light buffy grey, the buff colour becoming more dominant towards the posterior part of the body. Under surface of body grey, washed over with a rich tawny-buff tint. Head similar in colour to *M. u. apicalis*, but lighter in the light parts. Prominent light buff-coloured areas round the bases of the ears, continuous with the lateral face-stripes and practically meeting on the crown. Backs of ears black, with light margins. Forehead with an indistinct median black stripe. Fore limbs light buffy grey, the light-coloured shoulders contrasting strongly with the dark stripes behind them. Hands and feet black. Tail, for the greater part of its length black, basal part greyish and tip white.

Skull very much smaller than that of *M. u. apicalis*, and with a less elongated nasal region. Palate narrower and teeth smaller.

Dimensions of the type (measured in the flesh):—

Head and body 630 mm.; tail 640; hind foot 195; ear 78.

Skull—basal length 105 mm.; condylo-basal length 111; zygomatic breadth 60; nasals, length 48, greatest breadth 19·8, central breadth 12, constriction 17; palate length 66; diastema 23; tooth-row from $p^1$ to $m^3$ 36·5; length of secator ("$p^4$") 8·3; length of three anterior molariform teeth 21.

The skull of an old female with worn teeth has a basal length of 107 mm.

*Type.* Sub-adult female. B.M. No. 8.8.8.65. Original number 468. Collected 17th October, 1907.

This Wallaby would appear to be intermediate between the northern *M. u. apicalis* Günth. from Cape Grafton, and the southern *M. ualabatus* of New South Wales and Victoria, but is paler and smaller than either.

We have named this handsome animal in honour of Sir William Ingram, to whose initiative and generosity the acquisition of the collection is due.

17. Macropus parryi Benn.

♂. 285, 334, 341, 388, 389, 395, 470, 478.
♀. 370, 399, 477, 480.

18. Macropus agilis Gould.

♂. 270, 271, 274, 290, 292, 293, 294, 392, 421, 429, 508, 511.
♀. 280, 291, 346, 372, 380, 418, 424.
♀. 512. Mt. Elliot, near Townsville.

19. Petrogale assimilis Ramsay.

♂. 275, 282, 286, 335, 373, 430, 473, 482.
♀. 272, 281, 287, 307, 310, 333, 336, 385, 455, 456, 466, 483 484.

This series of skins indicates that *P. assimilis* of Ramsay* should be recognised as distinct from *P. penicillata* Gray, with which it was doubtfully united by Thomas †, who had at that date no specimens of it for examination.

20. Lagorchestes conspicillatus pallidior, subsp. nov.

♂. 416. ♀. 413, 432.

Most nearly allied to *L. c. leichardti* Gould, but differing in being much lighter in colour. The general tawny colour of the upper surface of *L. c. leichardti* is represented by a light fawn-colour, the difference being very evident on the sides and posterior half of the back.

Collett has already pointed out ‡ the existence of these light-coloured Queensland specimens, and it would appear, taking into consideration the type locality of *L. c. leichardti* §, that this Eastern form is deserving of subspecific rank.

Dimensions of the type (measured in the flesh):—

Head and body 470 mm.; tail 450; hind foot 156; ear 50.

Skull—basal length 70 mm.; zygomatic breadth 47·5; nasals, length 28, greatest breadth 17, least breadth 13, constriction breadth 13·4; palate, length 44·7, breadth outside $m^1$ 24·2, breadth inside $m^1$ 15; palatal foramen 5·2; diastema 9; length of upper cheek-teeth 28.

*Type.* Adult female. B.M. No. 8.8.8.104. Original number 413. Collected 30th July, 1907.

* Ramsay, Proc. Linn. Soc. N.S.W. i. 1876, p. 360; ii. 1877, p. 11.
† Cat. Mars. B. M. p. 67, 1888.
‡ Zool. Jahrb. ii. p. 889, 1887.
§ The type locality of *L. c. leichardti* is the "country between Port Essington and the Gulf of Carpentaria."

21. Æpyprymnus rufescens Gray.

♂. 510. Elliot R., Townsville.

22. Trichosurus vulpecula Kerr.

♂. 253, 256, 258, 264, 350, 358, 375, 387. ♀. 268, 277, 401, 436.

♂. 476. Mt. Abbot.

Some of these specimens exhibit a distinct tawny coloration, such as is found to a greater degree in the more northern form described by Ramsay from the Bellender Ker Mts., N. Queensland, under the name of *Phalangista johnstonii* *.

23. Phascolarctus cinereus Goldf.

Skull (♀).

Mr. Stalker informs us that this is the most northern point at which the Koala occurs.

24. Isoodon torosus Rams.

♂. 280, 318, 397, 404, 405, 412, 437. ♀. 331, 345, 382, 439. One female in spirit.

These specimens show that Ramsay's *Perameles torosus* †, described from Rockingham Bay, N. Queensland, should stand as a species distinct from *I. macrourus* Gould, with which it was united in the Catalogue of Marsupials.

All of them are much larger and more heavily built than the type of *I. macrourus*, a character that is very evident in the size of the skulls. The following are the average skull dimensions of 6 adult males, compared with the type skull, which is also that of an adult male.

| | *I. torosus.* | *I. macrourus.* |
|---|---|---|
| Greatest length | 88 mm. | 75·5 mm. |
| Zygomatic breadth | 40 | 37 |
| Length of upper tooth-row from $i^1$ to $m^3$ | 47 | 43 |

25. Dasyurus hallucatus Gould.

♂. 328, 348, 371, 384. ♀. 317, 332, and 7.9.15.36.

♂. 485. Mt. Abbot.

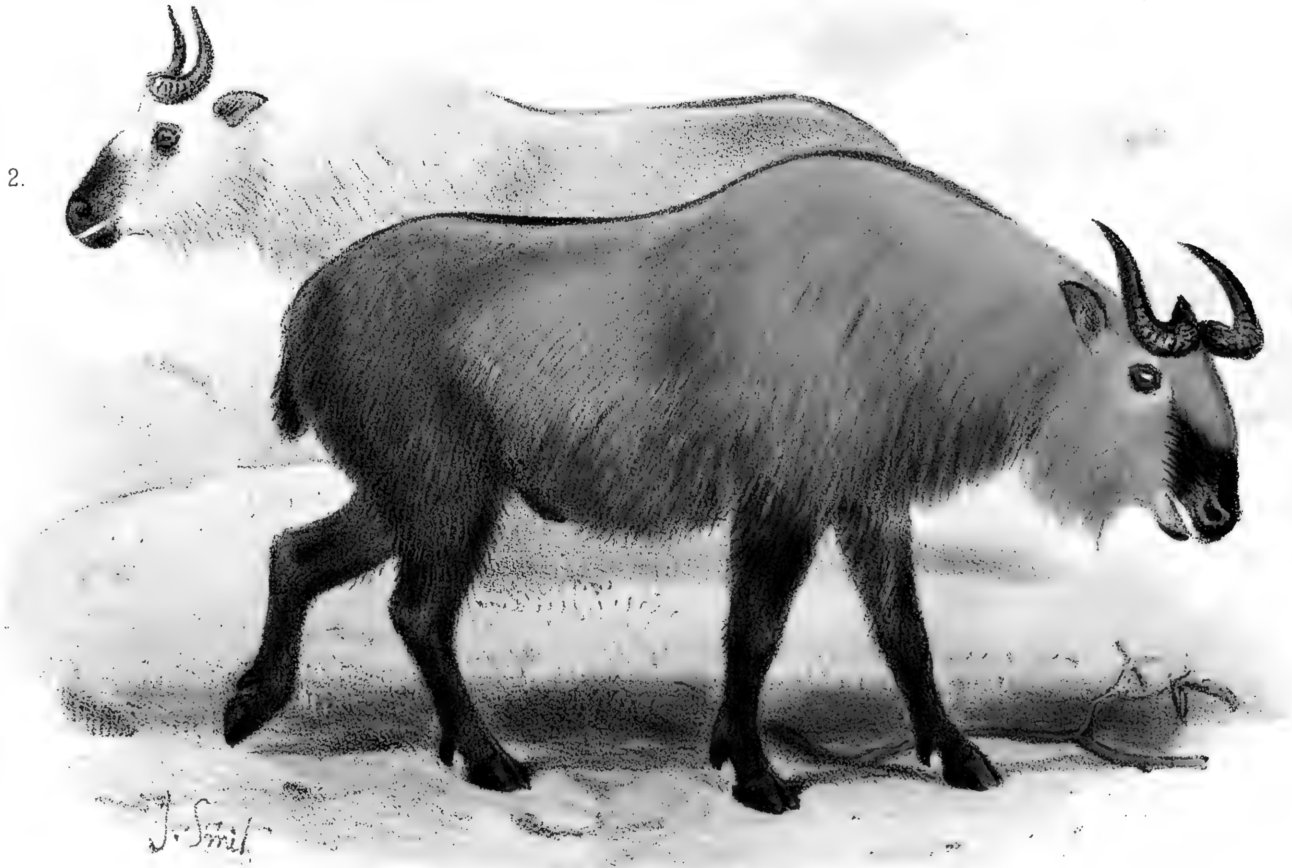
In No. 7.9.15.36 the posterior half of the body is wholly devoid of the characteristic white spots.

26. Tachyglossus aculeatus Shaw.

♂. 359. ♀. 273, 374.

Represents Collett's *Echidna acanthion*, described from west of Rockhampton.

* Proc. Linn. Soc. N.S.W. 2nd ser. iii. p. 1297, 1888.
† Proc. Linn. Soc. N.S.W. ii. p. 12, 1877.




West, Newman imp.

THE CHINESE TAKIN.
(*Budorcas tibetanus*) 1.♂, 2.♀.

## 3. The Sze-chuen and Bhutan Takins. By R. Lydekker.

[Received September 2, 1908.]

(Plate XLIII.* and Text-figures 168–171.)

The first recognition of a Takin distinct from the typical *Budorcas taxicolor* of the Mishmi Hills is due to the late Professor A. Milne-Edwards, who in 1874 ('Recherches pour servir à l'Histoire naturelle des Mammifères,' p. 367, pls. lxxiv. & lxxix.†) described and figured a representative of the species from Moupin under the name of *Budorcas taxicolor*, var. *tibetanus*. Here I may take the opportunity of mentioning that Moupin is stated in all zoological works that have come under my notice to be in Eastern Tibet. As a matter of fact, it is, as pointed out to me by my friend Mr. Thomas, situated in Sze-chuen; a circumstance which clears up a number of difficulties and misconceptions with regard to the range of the animals of this part of Central Asia. The name *Budorcas sinensis* has been applied to the Takin of Kansu, which, as shown by a specimen in the Tring Museum, is inseparable from the Sze-chuen animal; the authority for the name I am, however, unable to find.

Milne-Edwards described the male of the Sze-chuen Takin as a yellowish-red animal; and also stated that the female is paler and greyer. Neither his description nor his plate of the male is, however, satisfactory; and as mounted specimens of both male and female are now exhibited in the public galleries of the British Museum (Natural History), I consider that they should be figured before their colouring is deteriorated by exposure.

The male specimen (Plate XLIII. fig. 1), which was stated to come from Sze-chuen, was purchased by the Trustees of the British Museum from Rowland Ward Ltd. in 1905. The female (Plate XLIII. fig. 2), on the other hand, was given by Mr. Mason Mitchell, of the American Consular Service in Sze-chuen, to Mr. Rowland Ward in 1908, by whom it was, in turn, presented to the British Museum. In noticing the presentation of the latter specimen in the 'Field' newspaper (vol. cxi. p. 790, 1908), I stated that the presumption was that it represented the cow of the race described by Milne-Edwards. The original sender of the specimen stated, however, in a letter to Mr. Ward that there are two distinct kinds of Takin in Sze-chuen, differing not only in colour, but also in size and in habits; the smaller red kind—known to the Chinese as *yea-nu* (wild ox)—associating in small herds, while the larger grey one—the *tunu-yea* (big wild ox) of the Chinese—goes about singly, or at most in pairs. I accordingly suggested that if this statement were borne out by the facts, the larger grey race might be named *Budorcas taxicolor mitchelli*.

When, however, the grey female was mounted and placed

* For explanation of the Plate see p. 802.

† The work was published in parts from 1868 to 1874; as I do not know the dates of publication of the separate parts, I have given the date of completion of the work.

beside the yellow male (with which it is approximately equal in size, although its horns are considerably smaller), I could not entertain any doubt as to the two representing the different sexes of one and the same animal. Whatever, therefore, may be the truth with regard to the Chinese story, I cannot but regard the two specimens in the Museum as severally representing the male and female of the *Budorcas taxicolor* var. *tibetanus* of Milne-Edwards. Both specimens are subadult animals.

Text-fig. 168.

Imperfect skull and horns of adult male of the Mishmi Takin.

The distinctive characteristics of the Mishmi and the Sze-chuen Takins (which I now consider worthy of specific separation) will perhaps be made most readily apparent by the following comparison:—

1. Budorcas taxicolor.—Size large, although precise shoulder-

height not ascertainable, owing to the bad mounting of the British Museum specimen. General colour (apparently in both sexes) of upper-parts cigar-brown, with an elongated tawny "saddle" on the back, becoming much darker on the under-parts, and passing into deep blackish brown on the limbs; the ears and the whole of the head in advance of the same, together with the entire under surface of the lower jaw, and a dorsal stripe extending from the occiput to the root of the tail, black. No distinct beard in male; and tail apparently not distinctly tufted, and brown in colour.

Horns (text-fig. 168) stout, elevated into a strong, oblique, prominent, longitudinal ridge at the base, with the long smooth tips situated in a plane different from that of the basal portion, and generally directed (when fully adult) almost straight upwards, but inclining somewhat backwards at the extreme tips.

2. BUDORCAS TIBETANUS.—Size probably equal to that of the last; height at shoulder of subadult male $40\frac{1}{2}$ inches. General colour of upper-parts of subadult animals in winter coat orange or grey, strikingly different in the two sexes; dorsal stripe not extending further forwards than the withers; under-parts lighter than back; black on head confined to the backs of the ears, a ring round each eye, the front of the face in advance of the eyes, and the extreme tip of the inferior surface of the lower jaw, thus forming a striking contrast to the light area. A distinct beard on the throat of the male; tail strongly tufted, and blackish in colour.

Horns (text-fig. 169, p. 798) more slender than in *taxicolor*, with much less development of the oblique basal prominence, and the long tips in the same plane as the basal portion; these tips inclining somewhat inwards and also decidedly backwards throughout their length.

In the male, the whole of the fore-quarters, exclusive of the black areas, bright golden-yellow, gradually becoming more and more grey posteriorly till it passes on the hind-quarters into grizzled grey, which is continued on to the limbs, and also forms a vertically elongated patch on the lower part of the shoulder. Dorsal stripe extending as far forwards as the withers.

In the female (which, as in the type species, has much smaller horns) the yellow on the fore-quarters of the male replaced by dirty white; and the limbs a darker grey, becoming nearly black on the knees and hocks. Dorsal stripe not extending further forwards than the middle of the back.

These differences are, in my opinion, amply sufficient to justify the recognition of the Sze-chuen Takin as a species distinct from the typical Mishmi animal and its smaller Bhutan representative. With its bright golden-yellow or white fore-quarters, contrasting strongly with its black face, ears, and eye-rings, the former is indeed a much more strikingly coloured animal than the latter,—a feature in which it agrees with several of the other Sze-chuen mammals.

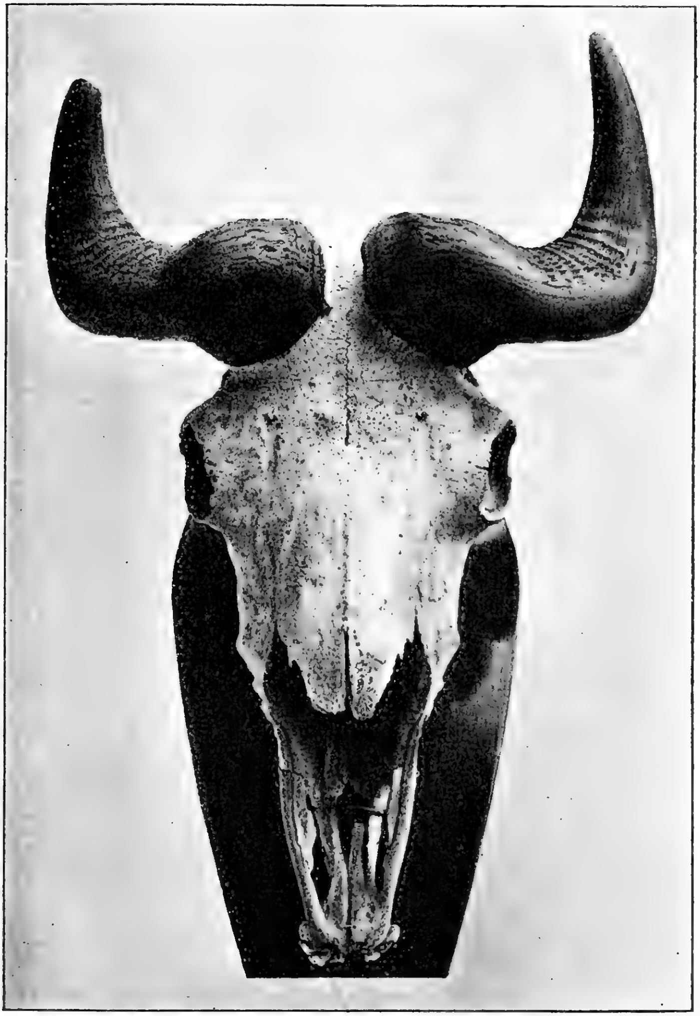
My only doubt is whether the name *tibetanus*, as being somewhat misleading, ought not to give place to *sinensis*. On the other hand, it is possible that the species may cross the border dividing Sze-chuen from Tibet.

Text-fig. 169.

Skull and horns of old male of the Sze-chuen Takin, collected by Mr. J. W. Brooke

Coming to the Bhutan Takin, which I described in the 'Field' for 1907 (vol. cx. p. 887) as a small local race of the typical species under the name of *Budorcas taxicolor whitei*, giving also a preliminary notice in the Society's 'Proceedings' for the same year (p. 749), I regret to say that the two skins there referred to as being in the possession of the Hon. Walter Rothschild have

Text-fig. 170.



Skull and horns of old male of the Bhutan Takin.

gone elsewhere than to the Tring Museum, and are therefore unavailable for fuller description and figuring. I must therefore rely mainly on the two pairs of horns (those of an old bull and of a subadult female) presented to the British Museum by Mr. J. Claude White, C.M.Z.S., British Commissioner in Sikhim, which form the type of this race.

Before proceeding further, it may, however, be well to mention that the Bhutan Takin, which lives high up on the mountains on the open zone between the upper limit of forest and the snow-line, is completely cut off by deep river-gorges from the habitat of its Mishmi representatative. On this ground alone it, therefore, undoubtedly belongs to a separate race.

As to the height attained by this race, I cannot, in the absence of a mounted skin, give even an approximate estimate; but I believe it to be somewhat smaller than the typical *Budorcas taxicolor*, although its chief claim to distinction rests on the relatively small size of its horns.

The type horns of the old bull are somewhat worn at their tips, as they also are at the base, where the rugosities have in consequence disappeared. When entire, they would probably have measured about 15 or 16 inches in length along the front curve, as against from 20 to 24 inches in adult bulls of the Mishmi Takin. The horns of a younger bull, associated with one of the skins referred to above, measured 13 inches, against 18 inches in horns of a Mishmi bull of about the same age. Horns of cows are much smaller. Similar characters are shown by the horns of the skull here figured (text-fig. 170, p. 799), which was sent to the Museum by Mr. White.

I have been hitherto unable to institute an exact comparison between the skins of the Mishmi and the Bhutan Takin, but I think the latter has a somewhat smaller lighter dorsal saddle than the former. Both agree in their general dark colour, and in the under-parts being darker than the back, as well as in the large extent of black on the head, and the extension of the dorsal stripe to the occiput.

In this place it may be mentioned that the skull of a large ruminant from the Pliocene of the Siwalik Hills, N.E. India, described by the late Professor L. Rütimeyer (by whom it was regarded as probably indicating a hornless species) as *Bucapra daviesi*, appears to represent an animal nearly related to the Takin. Certain details in the form of the skull, as well as of the teeth, seem, however, to indicate the generic distinctness of *Bucapra* from *Budorcas*. I have little doubt that, when entire, the Siwalik skull carried horn-cores of a type approximating more or less closely to those of the Takin.

---

Since the above was written the Museum has received from Mr. J. W. Brooke, skins, skeletons, and skulls of Takin of both sexes and of several ages from Sze-chuen, where the animals were killed in rhododendron and bamboo jungle at an elevation of about 10,000 feet. The skulls and skins include those of a fully adult bull and cow; the bull is larger and darker than the figured specimen. The skull represented in text-fig. 169 (p. 798) belongs to the bull obtained by Mr. Brooke.

Special interest attaches to the skull of a very young Takin (text-fig. 171), with the three pairs of milk-molars just about to cut the gum, and no traces of horns whatever. Unfortunately no skulls of Serow or Musk-Ox of corresponding age are available for comparison, so that it is impossible at present to get much further in the matter of the Takin's relationships.

Text-fig. 171.

Skull of very young Sze-chuen Takin, collected by Mr. Brooke.

Compared with that of a somewhat older Serow, in which horns are developed and the first true molars in use, the skull of the baby Takin is mainly distinguished by the great elevation of the frontal region, and the shortness and breadth of the nasal bones,—characters which become greatly exaggerated in the adult. The premaxillæ are still more widely sundered from the nasals than is the case in Serows; and above the supraoccipital, wedged in between the hind portions of the parietals, is a large undivided interparietal, which I believe to be represented in the Serow skull. Allowing for the greater breadth of that of the Takin, the two skulls seem in other respects to present a great general similarity.

[*Addendum.*—Since the paper was read I have received a letter from Mr. Brooke, in which it is stated that old males of the Sze-chuen Takin grow to a very large size, as, indeed, is indicated by the skin and skull sent to the Museum. Also, that in summer the long and rough orange or reddish coat is replaced by one of short greyish hair.]

EXPLANATION OF PLATE XLIII.

Subadult male (1) and female (2) of the Sze-chuen Takin (*Budorcas tibetanus*), in winter coat, from the mounted specimens in the British Museum.

## 4. On an Indian Dolphin and Porpoise. By R. Lydekker.

[Received September 2, 1908.]

(Plates XLIV. & XLV.*)

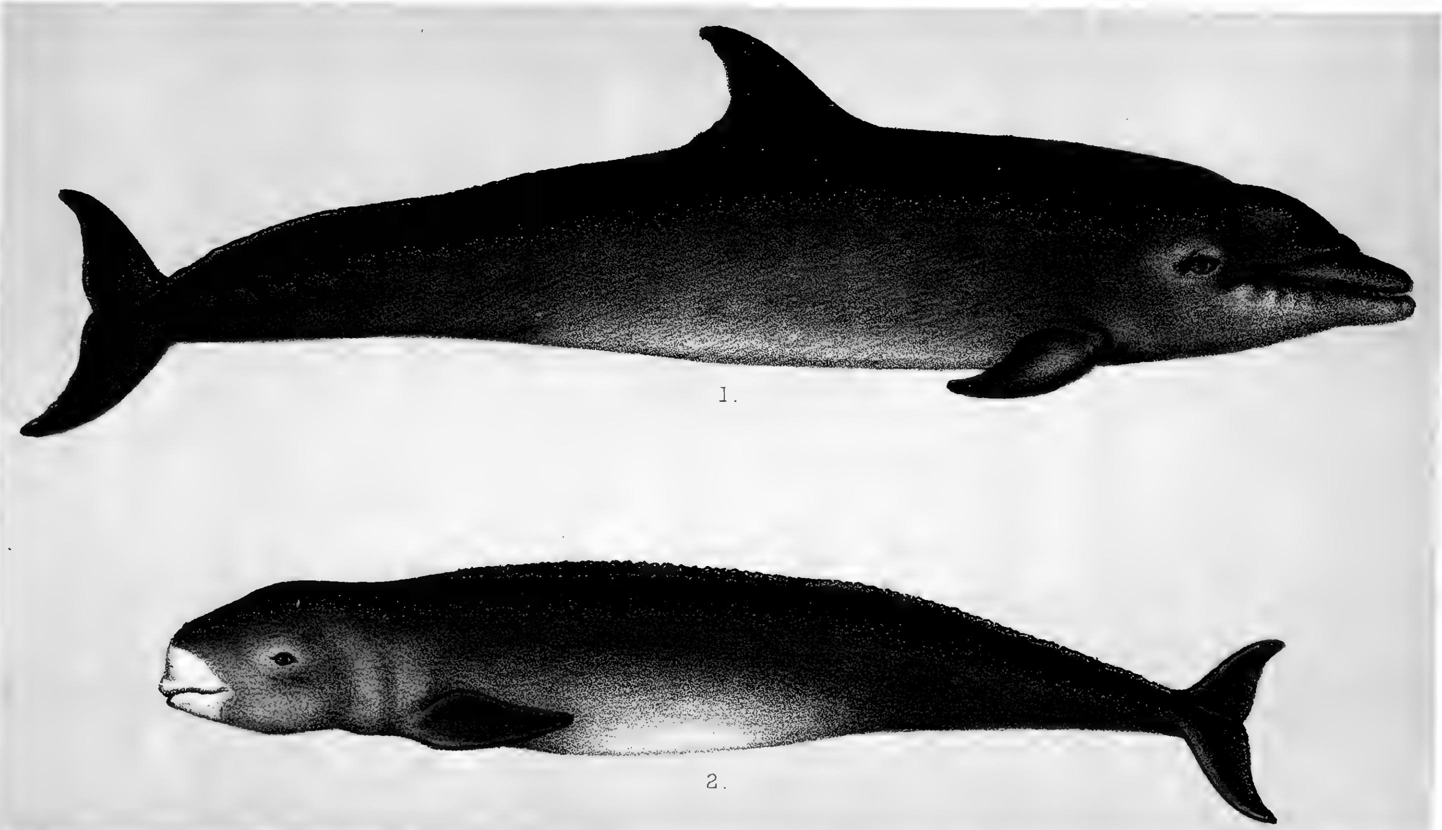
Once more I am indebted to the Director—Lieut.-Colonel F. W. Dawson—of the Trevandrum Museum for sketches and measurements of certain Cetaceans recently captured on the Travancore coast. These are represented by three specimens, referable to two species; they differ to a greater or less degree from the typical forms of all the Dolphins and Porpoises hitherto described from Indian waters, and from the world generally. The most remarkable fact about the new specimens is that two of them are Bottle-nosed Dolphins, referable to *Tursiops*, of which genus, in addition to the typical *T. tursio*, I have already recognised (Proc. Zool. Soc. 1905, vol. i. pp. 125–128) three, if not indeed four, Indian species.

Col. Dawson informs me that the two examples of this apparently new Bottle-nose were caught by fishermen about six miles to the north of Trevandrum, in the spring of the present year (1908). The skeletons of both were preserved; and one of these has, at my request, been presented by Col. Dawson to the British Museum, as it seemed desirable that an apparently new form should be represented in the chief English collection.

The following particulars concerning these two specimens (*A* and *B*) have been supplied to me from Trevandrum:—

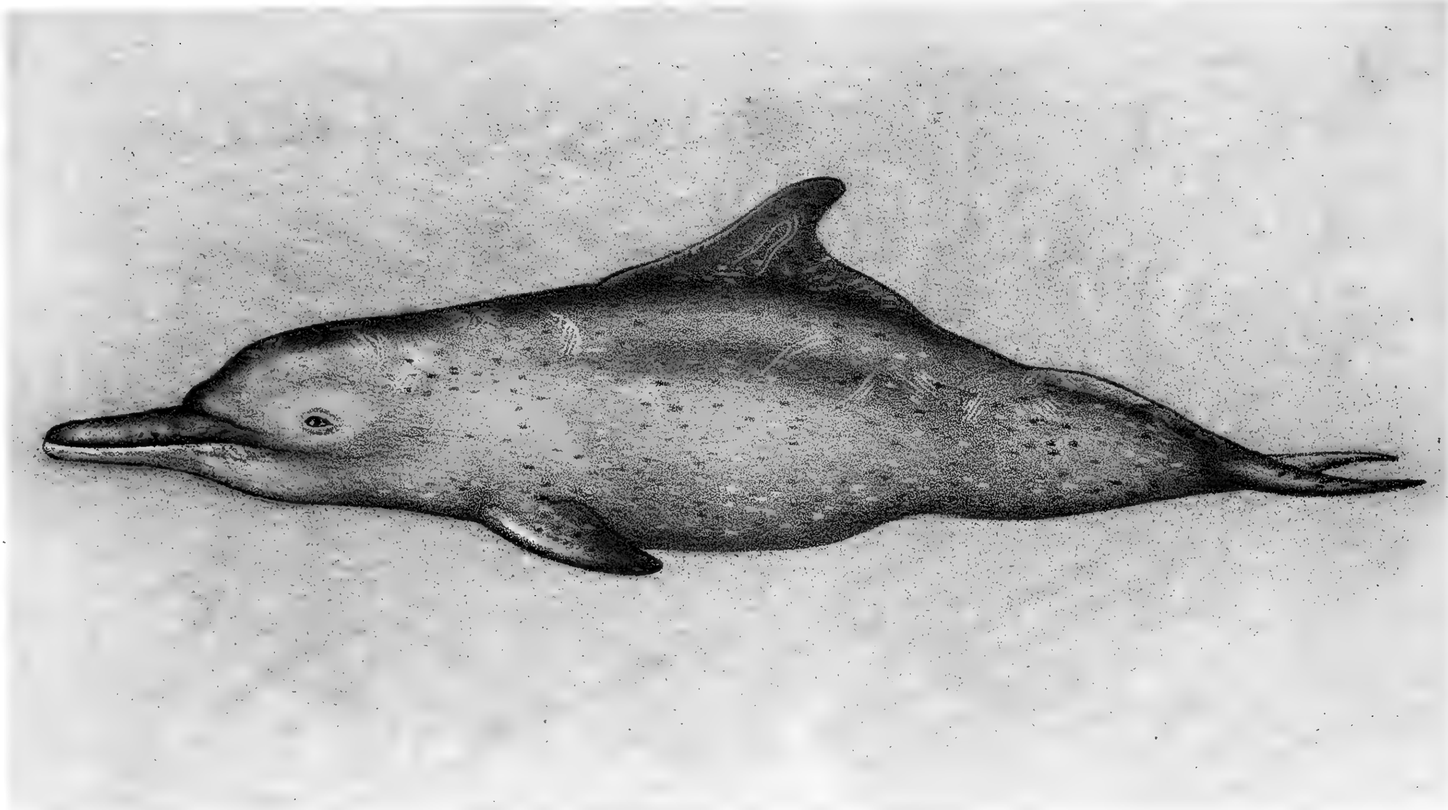
| | *A.* | | *B.* | |
|---|---|---|---|---|
| | ft. | in. | ft. | in. |
| Length from tip of snout to cleft in flukes ... | 9 | 0 | 9 | 4 |
| Do. to origin of dorsal fin ...................... | 4 | 0 | 4 | 2 |
| ,, flipper ...................... | 2 | 0 | 1 | 1 |
| ,, genital groove ...................... | 5 | 6 | 5 | 7 |
| ,, anal groove ...................... | 6 | 6 | 6 | 7 |
| Length of dorsal fin ...................... | 1 | 6 | 1 | 7½ |
| ,, flukes ...................... | 1 | 7 | 1 | 7 |
| Expanse of flukes ...................... | 2 | 1 | 2 | 6 |

* For explanation of the Plates see p. 808.




Pitcher Ltd. Lith.

1. TURSIOPS DAWSONI. 2. NEOPHOCÆNA SP.



SOTALIA LENTIGINOSA.

| | A. | | B. | |
|---|---|---|---|---|
| | ft. | in. | ft. | in. |
| Length of beak from groove which separates the forehead | | $4\frac{1}{2}$ | | 5 |
| Length of genital groove | | 7 | | 8 |
| ,, anal groove | | 2 | | 3 |
| Gape of mouth | 1 | 4 | 1 | 5 |
| Greatest breadth of body | 1 | 6 | 1 | 8 |
| ,, height of body | 1 | 6 | 1 | 8 |
| ,, circumference in front of dorsal fin | 3 | 10 | 4 | 0 |
| Smallest circumference at root of tail | | $1\frac{1}{4}$ | | $1\frac{3}{4}$ |
| Height of dorsal fin | 2 | $2\frac{1}{2}$ | 2 | 3 |
| Length from snout to blow-hole | 1 | 0 | 1 | 3 |

As regards shape, the body is rather elongate, with a prominent ridge extending from the back of the dorsal fin to the middle of the flukes. Both the flippers and the dorsal fin are distinctly falcate. The eyelids are well developed and somewhat mobile; while the blow-hole is, as usual, placed somewhat to the left of the middle line. In front of the blow-hole is a fatty cushion, marked off from the moderately tapering beak by an ill-defined **V**-shaped groove. The lower jaw projects somewhat in advance of its fellow.

The colour of the two specimens is described as follows :—

*A.*—Upper-parts deep glistening black, becoming somewhat lighter below, with a pinkish tinge round the anal and genital apertures; under side of lower jaw and muzzle dull white.

*B.*—Above deep glistening plumbeous black, abruptly passing into pale slaty on the sides; genital and anal regions lighter; lips dull white.

The teeth, which are relatively large, with rugose crowns, number:

$$\frac{25}{24} \text{ and } \frac{26}{25} = 49 \text{ and } 51 \text{ in } A, \quad \text{and}$$

$$\frac{25}{22} \text{ and } \frac{25}{22} = 47 \text{ in } B.$$

The vertebræ, of which the first two are in each case fused together, number:

C. 7, D. 12, L. 20, Ca. 25 = 64 in *A*, and

C. 7, D. 12, L. 17, Ca. 28 = 64 in *B*.

The first four pairs of ribs are two-headed.

The pterygoids are in contact, and the mandibular symphysis is short.

The phalanges number:

I. 2, II. 9, III. 7, IV. 3, V. 2 in *A*, and

I. 3, II, 9, III. 7, IV. 3, V. 2 in *B*.

Both specimens evidently belong to the same species, and from the general contour of the head, body, fin, and flippers, coupled with the number of vertebræ and teeth, the large size of the latter, the presence of four pairs of double-headed ribs, and the approximation of the pterygoids, there can be little hesitation in referring that species to the genus *Tursiops*.

As regards comparison, I think it will simplify matters to reproduce, with some slight modification, the synopsis of the species of the genus given in my above-mentioned paper in the Society's 'Proceedings' for 1905:—

1. *Tursiops tursio*.

   Type specimen: Teeth $\frac{22}{22} = 44$.
   Vertebræ: C. 7, D. 13, L. 17, Ca. 27 = 64.
   Pterygoids in contact.

2. *Tursiops abusalam*.

   Type specimen: Teeth $\frac{26}{26} = 52$.
   Vertebræ: C. 7, D 12, L. 16, Ca. 26 = 61.
   Pterygoids (?) in contact.

   Indian specimen: Teeth $\frac{27}{27}$ and $\frac{27}{26}$ = 54 and 53.
   Vertebræ: C. 7, D. 13, L. 15, Ca. 25 = 60.
   Pterygoids divergent.

3. *Tursiops catalania*.

   Type specimen: Teeth $\frac{25}{25} = 50$.
   Vertebræ: C. 7, D. 12, L. 15, Ca. 24 = 58.
   Pterygoids divergent (?).

   Indian specimen*: Teeth $\frac{25}{25}$ and $\frac{26}{25}$ = 50 and 51.
   Vertebræ: C. 7, D. 13, L. 17, Ca. 24 = 61.
   Pterygoids divergent.

4. *Tursiops parvimanus*.

   Teeth $\frac{25}{24} = 49$.
   Vertebræ = 62.

5. *Tursiops gilli*.

   Type specimen: Teeth $\frac{22}{22}$ and $\frac{23}{22}$ = 44 and 45.
   Vertebræ (?).

   Indian specimen: Teeth $\frac{27}{28}$ and $\frac{26}{27}$ = 55 and 53, or (in young) $\frac{24}{25}$ and $\frac{24}{26}$ = 49 and 50.
   Vertebræ: C. 7, D. 12, L. 16, Ca. 23 = 58.
   Pterygoids divergent.

If the foregoing identifications be correct, we shall have the

* *Tursiops fergusoni*, Lydekker.

following external characters of the four definable species of *Tursiops* included in the above list :—

1. *Tursiops tursio*. European Seas.
   Size large: 9 ft. 6 in.
   Upper surface blackish.
   Under-parts white and unspotted.

2. *Tursiops abusalam*. Red Sea and Indian Ocean.
   Size smaller: 7 ft. $2\frac{1}{2}$ in. (type), 6 ft. 11 in. (India).
   Upper surface dark greenish.
   Under-parts whitish and spotted with green in adult; whitish in young.

3. *Tursiops catalania*. N. Australia to Indian Ocean.
   Syn. (?) *T. fergusoni*.
   Size about the same as last: 7 ft. 8 in. (type), 7 ft. $4\frac{1}{2}$ in. (India).
   Upper surface dark slate.
   Under-parts yellowish *, flecked with lead-colour.

4. *Tursiops gilli*. N. Pacific to Indian Ocean.
   Size, Indian specimen, 6 ft. 8 in.
   Whole surface blackish, tending to lighten slightly on the under-parts, with a tinge of reddish in Indian specimens.

In addition to the above, Mr. F. Lahille † has described (without reference to my paper) a Bottle-nosed Dolphin from the La Plata estuary under the name of *Tursiops gephyreus*, of which the leading characteristics are as follows :—

Teeth $\frac{23}{22} = 45$.
Vertebræ: C. 7, D. 13, L. 17, Ca. 24 = 61.
Pterygoids divergent.
Phalanges: I. 1, II. 7, III. 6, IV. 2, V. 1.
Size, large, about 7 ft. 2 inches (276 cm.).
General colour leaden grey, becoming somewhat lighter on the under-parts; three or four reddish circles on the sides in advance of the vent.

Mr. Lahille considers his Bottle-nose as nearly allied to *T. catalania*, of which it may indeed be only a large race. In addition to its size and colouring, and slight differences in the number of the teeth and vertebræ, it is distinguished by its narrower beak and præmaxillæ and much broader temporal region.

That the new Indian Bottle-nose (Pl. XLIV. fig. 1) is quite distinct from *T. tursio*, *T. catalania*, and *T. abusalam*, in all of which the under-parts are light-coloured, is certain. In general colour it agrees much more closely with the Travancore specimen

* In the type the under-parts are described as whitish; if the orange tint of the Trevandrum specimens is a specific character, then the name *T. fergusoni* will be available for the Indian form.

† An. Mus. Nac. Buenos Aires, ser. 3, vol. ix. p. 347, 1908.

provisionally referred to *T. gilli* (Proc. Zool. Soc. 1905, vol. i. pl. xiii. fig. 1), but the under-parts are lighter, and there appear to be slight differences in the form of the beak and dorsal fin. These might be considered individual variations; but the difference in the number of the vertebræ is so great, while the relations of the pterygoids are also different, that I cannot refer the two specimens to the same species. From *T. gephyreus* the Travancore Bottle-nose differs, among other features, conspicuously in regard to the number of joints in the flippers. There accordingly seems no other course but to regard the new Trevandrum Bottle-nose as an undescribed species—a view in which I am supported by the taxidermist at the Trevandrum Museum, who has had under his hands all the Travancore Cetaceans described by myself. I therefore propose the name *Tursiops dawsoni* for the new specimens, taking the skeleton in the British Museum as the type.

The second species to which I have to refer on the present occasion is a representative of the Finless Porpoises, *Neophocæna* (*Neomeris*), taken by fishermen off Trevandrum in June last and purchased by the local museum. While agreeing in all general respects with the typical *Neophocæna phocænoides*, this specimen (Pl. XLIV. fig. 2) differs by the circumstance that the purplish-red patches on the lips and throat are replaced by pale grey areas of corresponding shape; while there are likewise numerous irregularly disposed, narrow, lead-coloured streaks on the under surface of the lower jaw, not noticed in descriptions of the ordinary form. The general colour is uniform dark plumbeous, becoming gradually paler on the flanks and under-parts. The teeth are $\frac{20}{19}$ and $\frac{21}{20}$ = 39 and 41. The vertebræ number C. 7, D. 14, L. 12, Ca. 26 = 59; and of the fourteen pairs of ribs, seven are double-headed.

Since *Neophocæna phocænoides* is generally described as having about $\frac{18}{18}$ (= 36) teeth, while its vertebral formula is given as C. 7, D. 12, 13, L.+Ca. 38–43 = 57, 58, or (maximum) 63, nothing of any decisive importance can be inferred in these respects with regard to the new specimen, which, for the present, at any rate, I prefer to leave unnamed.

It may be useful to publish the following dimensions of this specimen, as supplied from Trevandrum:—

| | ft. | in. |
|---|---|---|
| Length from tip of snout to notch in the tail | 3 | 9 |
| Do. to origin of flipper, right side | | 11 |
| ,, ,, ,, left side | | $10\frac{1}{2}$ |
| ,, genitals | 2 | 4 |
| ,, anal opening | 2 | 6 |
| Length of flippers, right side | | $8\frac{1}{4}$ |
| ,, ,, left side | | 8 |
| Expanse of tail | 1 | 2 |
| Greatest circumference of body | 2 | 1 |
| Smallest ,, ,, at root of tail | | 6 |
| Genital groove | | 2 |

Mammary groove half-an-inch in length; situated on the posterior half on each side of the genital groove, which is placed on a ridge 6 inches long, marked off from the abdominal region and gradually widening towards the anal opening; ear-hole minute.

Since the foregoing was written I have received from the Director of the Trevandrum Museum a sketch and description of another Dolphin purchased from the local fishermen on the eleventh of August 1908.

Of this specimen (Pl. XLV.) the following particulars have been sent me :—

| | ft. | in. |
|---|---|---|
| Extreme length from tip of snout to notch on the tail-flukes | 7 | 2 |
| From tip of snout to the basal angle of the prenarial adipose elevation | | 8 |
| From tip of snout to angle of mouth | 1 | 3 |
| Do. to anterior angle of the eye | 1 | 3½ |
| ,, blow-hole | 1 | 4 |
| ,, flippers | 2 | 0 |
| ,, origin of dorsal fin | 2 | 10 |
| ,, anterior commissure of genital grove | 4 | 0 |
| ,, vent | 5 | 6 |
| Length of front margin of flipper along the curve | 1 | 2 |
| ,, ,, ,, dorsal fin ,, ,, | 1 | 7½ |
| Height of dorsal fin | | 8 |
| Greatest girth of body in front of dorsal fin | 4 | 3 |
| ,, ,, including dorsal fin | 5 | 2 |
| Smallest circumference at root of tail | 1 | 0 |
| Expanse of flukes | 2 | 1 |

Eye 1¼ in. longest diameter; ear vertically ovate, length 3 mm.; genital groove 8 in.; vent 2½ in. in diameter; between genital and anal openings 8 in.

A prenarial adipose elevation marked off from the tapering snout by a **U**-shaped, ill-defined groove. Body fusiform, much compressed towards the tail, the prominent backward extension of the dorsal fin gradually shelving off into the caudal ridge, which is continued along the corresponding line of the under surface. Flippers feebly falcate.

The colour is uniform pale plumbeous, washed with pale brown and becoming lighter towards the under side; the body being profusely flecked with long pear-shaped pale pinkish and dark plumbeous markings of varying sizes. Angle of mouth, margin of upper lip, and top of snout mottled with whitish; lower lip creamy white mottled with brown; belly mottled with white, less so on the pectoral region. There are also groups of milk-white parallel striations in different parts of the body and on the flippers and flukes.

Teeth $\frac{36}{36} \times \frac{36}{36} = 144$; moderate, conical, the tips curving inwards and enamelled, and the sides compressed with the base expanded. Pterygoids narrow, separated from each other in the middle line, with their inner border divergent posteriorly.

Palatines somewhat **W**-shaped, with the median suture extending nearly halfway between the widely separated pterygoids.

Ribs 12 pairs; six pairs double-headed.

Vertebræ: C. 7, D. 12, L. 9, Ca. 23 = 51. The first two cervical vertebræ are united, but the epiphyses are not fused with the centra of the vertebræ. Symphysis of the mandible one-third the length of the ramus.

Phalanges: I. 1, II. 7, III. 6, IV. 3, V. 2.

There can be no doubt from this description and the figure that this Dolphin is referable to the genus *Sotalia*, as redefined by myself in the 'Journal of the Bombay Natural History Society,' vol. xv. pp. 412 & 413, 1903 *. It is equally evident that it is identical with the Speckled Dolphin (*Sotalia lentiginosa* †); and this being so, it is apparent that the young Trevandrum Dolphin named and figured by myself in the paper just cited as *Sotalia fergusoni* (pl. D) cannot (as I suggested might prove to be the case) be separated from *S. lentiginosa*, the absence of spotting being a feature of immaturity.

The present specimen renders necessary the following slightly amended definition of *Sotalia*:—

Teeth medium, smooth, and numerous (26–35).
Pterygoids separate.
Palatines **W**-shaped, with a long symphysis below the pterygoids.
Vertebræ 49–55.

In *S. lentiginosa* the number of the teeth in the adult may now be given as $\frac{34}{34}-\frac{36}{36}$ = 68 or 72; and that of the vertebræ as C. 7, D. 11 or 12, L. 10 or 9, Ca. 21 or 23 = 49 or 51. At least this is, I think, the best way of harmonising the vertebral formula of the present specimen with that of the type of *S. fergusoni*.

## EXPLANATION OF THE PLATES.

### Plate XLIV.

Fig. 1. *Tursiops dawsoni.* $\frac{1}{16}$ nat. size.
Fig. 2. *Neophocæna* sp. About $\frac{1}{7}$ nat. size.

Both from the neighbourhood of Trevandrum.

### Plate XLV.

*Sotalia lentiginosa.*

From the neighbourhood of Trevandrum.

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* In the figure on p. 414 the lettering *pal.* and *pt.* should be transposed.
† = *Steno lentiginosus* Blanford.

November 17, 1908.

Prof. E. A. Minchin, 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 October 1908:—

The number of registered additions to the Society's Menagerie during the month of October was 131. Of these 38 were acquired by presentation, 5 by purchase, 83 were received on deposit, and 5 were born in the Gardens. The number of departures during the same period, by death and removals, was 186.

Among the additions special attention may be directed to:—

One Vicuna (*Lama vicugna*), from South America, presented by T. Rome, Esq., on October 16th.

A Collection of 26 Birds of Paradise, including 5 Count Raggi's Birds of Paradise (*Paradisea raggiana*), 7 Lawes' Birds of Paradise (*Parotia lawesi*), 10 Hunstein's Birds of Paradise (*Diphyllodes hunsteini*), 1 New Guinea Rifle-bird (*Ptilorhis intercedens*), 2 Violet Manucodes (*Phonygama purpureo-violacea*), and 1 Prince Rudolph's Bird of Paradise (*Paradisornis rudolphi*), never previously imported, from S.E. New Guinea, deposited by Sir William Ingram, Bt., F.Z.S., on October 5th.

A Collection of Mammals, Reptiles, and Birds, including a Black-and-White Sparrow-Hawk (*Accipiter melanoleucus*), from S. Nigeria, presented by Dr. W. F. Macfarlane, F.Z.S., on October 30th.

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Mr. E. E. Austen, F.Z.S., exhibited living specimens of a Fly, *Hermetia illucens* L., caught in Manchester and received from Dr. W. E. Hoyle. Since larvæ of this fly (a native of Tropical South America, Central America, and the West Indies, breeding in decaying vegetable matter) had previously been found in Liverpool in cargoes of raw rubber from the Amazons, it was thought that these specimens might possibly have been introduced into Manchester in a similar way.

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The Reports on the Ruwenzori Expedition Collections were communicated to the meeting, and will be published entire in the 'Transactions.'

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The following papers were read:—

# 1. Contributions to the Morphology of the Group Neritacea of Aspidobranch Gastropods.—Part I. The *Neritidæ*. By Prof. GILBERT C. BOURNE, D.Sc., F.Z.S.

[Received October 27, 1908.]

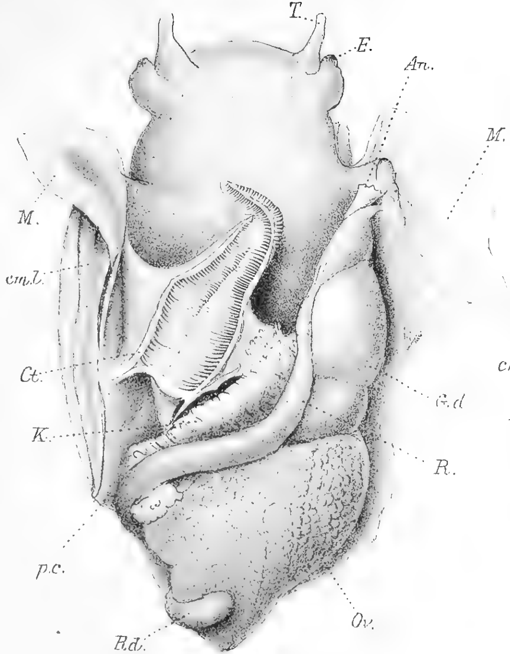
(Plates XLVI.–LXVI.* and Text-figure 172.)

While the Haliotidæ, Fissurellidæ, Pleurotomariidæ, Trochidæ, Patellidæ, and other members of the Aspidobranch Gastropoda have received a large amount of attention from morphologists, the Neritacea have, until recent years, attracted little interest. The anatomy of so familiar a species as the European *Neritina fluviatilis* was imperfectly known till the appearance of Lenssen's memoirs in 1899 (**25**) and 1903 (**26**). Thiele's (**39**) short but accurate descriptions of various organs of tropical species of Neritidæ have added largely to our knowledge of the group, but even when these are taken into consideration it can hardly be said that a sufficiently comprehensive comparative account of the Neritidæ exists in a form available for students of molluscan anatomy.

It has been too readily assumed that the Neritacea, forming, as they do, an extremely specialized section of the Rhipidoglossa, are unlikely to retain any considerable traces of primitive organization, or to yield evidence bearing on the ancestry of the Gastropoda. Thus Pelseneer (**30**) writes: "D'autre part les Néritacés sont plus spécialisés que tous les autres Rhipidoglosses (*Haliotis* etc.) ou la commissure viscérale est déjà croisée, par: 1°. L'existence d'une seule branchie et d'un seul osphradium. 2°. L'existence d'un seul rein. 3°. L'existence d'un orifice genital propre. 4°. L'existence d'yeux à cavité fermée. 5°. La séparation plus complète des ganglions pleuraux et pedieux." There is no doubt that the Neritacea are specialized in these respects, but this is no reason for regarding them as probably uninteresting subjects for anatomical study, for animals highly specialized in some respects may, nevertheless, retain many primitive features, and there are so many points in which the Neritacea seem to approximate to the Pectinibranchs, *e. g.* the existence of a single kidney with a slit-shaped opening into the mantle-cavity, the complex genital ducts with accessory glands, &c., that it has long been a matter of interest to determine whether they are intermediate between the less specialized Aspidobranchia and the Pectinibranchia, or whether their apparent resemblances to the latter group are due to convergence.

Finally, the Helicinidæ, interesting because they are terrestrial and pulmonate, have not been the subject of any comprehensive

* For explanation of the Plates see p. 884.

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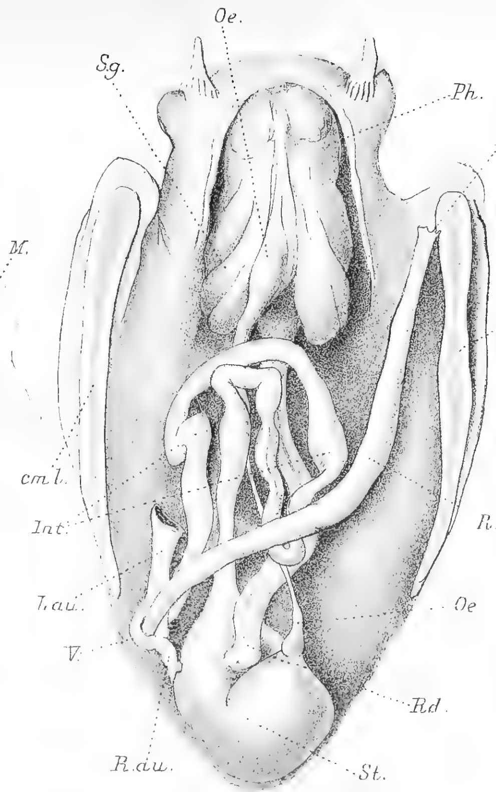


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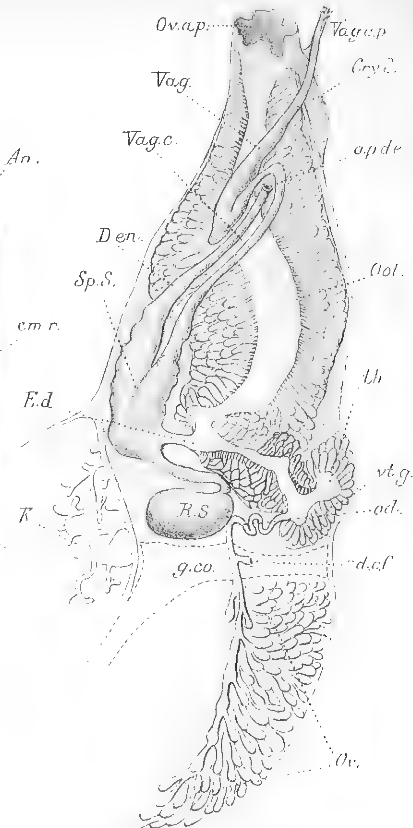
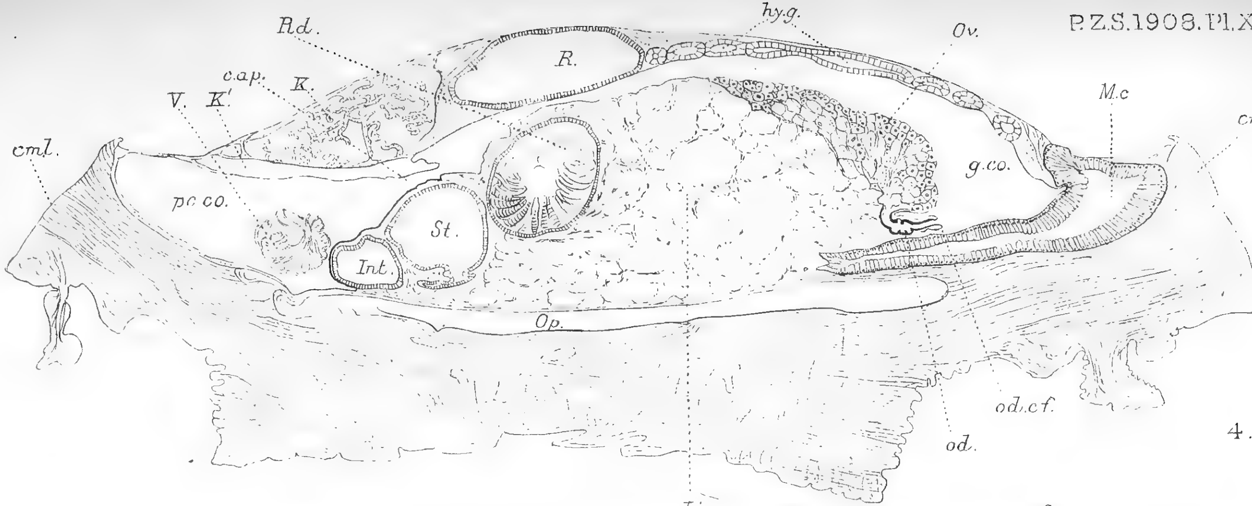



3.

G. C. Bourne del. Ruth London.

SEPTARIA BORBONICA.

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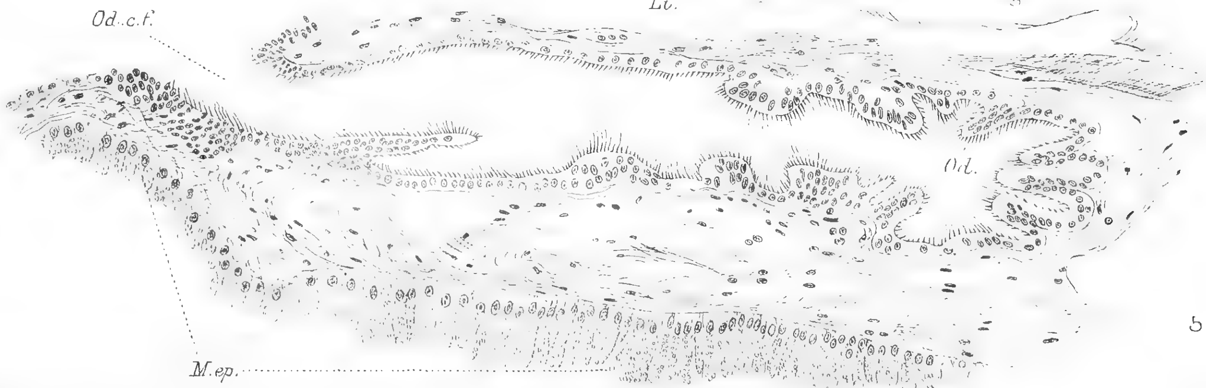
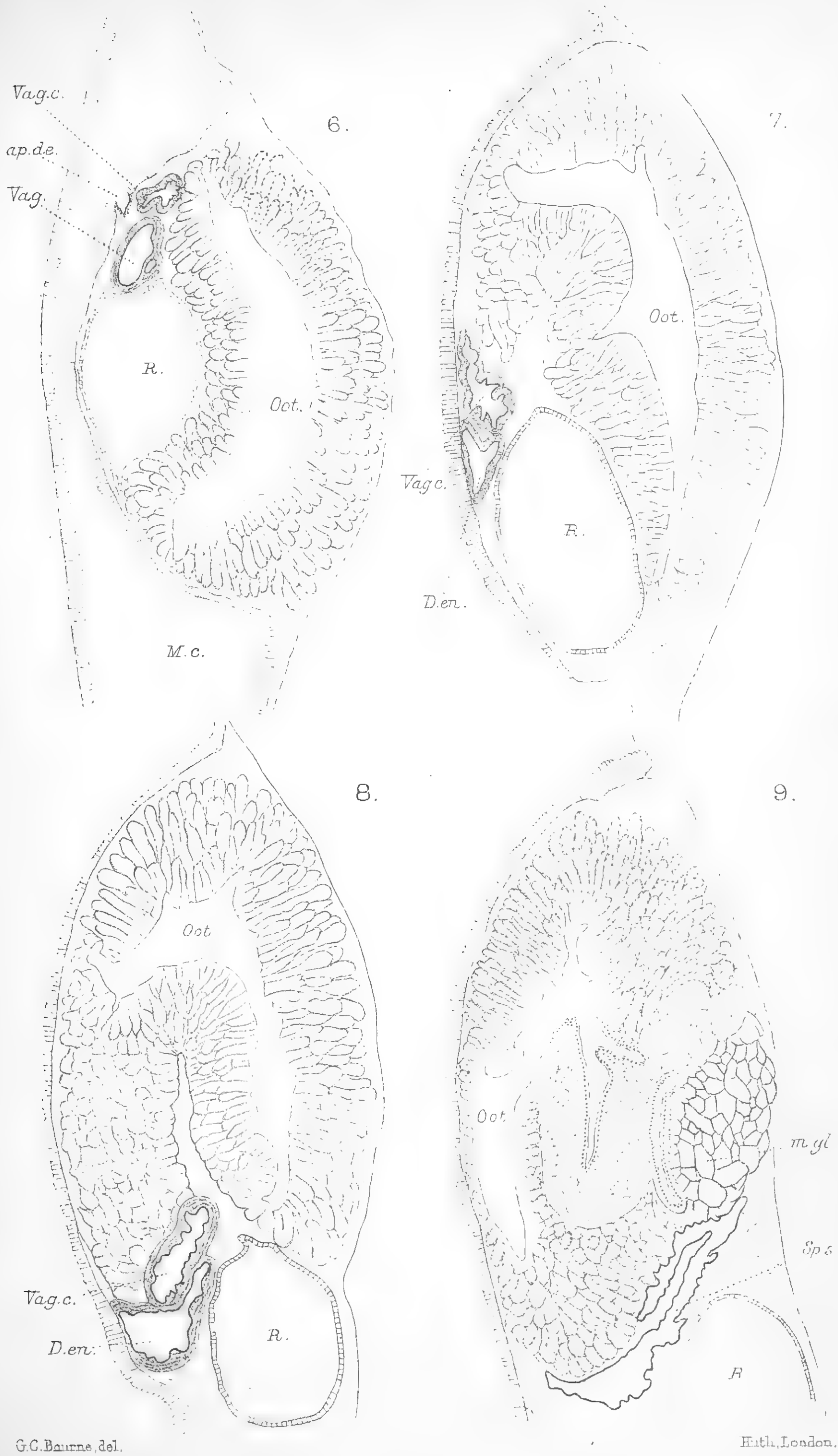



5.

G.C.Bourne, del. Huth London.

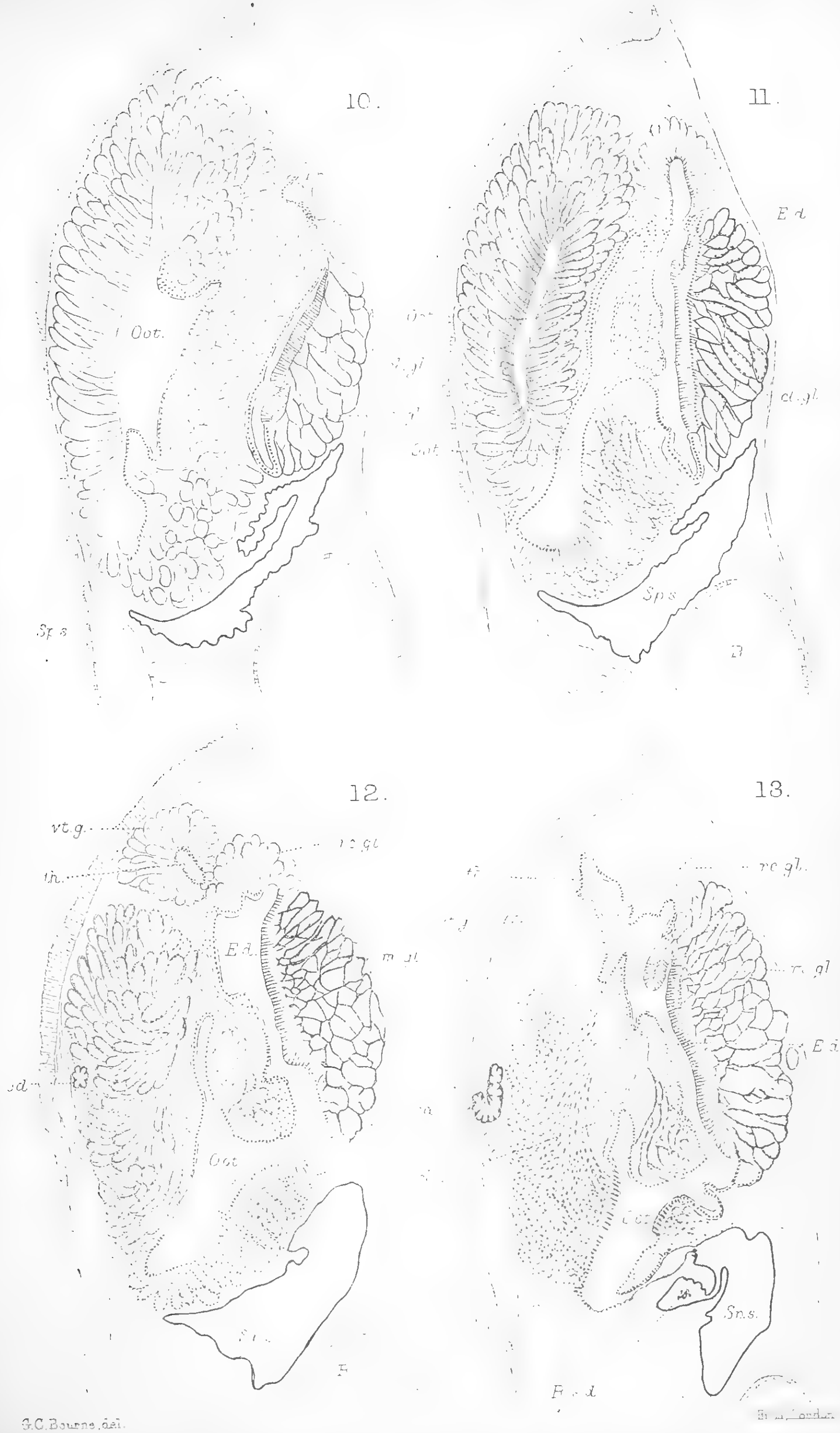
CŒLOM & OVIDUCO-CŒLOMIC FUNNEL OF SEPTARIA.




G.C.Bourne, del.

Huth, London.

GENITAL COMPLEX OF SEPTARIA BOUGAINVILLEI ♀

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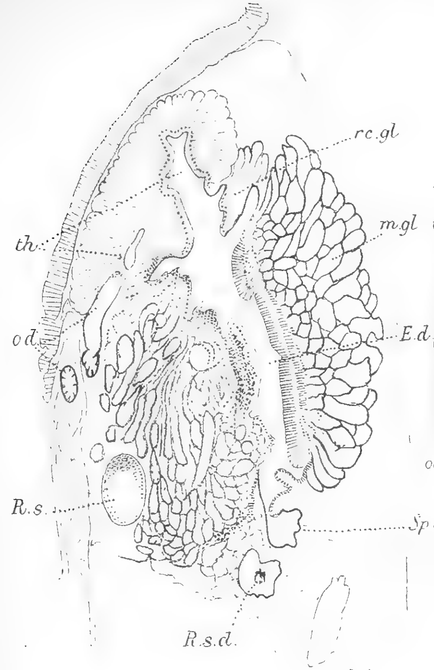
GENITAL COMPLEX OF SEPTARIA BOUGAINVILLEI ♀.

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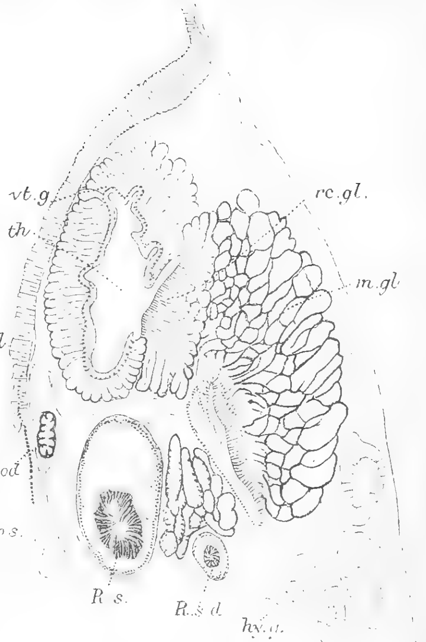


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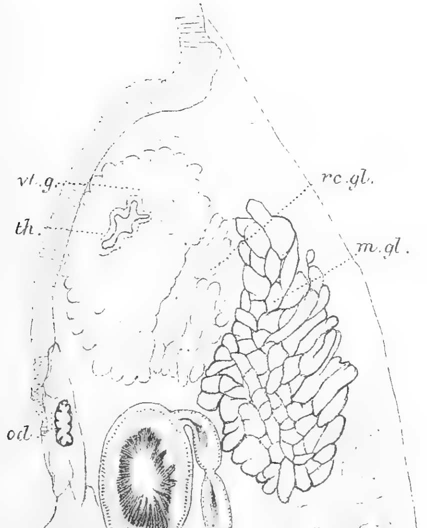


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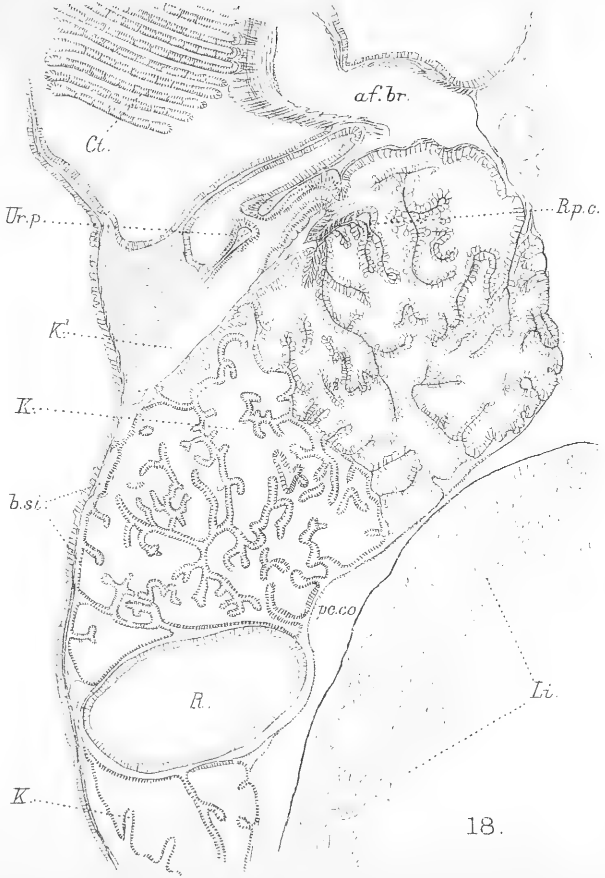
17.

G. C. Bourne del. Huth, London.

FEMALE DUCTS & OSPHRADIUM OF SEPTARIA.

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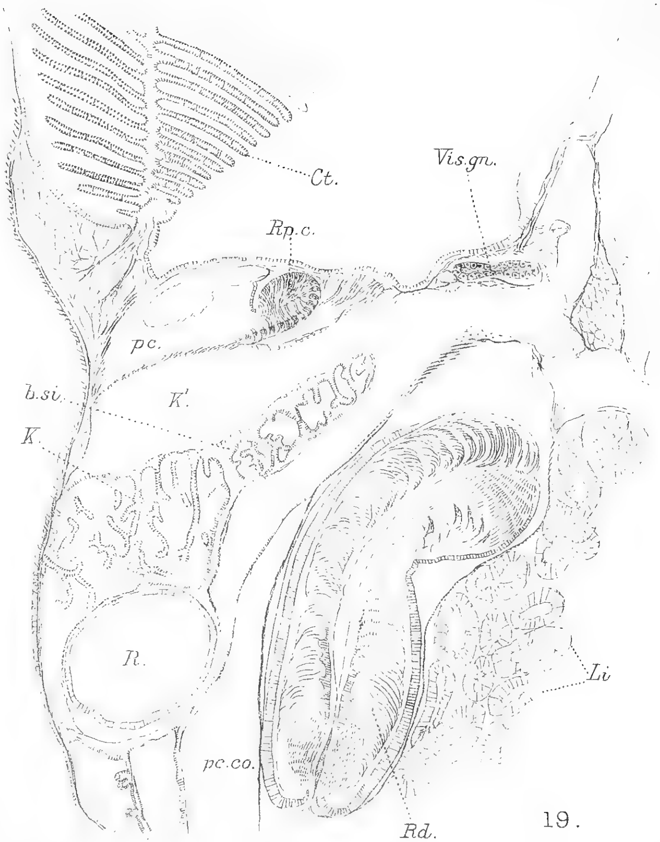
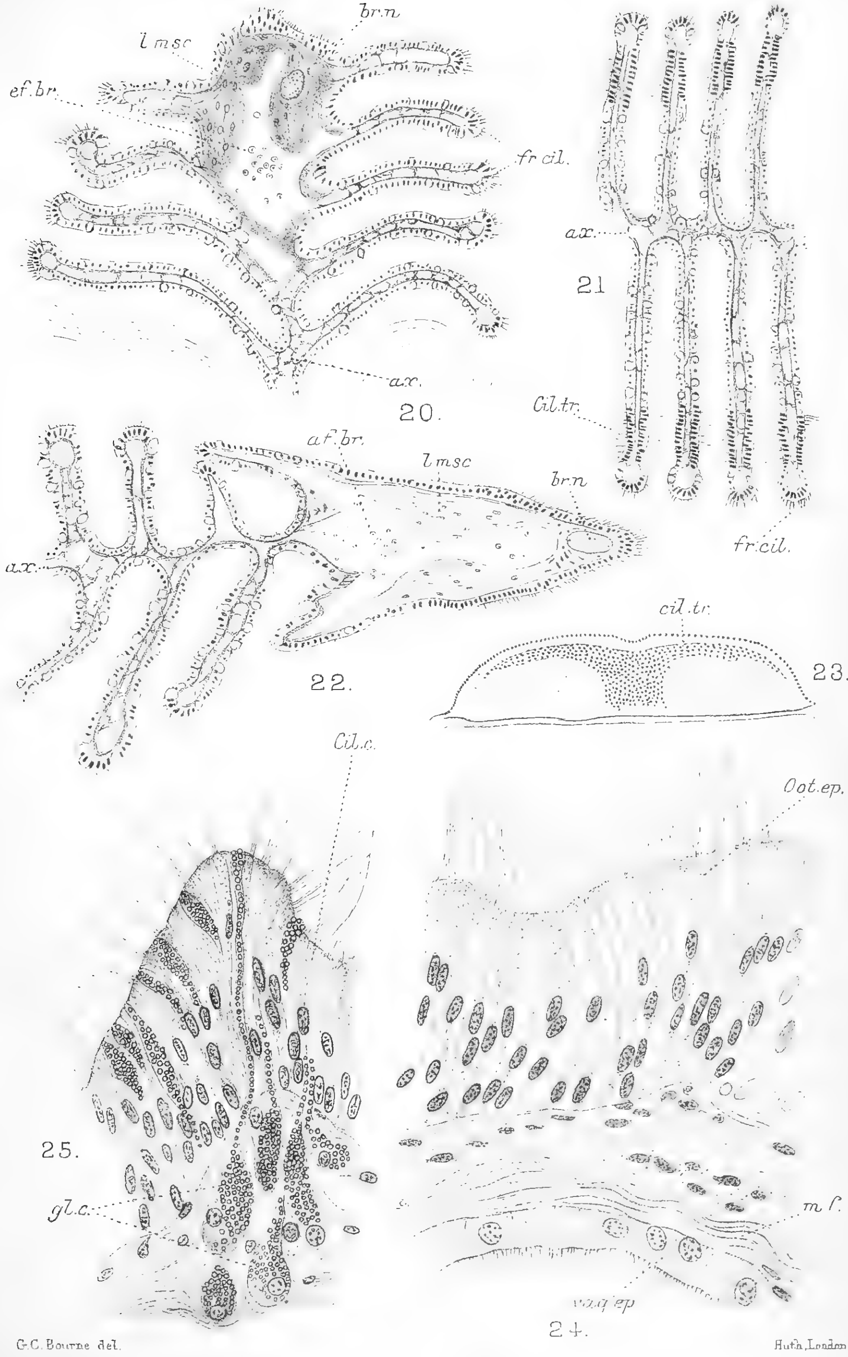



19.

G. C. Bourne, del.

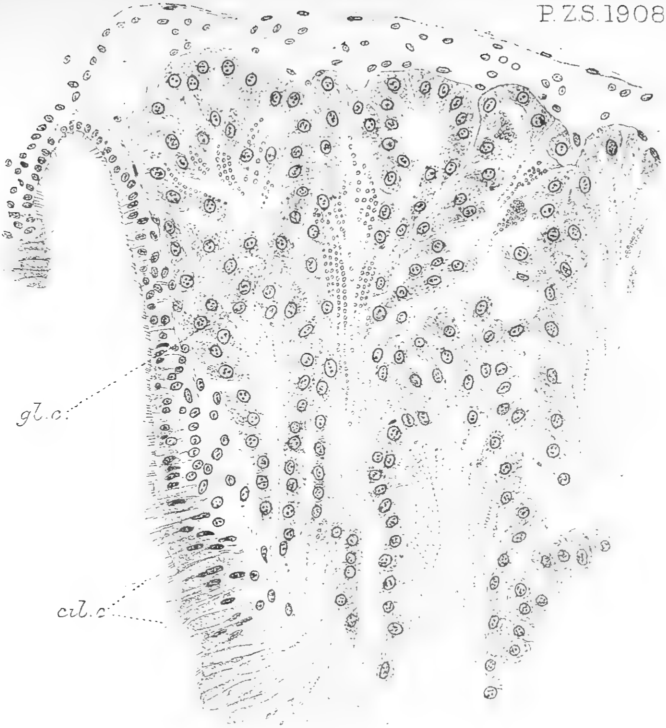
Huth, London

KIDNEY OF SEPTARIA DEPRESSA.




G.C. Bourne del. Huth, London

GILL-LAMELLÆ ETC. OF SEPTARIA.

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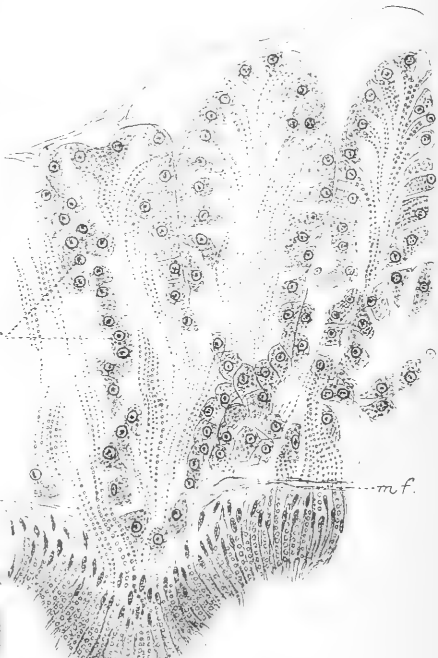


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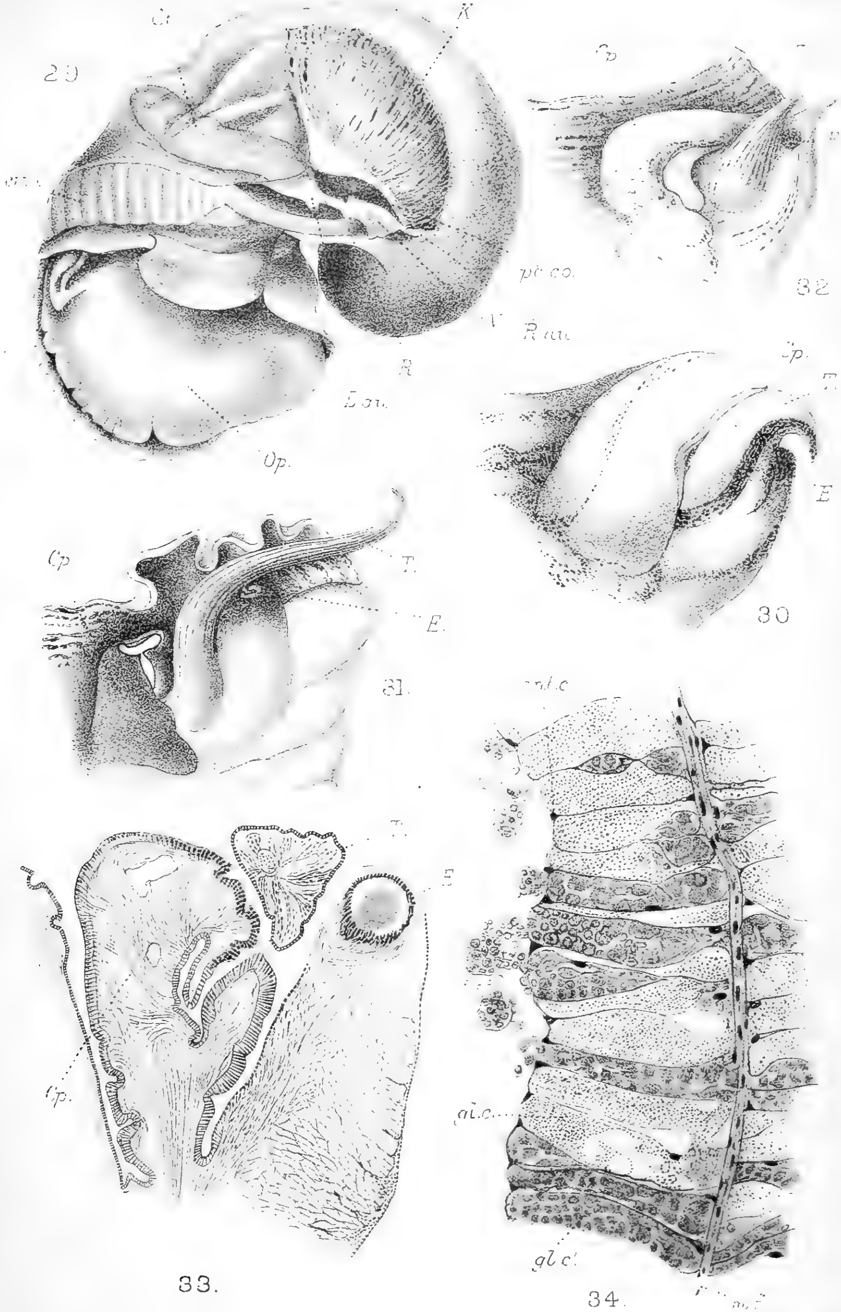
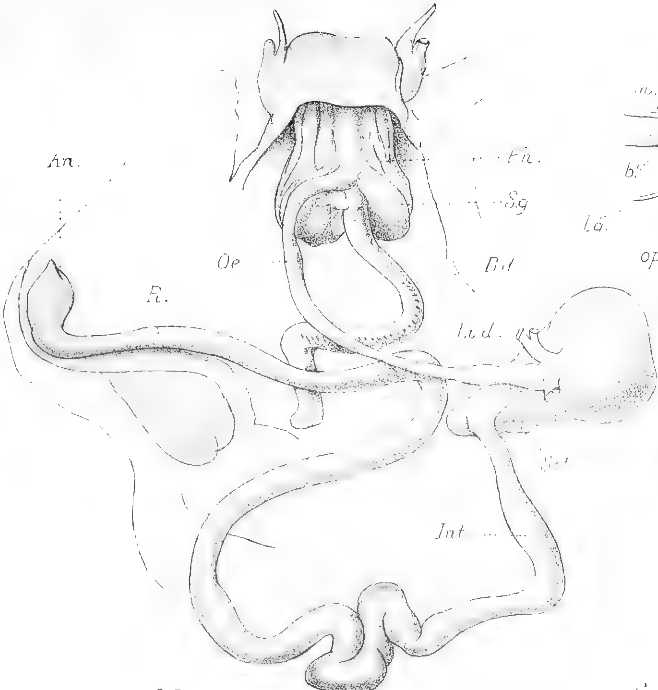
G C Bourne del.
Bath, London.

HISTOLOGY OF GENITAL DUCTS OF SEPTARIA.




G. C. Bourne, del.

ANATOMY OF NERITA, PARANERITA & NERITINA.

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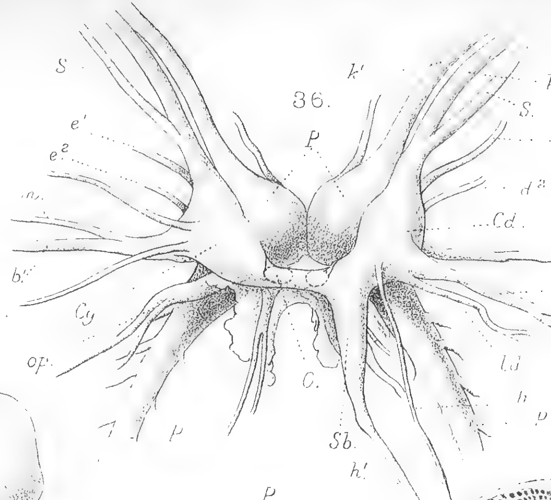


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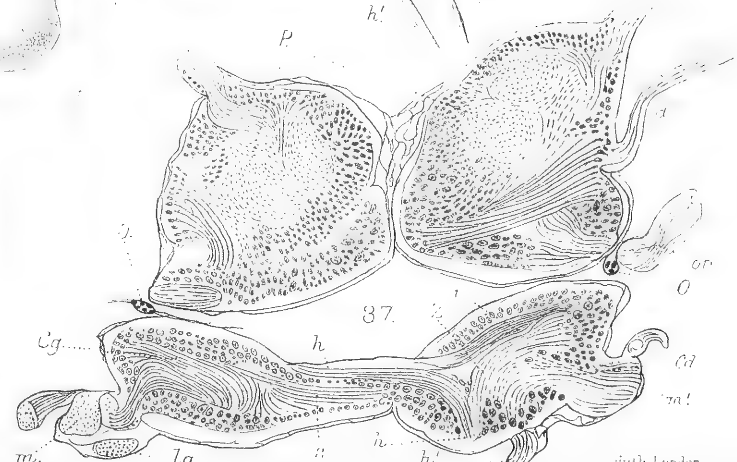
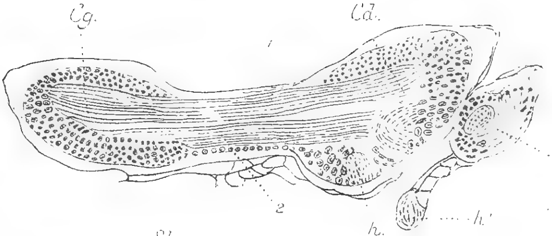



37.

G.C. Bourne, del. Huth London.

ALIMENTARY TRACT & NERVOUS SYSTEM OF PARANERITA.

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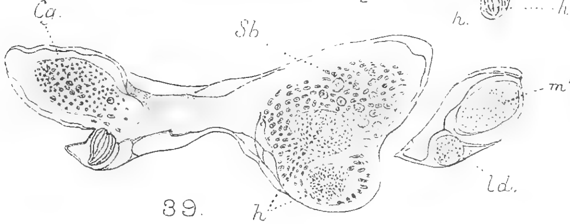


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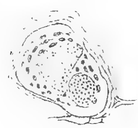

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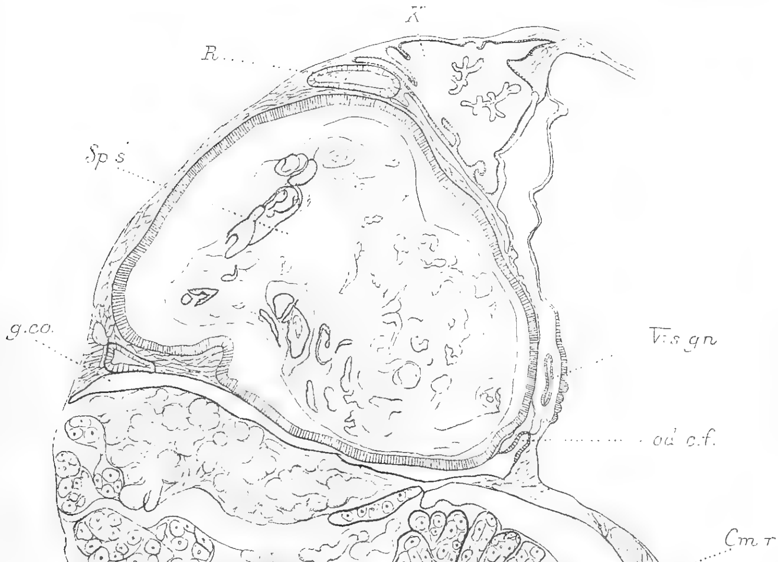


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G.C. Bourne, del.

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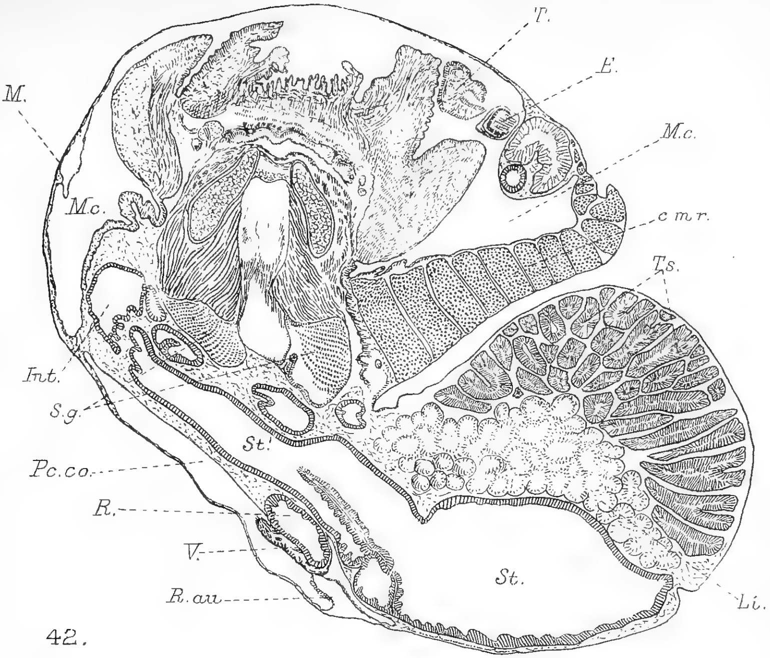
ANATOMY & HISTOLOGY OF NERITIDAE.

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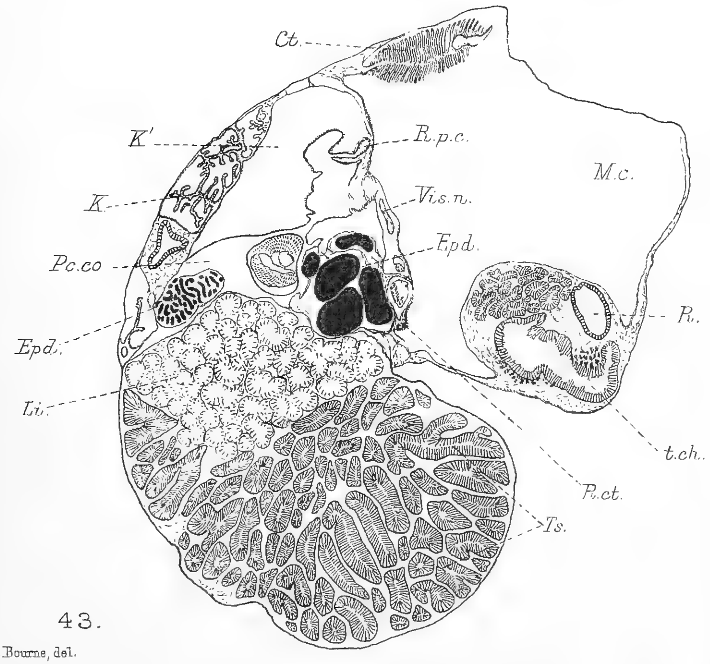


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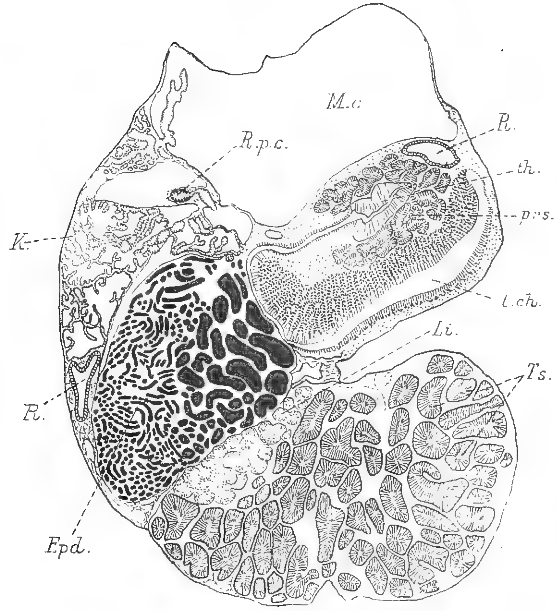
G.C.Bourne, del. Huth, Phot.

PARANERITA GAGATES.

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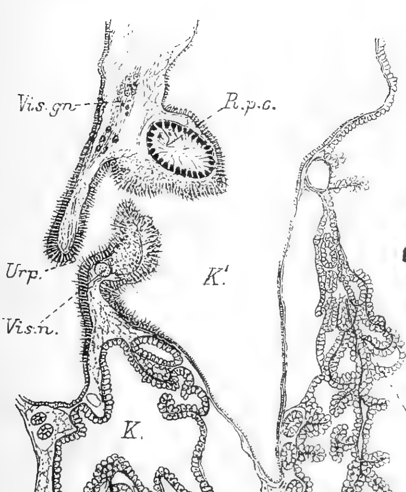


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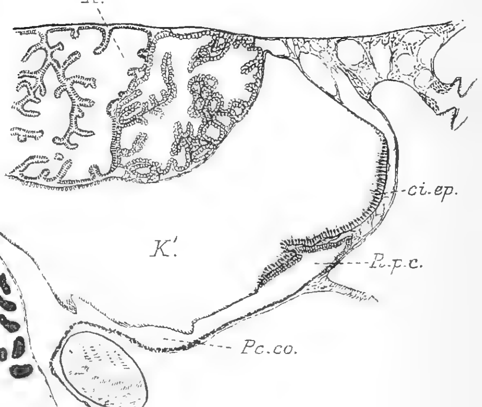


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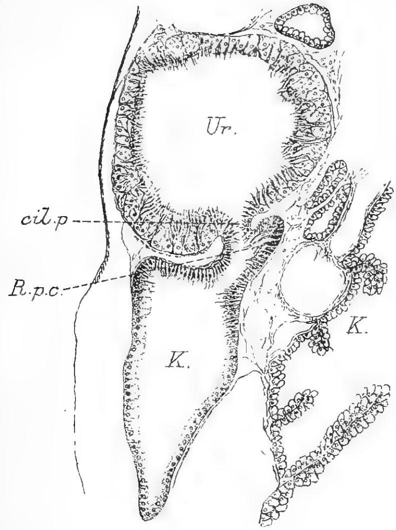
G. C. Bourne, del.

Huth, Phot.

PARANERITA VARIEGATA AND GAGATES.

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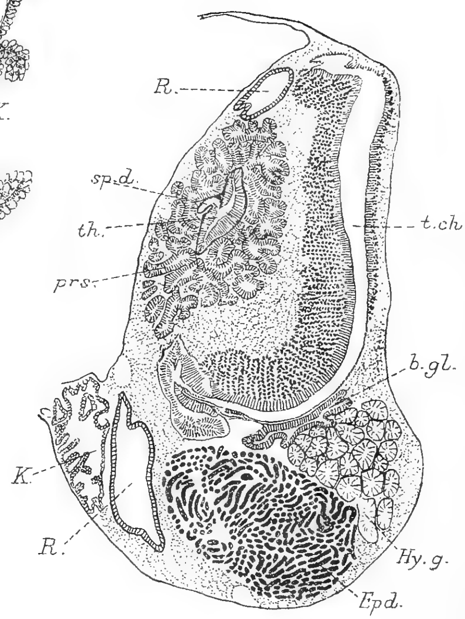


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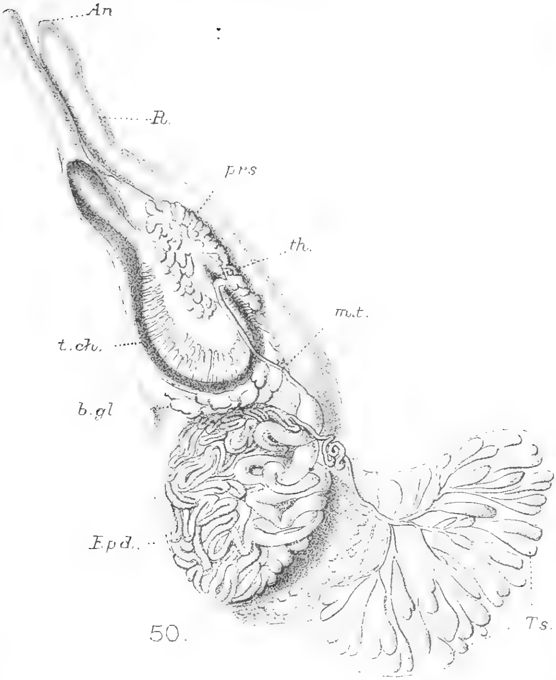
G.C. Bourne, del. Huth, Phot.

PARANERITA VARIEGATA AND GAGATES.

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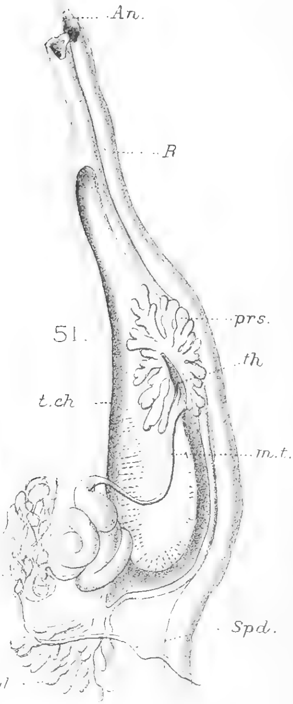


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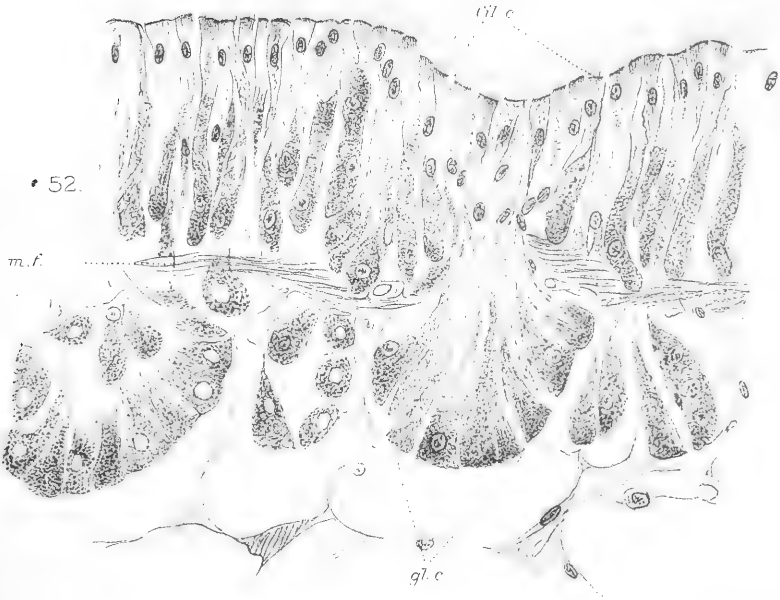


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G.C.Bourne del. Huth, London.

MALE DUCTS OF NERITA AND PARANERITA.


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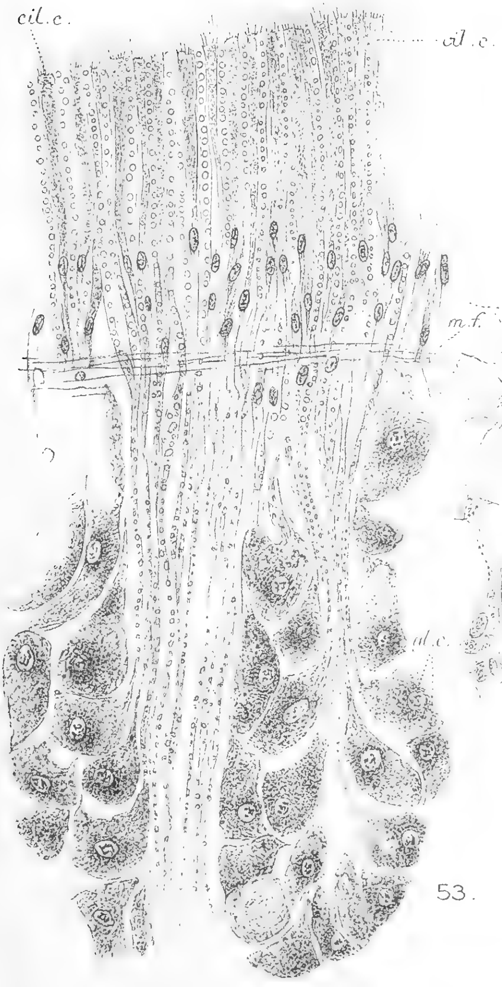



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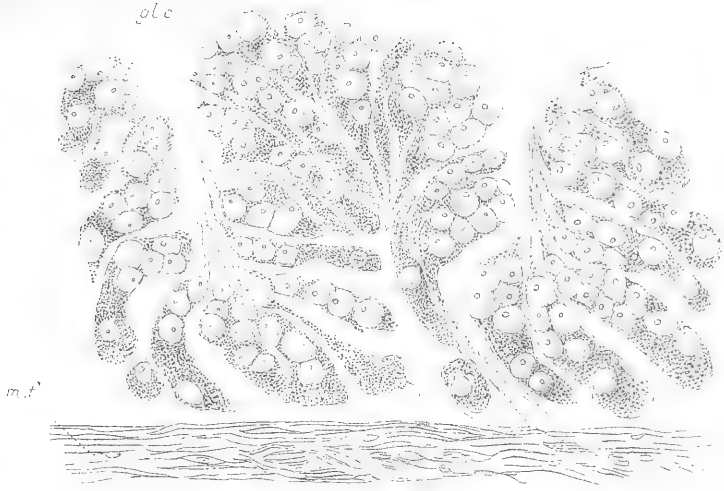
G.C.Bourne.del.

Huth London.

MALE DUCTS OF PARANERITA.

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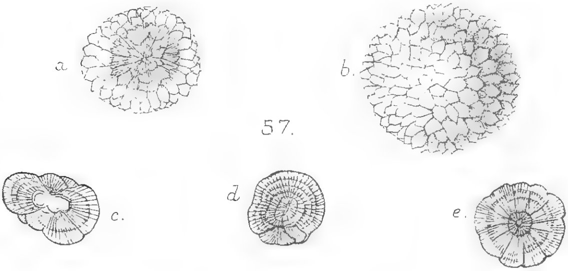


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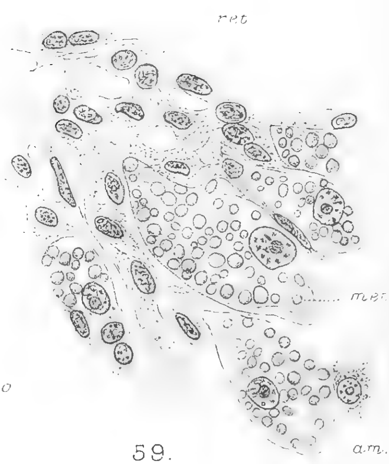


59.

G.C. Bourne, del.

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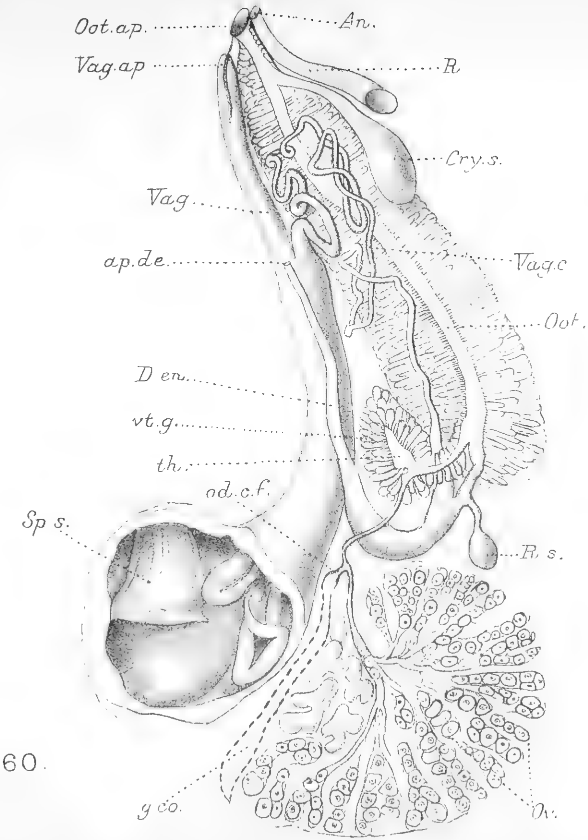
ANATOMY & HISTOLOGY OF NERITIDAE.

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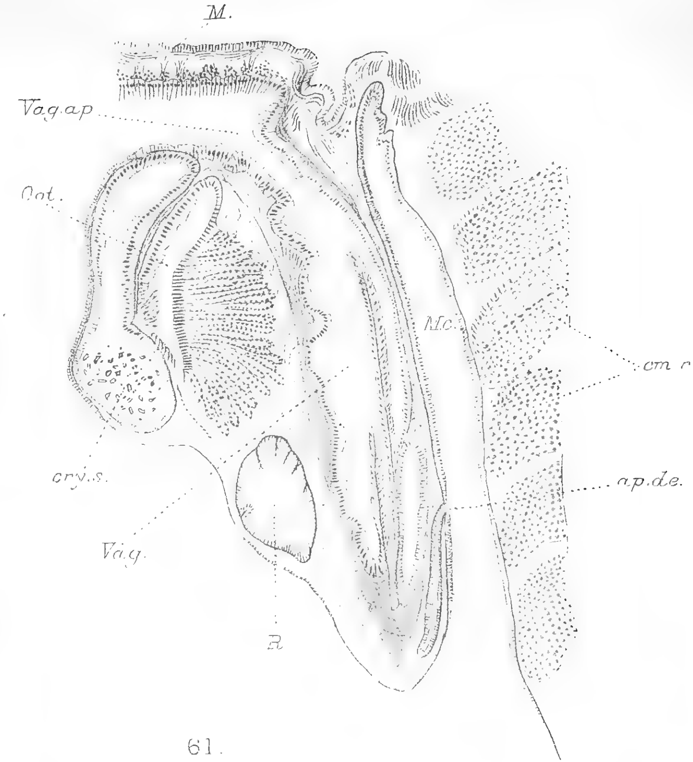



61.

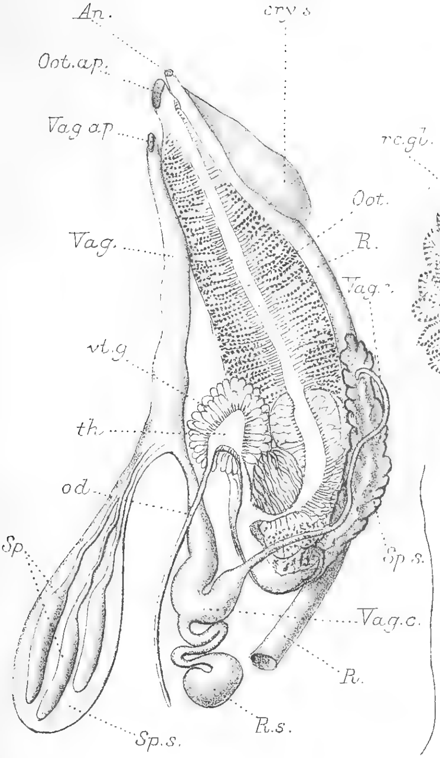
G.C. Bourne del.

Huth, London.

REPRODUCTIVE ORGANS OF PARANERITA ♀.


G C Bourne del. Huth, London.

FEMALE ORGANS OF PARANERITA.

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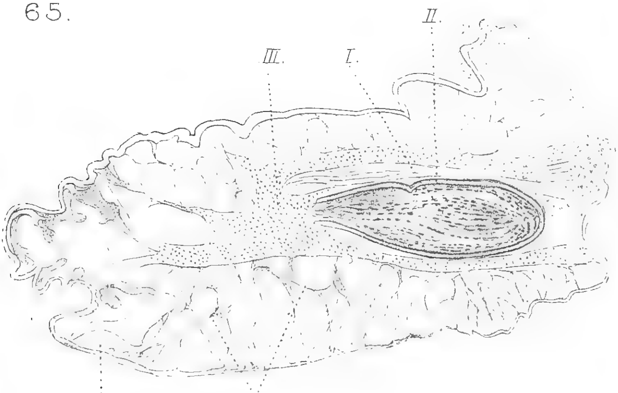
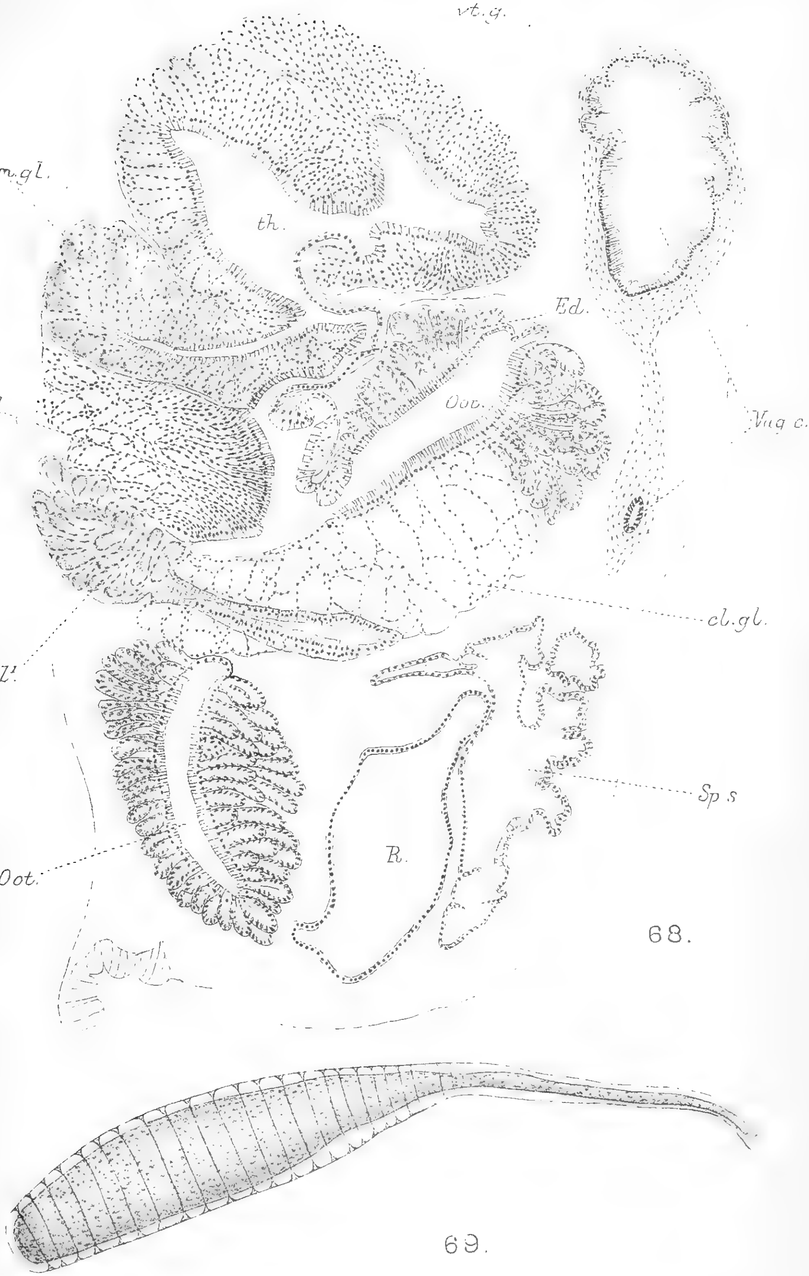



66.

G. C. Bourne, del.

Huth, London.

REPRODUCTIVE ORGANS OF NERITA PLICATA ♀.




G.C. Bourne, del.

Huth, London.

REPRODUCTIVE ORGANS OF NERITA PLICATA ♀.

anatomical memoir since Isenkrahe published an incomplete account of their structure in 1867, and it is high time that this gap in our knowledge of Gastropodan anatomy should be filled up. If comparative anatomists have given but small heed to the Neritacea, the conchologists and systematists have done their full share of work on the group, and the works of Martens (**27**) and Pilsbry and Tryon (**40**) give a most complete account from a taxonomical point of view. But, as is often the case when classification is founded on external characters only, such as the shell and the operculum, a more complete study shows that it rests on insecure foundations; and while I am unable to do more than criticize the genera *Nerita* and *Neritina* as usually defined, I shall bring forward evidence which will, I hope, induce authors more conveniently situated for the study of these forms than I am to undertake a revision of the family Neritidæ, based upon anatomical characters.

The name Neritacea—the group has not been raised to the rank of a suborder or even of a tribe or section—was used by Lamarck as a collective designation for the recent families of Neritidæ, Neritinidæ, and Helicinidæ. To these have been added the Neritopsidæ, Titiscaniidæ, Scutellinidæ, Hydrocenidæ, and Proserpinidæ, and the fossil families Maclureidæ and Naticopsidæ.

It is not part of my present intention to criticize the recent and extinct families and genera that have been founded by conchologists, nor to discuss the probable relationships of the palæozoic forms which, like the genus *Deshayesia*, have been held to occupy a position intermediate between the Neritidæ and Naticidæ (see Pethö (**33**), who refers it to the latter family). But as it will appear in the latter part of this paper that the result of my anatomical investigations is to show that the Neritacea retain some primitive characters, and in so far as they are specialized do not show any approximation to the Pectinibranchia, but are contrariwise modified in a special direction, which culminates in the terrestrial Helicinidæ, &c., it is of interest to consider how far the group may be regarded as of undoubted geological antiquity. The family Neritidæ is of respectable antiquity. The genus *Nerita* is represented by the subgenus *Lissochilus* Pethö in the Triassic and Jurassic, and by the subgenus *Otostoma* d'Archiac in the Cretaceous of Europe, Algiers, and Asia Minor. The genus *Deshayesia*, which is considered by some conchologists to "present a very remarkable combination of the characters of *Nerita* and *Natica* and appears to establish a passage between those genera" (Pilsbry and Tryon, vol. x. p. 5), is from the Eocene and Miocene of the Paris and Bordeaux basins, and if it is really a Neritid, its Naticid characters must be due to convergence and must not be taken as indicating a passage between the Aspidobranchiate and Pectinibranchiate Gastropods, for such a passage must have been effected long before the Tertiary period.

The genus *Neritina*, if indeed it is as distinct from *Nerita* as conchologists assume, is found fossil from the Liassic onward, and is most numerous in species in the Miocene and Pliocene. The subgenus *Neritodonta* Brusina, from the Tertiary of Dalmatia, is of special interest, as being possibly a forerunner of the pulmonate *Hydrocena*, now living in the same region. The genus *Neritoma* Morris is found in the Jurassic of Europe, and the subgenera *Neridomus* Morris and Lycett and *Onchochilus* Pethö in the Oolite and the Triassic and Jurassic respectively. The genus *Deianira* Stoliczka is from the lacustrine deposits of the Cretaceous of Europe, and *Velates* Montfort from the Tertiaries of Europe, India, and Madagascar. The limpet-like *Pileolus* Sowerby, resembling the modern *Septaria*, dates from the Jurassic and Cretaceous. The Neritopsidæ, differing from the Neritidæ in the characters of radula and operculum, are represented by a single recent species, *Neritopsis radula*, from the E. Indies and Polynesia, but are fossil from the Secondaries and Tertiaries. Since, with the exception of *Deshayesia*, there is no doubt as to the relationship of these extinct genera, it is clear that even in earlier Secondary times the Neritacea were differentiated into marine, estuarine, and freshwater forms more or less resembling those of the present day, and must have been derived from an earlier stock, which we may look for in primary formations. But the remains of Neritacea from palæozoic deposits are at the best doubtful. As for some species of *Nerita* which have been described from this period, it is only necessary to quote von Martens (**27**): "Einige angebliche Arten von Nerita aus den palæozoischen Formationen sind betreffs der Gattung höchst zweifelhaft, wie es überhaupt meist eine unsichere und hoffnungslose Sache ist, palæozoische Gastropoden auf Gattungen der Gegenwart zu beziehen."

The family Maclureidæ, of which *Maclurea* Lesueur, from the Cambrian and Silurian of N. America and Scotland, is the sole genus, is placed near the Neritidæ because of its opercular apophyses, but its affinities are very doubtful, and it has at various times been placed in the Solariidæ, Atlantidæ, Pleurotomariidæ, or between the Bellerophontidæ and Haliotidæ. *Naticopsis* M'Coy, ranging from the Devonian to the Trias, and the subgenus *Trachydomia* Meek and Worthen, from the Carboniferous, are placed in the Neritopsidæ because of the characters of the operculum, but the shell is more like that of the Naticidæ. If these palæozoic genera are really allied to the Neritacea, the latter group is of great antiquity. On the other hand, the most specialized of all the Neritacea, the pulmonate Helicinidæ, Hydrocenidæ, and Proserpinidæ, are only found in late tertiary deposits, and have clearly been evolved in comparatively recent time from Neritiform ancestors.

The sole exception to this statement is furnished by the genus *Dawsoniella* from the Carboniferous of Illinois. It is found in association with shells of the genus *Pupa*, and there can be no doubt that it was of terrestrial habit. Formerly placed in the genus *Helix*, it is now regarded as a member of the Helicinidæ, but differs from the latter in possessing a large basal columellar callosity covering the umbilical region. The operculum is apparently unknown. The affinities of *Dawsoniella* must be considered doubtful, but in any case its resemblance to the Helicinidæ is to be regarded as due to convergence, and not to natural affinity. In the first place, it is highly improbable that if Helicinidæ had existed from the Carboniferous onwards, no trace of their remains should have been discovered in secondary and earlier tertiary deposits. In the second place, the Helicinidæ are unquestionably derived from the Neritidæ, and, as we have seen, the Neritidæ were not established in Carboniferous times. It is interesting, however, to note that the genus *Naticopsis* (*Trachydomia*) occurs in the same formation as *Dawsoniella*, and it seems probable that we have here an interesting case of parallel development. If *Naticopsis*, a marine form, was the forerunner of the later Neritidæ, it would seem to have given rise in Carboniferous times to the terrestrial *Dawsoniella*, just as the marine Neritidæ have given rise in later time to the terrestrial Helicinidæ; and the ancestry and conditions of life being similar, the two terrestrial forms acquired such a similitude that their shells have been classified together in the same family.

Though the several genera of recent Neritacea have been studied with minute care from a systematic point of view, we have no very satisfying account of their habits. The genus *Nerita* is confined to tropical or subtropical seas, and if we accept for the moment the limitations of the genus as defined by conchologists, all the species are marine and are found for the most part between tide-marks, clinging like limpets to the rocks. Some of the more brightly coloured species live on coral-banks. It has been remarked by several travellers that they are capable of enduring a considerable amount of exposure to the air. Thus Quoy and Gaimard (**36**) were surprised to see *Neritæ* attached to black rocks under the full glare of a tropical sun, without apparent injury, and they observed that these animals always retained a few drops of water in their shells which they ejected when forcibly torn from their attachment. C. B. Adams observed a West-Indian species living in crevices in the rocks between the tide-marks at the height of three-quarter ebb-tide, and the young forms were even higher up, attached to rocks and stones which were only wetted by spray. Practically nothing is known of the breeding-habits of *Nerita*, and in view of the complexity of the accessory genital organs, especially in the female, observations on this point are very much to be desired.

As to the extent to which different species of *Nerita* are tolerant of brackish or even of fresh water, very little information of a satisfactory character is forthcoming. Many species are recorded from bays at the mouths of rivers or from estuaries, where there must be a considerable admixture of fresh and salt water. *Nerita lineata* Chemnitz is recorded as ascending the

Saigon River in Cochin China, as far as 20 or 25 miles from its mouth, and must therefore be capable of living in fresh or at least slightly brackish water. This species is a typical member of the genus *Nerita*, having a thick shell with spiral costæ, a denticulate outer lip, and a granular operculum, and is remarkable as being one of the few species with these characters which is tolerant of both salt and fresh water, though there are several species of *Neritina*, usually a freshwater genus, which live in brackish water or are even marine. It seems probable, however, that several species of *Nerita* are capable of existing in brackish water, since many of them are recorded from bays at the mouths of large rivers, and an observation made by Mrs. Longstaff—to whom I am indebted for some well-preserved specimens of *Nerita plicata* Linn.—shows that fresh water is not fatal even to exclusively marine species. Mrs. Longstaff attempted to kill some individuals of this species by immersing them in fresh water: they were apparently uninjured, but did not like the new conditions and crawled up the side of the vessel in which they were placed, fixing themselves round its rim, apparently ready to withstand a considerable sojourn in the air.

This question of habitat, in fresh, brackish, or salt water, is of some importance in considering the generic distinction between *Nerita* and *Neritina*. The species of the latter genus are mostly inhabitants of fresh water, and some are found only at the sources of streams, far away from the sea. The numerous European species, of which *N. fluviatilis* is the most familiar example, are freshwater forms, but occasionally occur in brackish or even salt water. Yet many of the tropical species are partly or wholly marine, e. g. *N. ualuensis* Lesson of the Indian Ocean and Polynesia. Quoy and Gaimard (**35**) found *N. auriculata* Lam. in the sea. Dr. Ed. von Martens (**27**) describes the following S. American forms as "species submarinæ." *N. virginea* is common in brackish water, but var. *listeri*, of E. Nicaragua, is found throughout the river San Juan, and also in Greytown harbour in localities where the water is alternately brackish and fresh. *N. picta* Sowerby from S. Panama was observed in abundance on a mudbank covered at times with fresh water, and has been described as strictly marine by C. B. Adams. *N. viridis*, not rare in the Mediterranean and in the Caribbean Sea, also in the Bermudas, is truly marine and lives on Zostera. From all of which it follows that whereas *Nerita* is very rarely found in fresh water, *Neritina* is much more easily accommodated to different conditions of life.

In what precedes, I have accepted the usual distinctions between the two genera founded upon the characters of shell and operculum, but it is a question, as will be more clearly shown in the sequel, whether these characters are of sufficient importance to afford generic distinctions between forms, the internal anatomy of which is, in nearly all respects, so similar as to be practically indistinguishable; and the further question will be raised as to whether anatomical differences of an important character do not indicate the distinction of *Neritina fluviatilis*—and possibly of other nearly allied European species from the tropical forms usually classed in the same genus. It may be pointed out here that the conchological characters relied upon in the determination of the two genera are confessedly somewhat obscure. In general, *Nerita* has a thicker and more solid shell, usually ornamented with spiral ribs, but these may be absent, as in *polita*, *morio*, *picea*, &c.; when ribs are present they usually project slightly beyond the outer lip, which is then dentate, but it may be smooth. The inner surface of the outer lip is generally dentate, but this character may be absent. The operculum is usually solid, with a granular outer surface, or with a marginal zone, and the shape of the apophyses springing from its inner side is claimed to be characteristic.

Dr. Ed. von Martens (**27**), the leading authority on the classification of the Neritacea, maintains that the denticulation on the inner side of the outer lip and the characteristic sculpture of the operculum are the most constant differences between *Nerita* and *Neritina*, " in den meisten Fällen auch der allgemeine die Meerbewohnerin verkündende Habitus, der aber bei den kleineren schwarzen Arten weniger hervortritt." In *Neritina* the shell is usually thinner and less solid, not ornamented with spiral ribs, though these are present in *N. cornea* Linn. and especially in its variety *subsulcata*, and spirally arranged rows of spines or nodules are not uncommon. The outer lip is smooth and not dentate (it is distinctly crenulate in *N. granosa* Sowerb. and *N. aculeata* Gmelin) and the inner denticulations of the outer lip are wanting. The operculum is not granular or sculptured, but minute granulations may be discerned with the aid of a lens in several species; I found them specially well marked in a specimen of *N. recluziana* Guillou. As for the apophyses, after making a careful comparison of these structures in all the species of both genera that I possess, I have concluded that they offer so many examples of convergence that they are quite unreliable for the purpose of generic distinction, but, as I make no pretension to skill as a systematist, my judgment in this matter must be taken for what it is worth.

A certain number of Neritinæ have the last whorl of the shell broadly expanded, the aperture enlarged, and the spire reduced, so that they acquire a secondary symmetry; such, for instance, are *N. dilatata* Brod. and *N. crepidularia* Lam. It is interesting to note that those forms which tend towards a bilateral symmetry, such as the two species quoted, and also *N. auriculata* Lam., *N. tahitensis* Lesson, *N. bicanaliculata* Récluz, are all from the Indian or Pacific Ocean, and are clearly intermediate between the more common spirally coiled Neritinæ and the genus *Septaria* (= *Navicella* Lamarck), which is confined to the same regions. On the other hand, the expanded American species of *Neritina*, e. g. *latissima* Brod. and *intermedia* Sowerby, retain the distinct dextral coil of the spire and their shells are asymmetrical, in general form somewhat like *Haliotis*. The same is the case with *N. oweniana* Gray, from the W. Coast of Africa, Fernando Po, and Cape Palmas; and thus it appears that the Neritinæ of rivers running into the Indian and Pacific Oceans (but not of American rivers on the Pacific slopes) have given rise to the limpet-like fluviatile genus *Septaria*, whilst those of the Atlantic shores have followed a different line of evolution and have in no case given rise to *Septaria* forms.

The genus *Septaria* Férussac is commonly referred to in zoological works as *Navicella* Lamarck, but Férussac's name has the priority and, according to all rules of zoological nomenclature, ought to be adopted. It appears to be a characteristically fresh-water genus, living on the roots of Nipa palms and other trees on the banks of rivers in India, Mauritius, Bourbon, N. Australia, and the Pacific Islands. The *Septariæ* of the Mascarene Islands and Madagascar affect the vicinity of waterfalls, and are found adhering to stones out of the water but constantly wetted by spray. Due allowance being made for the secondary symmetry which they have acquired, the internal anatomy of individuals of this genus closely resembles that of *Nerita* and the tropical Neritinæ. Little or nothing is recorded of the breeding-habits and development of *Septaria*, but some specimens of *S. bougainvillei* Récluz, a Fijian species in my possession, have egg-cases, resembling those of *Neritina fluviatilis*, attached to the shell, each case containing a number of veliger larvæ.

No more than a passing mention can be made here of the Titiscaniidæ, of which *Titiscania* Bergh is the sole genus. It is a slug-like marine form, probably widely distributed in the Indo-Pacific seas, but hitherto recorded only from the Philippines and Mauritius. It is a highly specialized member of the Neritacea, with something of the form and habits of a Nudibranch. The shell is lost, but the ctenidium and mantle-cavity, though reduced, remain. Bergh (**2**) has given an account of the anatomy of this remarkable genus, from which it is evident that it is rightly placed among the Neritacea, and probably near to *Neritopsis*, because of the absence of the median plate in the radula. There are, however, many imperfections in Bergh's account of the anatomy. Believing that the supra-intestinal nerve was absent in *Nerita*, he failed to find it in *Titiscania*, and we are left in doubt as to whether it is really present in the latter genus or not. For similar reasons doubt must be thrown on his description of the heart with a single auricle, and his account of the generative organs is so wanting in precision and detail that one can only gather from it that the accessory glands and ducts are complicated, and may very possibly resemble those of *Nerita*.

The remaining families of the Neritacea, the Helicinidæ, Proserpinidæ, and Hydrocenidæ, are, as is well known, terrestrial pulmonate forms, with the habits of snails. Their distribution coincides on the whole closely with that of the tropical *Neritæ* and *Neritinæ*. The Helicinidæ occur chiefly in islands in the Indo-Pacific region, and in the Antilles, reaching their maximum in the last-named locality. As has been already remarked, they are only found fossil in later Tertiary deposits, with the exception of the remarkable *Dawsoniella*, which occurs in the Carboniferous of Illinois, and is apparently related to *Trachydomia*, a subgenus of *Naticopsis*, from the same formation. The present distribution and the geological history of these Pulmonate Neritacea suggest problems which will be dealt with in the second part of this paper. With the exception of *Dawsoniella*, they are unquestionably descended from Neritid or Neritinid ancestors, and it is difficult to account for their dispersal in islands so widely separated from one another without making assumptions which differ widely from accepted doctrines of animal evolution.

It was my original intention to undertake a monographic account of the anatomy of the Neritacea, but as the work proceeded it became evident that, owing to the difficulty of obtaining suitable material, and the great number of species which must necessarily be subjected to microscopical examination before completeness could be attained, this would be a task of many years' duration. The results already attained seem of sufficient importance to merit publication, and may induce zoologists travelling or living in tropical regions to give attention to a group deserving more attention than it has received. I therefore purposely omit a detailed account of certain organs, such as the buccal bulb, the radula, and the histology of the alimentary tract, the mantle, &c. My chief attention has been directed to the nervous system, the kidney, the pericardial cavity and its connection with the rest of the cœlom, and the generative organs.

The difference between the aquatic Neritidæ and the terrestrial pulmonate Helicinidæ is so considerable that they must be dealt with in separate sections of this memoir, and in each case, in order to avoid a confusion of my own observations with a criticism of the work of other authors, I will preface my statements with a short account of the literature of the subject.

## Family Neritidæ.

The first important contributions to the anatomy of *Nerita* are those of Quoy and Gaimard (**35** & **36**), whose figures and descriptions of the nervous system and alimentary tract leave much to be desired, and it is not necessary to enter into an examination of their errors and omissions. But they made some observations on the generative organs which, though far from complete, have not been followed up, and have scarcely been noticed by any subsequent author except Bergh. It will be best to quote their description in full:—"Dans le sexe femelle est un groupe d'organes qui mérite quelque attention. On y voit l'extrémité du rectum, puis un corps pyriforme très-allongé entouré en partie d'une sorte de glande striée en travers, qui s'ouvre vers le bas.

Cet organe est creux et contient dans sa cavité, accollés les uns aux autres, plusieurs corps en massue allongée, finissant en filaments. Ils sont résistants, comme fibreux, et paraissent grenus à la loupe. Nous ne pouvons deviner l'usage de ce petit appareil, qui remplit sans doute quelques fonctions relatives à la génération, puisqu'on ne le trouve que chez les femelles. Plus en dehors est l'utérus, composé d'une poche pyriforme et d'un renflement qui lui est accollé, lequel contenait une grande quantité d'œufs, ronds blancs et crétacés. L'oviducte, gros long et tortueux, fait communiquer cet organe avec l'ovaire, placé au bord droit du foie." Though this description and the figure accompanying it are inexact, it is evident that the "corps pyriforme" is the spermatophore-sac, the "corps en massue allongée" are the spermatophores, the "glande striée en travers" is the ootype, with its glandular walls, the "uterus," as described and figured by these authors, has no separate existence, but the "renflement qui lui est accollé" is the crystal-sac, which does, in fact, open into the distal end of the ootype. It also seems probable that MM. Quoy and Gaimard mistook the spherical crystalline concretions in the crystal-sac for ova.

Of the male, Quoy and Gaimard give a very insufficient account of the accessory generative organs, but observed the excessively long coiled region of the sperm-duct to which I have given the name of epididymis.

In an earlier memoir Quoy and Gaimard (**35**) gave a superficial account of the structure of *Nerita*, which only merits attention because it contains two figures showing the modification of the cephalic integument at the base and to the inside of the right tentacle of the male, which has been referred to, but seldom correctly figured or described, by subsequent authors as a "cephalic penis." In the figures referred to this structure is represented in the correct position, but simply as a conical eminence, without any detail.

From the time of Quoy and Gaimard there is no work dealing with the anatomy of *Nerita* till that of Bouvier in 1886. Von Jhering (**22**), in his well-known work on the nervous system of mollusca, abruptly removes the whole of the Neritacea from their position alongside of the other Rhipidoglossa and places them in a class Orthoneura, which has long since been broken up, its contents being restored to their proper places by subsequent and more exact observers. But his investigations were confined to the nervous system of *Neritina fluviatilis*, and had he carefully studied the anatomy of some of the larger species of *Nerita* or of a *Septaria* he would probably have paused before promulgating the opinions set forth in his lengthy memoir.

Bouvier (**8**), in a preliminary note published in 1886, gave a short account of the principal external features of the anatomy of *Nerita* and some details of the nervous system, but the reader should turn for a more complete account to his great work (**9**) on the nervous system of prosobranchiate Gastropods. As he himself subsequently corrected his errors about the nervous system, it is not necessary to dwell on what is now a matter of history. Failing to recognize the extremely fine supra-intestinal nerve in any of the Neritidæ he dissected, he wrote with characteristic emphasis, "Il n'y a pas de commissure viscerale croisée," and classed the Neritacea as "Rhipidoglosses orthoneuroïdes." Following de Lacaze-Duthiers, he identified the swollen origin of the subintestinal nerve with its sheath of ganglion-cells as the subintestinal ganglion, but, curiously enough, did not observe the large ganglion on the visceral commissure, afterwards discovered and called the subintestinal by Béla Haller (**20**) and Boutan (**6**). But his description of the nervous system is much in advance of anything that preceded it. He was the first to discover the course of the subintestinal nerve and of the left pallio-branchial nerve. He discovered and described correctly the labial commissure, characteristic of the more primitive prosobranchs. This commissure, as he says, is "très facile à préparer," and it is curious that Béla Haller, who succeeded in the much more difficult task of tracing the supra-intestinal nerve, should have emphatically denied the existence of this very obvious labial commissure. There is a further point of difference between these two authors, in which Bouvier appears to me to be correct. Béla Haller describes no less than fourteen transverse commissures behind the anterior commissure of the pedal nerve cords, whereas Bouvier found, as I find, nothing more than fine nerves passing from the inner sides of the cords to the muscles of the foot. In Bouvier's brief account of some of the more important anatomical features of *Nerita peloronta* there is a curious misprint, which has created some confusion among some subsequent authors. On p. 47 he writes: "Au fond de la cavité branchiale, à *droite*, se trouve la branchie bipectinée, libre en avant, en arrière rattachée au manteau à droite et à gauche par un expansion de la lame médiane, de sorte que le fond de la cavité branchiale est divisé en deux étages superposés. A *gauche* de la branchie se trouve le rein; il s'ouvre dans la cavité branchiale par un orifice en boutonnière situé dans la paroi antérieure du nucléus." The words italicised ought to be transposed: the ctenidium, of course, is on the left side of the mantle-cavity, and the kidney is to the right of the ctenidium. Bouvier further describes the so-called cephalic penis "toujours assez réduit dans les Nérites," and gives a figure of a remarkable development of this organ in *Neritina cariosa*. Though his description and figure are not very clear on this point, Bouvier appears to have determined the true position of the osphradium in *Nerita*, but as he did not examine the structure of this organ and did not recognize the ganglia connected with it, his determination is rather of the nature of a conjecture than of proof.

The next contribution to the anatomy of *Nerita* is that of Rémy Perrier (**34**), whose researches were confined to the kidneys and associated organs in *Nerita peloronta*, *Neritina* *oweni*, and *Septaria* (*Navicella*) *janelli*. The position and general anatomy of the kidney of *Neritina fluviatilis* had been previously described by Landsberg (**24**); and Perrier adds some details relating to the trabecular structure of the excretory portion of the kidney and the reno-pericardial canal. He did not, however, fully elucidate the relations of the glandular and non-glandular parts of the kidney, and described the latter as a closed sac intervening between the kidney and the pericardium. This error was afterwards corrected by Lenssen. The most important part of Perrier's work, in so far as it relates to the Neritidæ, is his account of the heart. He discovered and gave an accurate figure of the left auricle and showed that, contrary to Landsberg's statements, the ventricle is in fact traversed by the rectum.

Bergh (**2**) in 1890, as an addendum to his paper on *Titiscania*, gives an account of the anatomy of *Nerita peloronta* and *Neritella* (*Neritina*) *pulligera*. This is the first attempt, since Quoy and Gaimard, to give a complete account of the anatomy of *Nerita*, but it is unfortunately very incomplete and contains some serious errors and omissions. For example, Bergh denies the existence of a second auricle, and lays considerable stress on its absence. He describes the eyes as open, whereas they are in fact closed. His description of the nervous system, correct enough as far as it goes, is no advance on the original description of Bouvier. He gives a more or less detailed and tolerably correct account of the buccal bulb, odontophore and radula, and notes the presence of salivary glands, but mistakes an œsophageal dilatation for the stomach, and describes the true stomach as enlargements of the hepatic ducts. The position of pericardium and kidney are correctly described without adding anything to previous knowledge of the subject; but the reno-pericardial duct was not recognized. All of Bergh's specimens appear to have been females, and he makes an attempt to describe the complicated accessory generative ducts and glands, but, as he says, "bei den vorliegenden Materiale konnten die ganz unklaren Verhältnisse dieser Theile nicht genauer eruirt werden." He recognized, however, the spermatophore-sac, and gives a good outline figure of a spermatophore of *N. pulligera*.

In 1892 two short papers by Boutan (**6**) and Bouvier (**10**), the atter published very shortly after the former, established the existence of a supra-intestinal nerve in *Nerita* and *Septaria*, thus restoring the Neritacea to their proper place among the Streptoneurous Rhipidoglossa. Shortly afterwards Boutan (**7**) published a further account of the nervous system of *Nerita polita* and *Septaria* (*Navicella*) *porcellana*, in which the course of the supra-intestinal nerve is correctly figured, but he failed to recognize the supra-intestinal ganglion which Bouvier had signalized in the previous year. Boutan appears to have been in error as to the position of the osphradium, which he says "s'étend le long du septum branchial qui réunit la branchie au plancher de la cavité et est à peine distinct à l'œil nu." The osphradium, as I shall show, is in fact in front of the suspensory membrane of the ctenidium, close behind the thickened margin of the left side of the mantle and in front of the anterior end of the left columellar muscle. Close below the osphradium is a complex of ill-defined ganglionic enlargements, and as Boutan failed to find the true osphradium he missed the ganglia lying beneath it. In this same paper Boutan argues, erroneously as I now think, that the so-called subintestinal ganglion of Bouvier is not a member of the group of visceral ganglia and gives figures of the pleuro-pedal ganglia of *Nerita* and *Septaria* correcting the older figures of the latter author.

In the following year Béla Haller (**20**), in the course of his studies on docoglossate and rhipidoglossate Prosobranchs, gave a tolerably full account, not only of the nervous system, but also of the alimentary tract, kidneys, and genital organs of *Nerita ornata*. This work contains a curious mixture of acute and accurate observations and incomprehensible errors and omissions. His elaborate figure of the nervous system is in some respects the best that has been published, but in other respects is most misleading. As has already been mentioned, he flatly denies the existence of a labial commissure, which is not only certainly present, but much easier to dissect than in any other Rhipidoglossate. I can positively assert that the numerous pedal commissures figured by Béla Haller are not present: Bouvier was perfectly correct on this point. In a simple dissection, one may easily make mistakes in attempting to trace delicate nerves through the mass of muscle in which they are embedded, but a study of microscopical sections leaves no room for error. A careful examination of a series of sections of several species fails to reveal any trace of transversal commissures posterior to the main pedal commissure. B. Haller discovered the supra-intestinal nerve, independently it seems of Boutan and Bouvier, and gives a fairly correct figure of the crossed visceral commissure. Like Boutan he identifies the elongated ganglion on the right of the crossed visceral commissure as the subintestinal, but he did not see the stout nerve given off from it, almost immediately swelling up to form the genital ganglion lying on the oviduct or sperm-duct. In respect of the supra-intestinal and branchial or osphradial ganglia, Haller gives a complicated figure which, as far as I am able to reconstruct these ganglia from serial sections, may be correct, but after many attempts I have been unable by simple dissection to verify his account. These ganglia are covered by the thickened and folded epithelium of the osphradium, which in all the species at my disposal is too opaque to allow the ganglia to be seen by transparency.

Haller's description of the alimentary tract is much more accurate than that of his predecessors. He gives a good account of the position and general relations of the stomach, œsophagus, and course of the intestine, but his observations on the buccal bulb, salivary glands, &c. seem to me defective. He describes and figures a posterior diverticulum of the buccal bulb which I have failed to discover either in sections or by dissection, and his drawing of the salivary glands is incorrect in detail. In describing the heart he has, curiously enough, fallen into the same error as some of his predecessors, since he categorically denies the presence of a rudimentary right auricle: "da von einem rechten Vorhof nicht einmal ein Rudiment mehr erhalten ist."

After criticizing Perrier's account Béla Haller gives a somewhat detailed description and a figure of the kidney of *Nerita ornata*, but neither description nor figure is correct. According to him the kidney is an acinous gland, not differentiated into anterior and posterior lobes differing in histological structure. The ducts of the acini unite and open by large apertures directly into the bladder (Urinkammer). The reno-pericardial canal opens into the bladder and is dilated into a large sac which runs back posteriorly between the pericardium and the ureter, and is identified with the cavity described by Perrier as lying between pericardium and kidneys and incapable of being injected from the general body-cavity. I shall prove, in due course, that the glandular part of the kidney is not acinous, that there is a histological differentiation between the anterior and posterior moieties, that there are not several ducts leading from the glandular part to the ureter, and that the reno-pericardial canal opens not into the bladder but into the glandular portion.

As for Haller's description of the male and female generative organs, I need only say that his work is scarcely an advance on that of Claparède, and he failed to discover the remarkable complexity of these organs, which, indeed, could hardly have been discovered without careful and laborious reconstruction of sections.

It could not be guessed from the title "Die systematische Stellung der Solenogastren und die Phylogenie der Mollusken" that Thiele's (**39**) memoir, published in 1902, contains a number of new and acute observations on the morphology of the Neritacea. Interpolated as they are in a lengthy discussion of the phylogenetic history of the Gastropoda, Thiele's results are somewhat difficult to summarize, and it is to be regretted that he did not see fit to embody them in a separate memoir. He studied sections of *Nerita pica*, *Septaria parva* and *suborbicularis*, *Scutellina cinnamomea*, and *Helicina japonica*. It should be noticed in the first place that he places *Scutellina* without comment among the Neritidæ. *Scutellina* was classified by Fischer (**15**) among the Docoglossa, by Pilsbry and Tryon (**40**) near the Haliotidæ, and I have been unable to discover what author detected their relationship to the Neritidæ. It is clear, however, from Thiele's account of the female generative organs that it belongs to the last-named family. After touching on various points of the anatomy of the Neritidæ, such as the ctenidium, which he compares with that of the Acmæidæ rather than the Trochidæ; the subpallial sense-organ, which he describes and figures correctly but is inclined to identify with the subpallial sensory tracts of Patellidæ, &c., rather than with a true osphradium; the left columellar muscle, which he considers to be derived from the subdivision of the primitive right muscle; the salivary glands, in respect of which he corrects the statements of Haller and Amaudrut, Thiele proceeds to give a more detailed account of the accessory genital organs. Though his diagrams are too schematic, his drawings of sections too few in number, and his description too condensed to convey a clear impression to anyone unfamiliar with these complex structures, his account of the female organs of *Nerita pica* and *Septaria parva* is very exact, both as regards the general anatomy and the histology. I shall have occasion to refer frequently to it in the descriptive part of this paper. It need only be mentioned here that he does not appear to have found spermatophores in the spermatophore-sac, and therefore is obscure as to the function of this organ. Though he found and has figured the peculiar crystalline concretions in the crystal-sac, he names this structure the uterus—for insufficient reasons, as it appears to me. He did not discover the oviduco-cœlomic funnel, and does not mention the presence of the third duct, which I have called the ductus enigmaticus in *Septaria parva*. It is of course possible that it is not present in this species. The description of the female organs of *Scutellina cinnamomea* leaves no doubt that this form is a member of the Neritidæ. The description of the male organs of *Helicina japonica* will be dealt with in the second part of this paper, and I can supplement it by an account of the female organs of *Alcadia*. Thiele regards the "receptaculum seminis," *i. e.* the spermatophore-sac, as the representative of the right kidney in female Neritidæ, and though I do not agree with this conclusion it is not far from the truth.

Further on Thiele gives a description of the kidney in *Nerita pica* and in *Septaria*, and here also makes more accurate observations than any of his predecessors. He also notices the extension of the pericardial cavity to the right side of the animal in *Septaria*, and makes a just comparison between the conditions obtaining in this animal and the Cephalopoda. In conclusion, Thiele suggests that the Neritidæ may have been derived from the Trochidæ, but points out features in which they show a resemblance to the Docoglossa. The latter, however, as he says, are more probably analogies than homologies, as the radula and the structure of the generative organs preclude any idea of close relationship between these groups.

The genus *Neritina*, owing to the abundance of the common *N. fluviatilis* in European rivers, has been more often and more thoroughly studied than the genus *Nerita*. It is not necessary to do more than refer to the works of Moquin-Tandon (**28**), Claparède (**12**), and Landsberg (**24**), or to the paper on the development of *Neritina* by Blochmann (**4**), because the results obtained by these authors have already been discussed and entirely superseded by the admirable papers of Lenssen (**25** & **26**). In the first of these two papers Lenssen deals with the digestive and genital systems, giving a detailed account of the bucco-pharyngeal cavity, the odontophore, the œsophagus with its glandular appendages, and the stomach. He and Gilson (**18**) are the only authors besides Thiele who have published an accurate account of this system of organs in the Neritacea. Gilson and Lenssen discovered the remarkable fact that in *Neritina*, a diœcious Gastropod, the female ducts are diaulic, whereas the male ducts are monaulic; and the latter author gives a thorough and accurate description of the very complex arrangements of both male and female organs. I have only to say that I have carefully verified Lenssen's statements and find nothing to correct and very little to add to them as regards the species examined, *Neritina fluviatilis*, but I find considerable and important differences in some of the tropical Neritinæ.

In his second paper Lenssen deals with the nervous, circulatory, respiratory, and excretory systems of *Neritina fluviatilis*. Here he has not been in some respects as accurate as in his first paper. For instance, in the description of the nervous system (p. 297) he confuses the labial with the buccal commissure. It is clear both from his text and figure that the commissure that he discovered is the buccal commissure, but he calls it the labial.

It is practically impossible to dissect out the true labial commissure in so small an animal as *N. fluviatilis*, and it is exceedingly difficult to trace it in sections; but I have satisfied myself that it exists. In other respects Lenssen's account and figure of the nerve-centres appear to be correct, and I can confirm his statement that there are no transverse commissures behind the single large commissure uniting the anterior ends of the pedal cords.

As regards the visceral and pallial nerves Lenssen makes a considerable advance on his predecessors and he accepts Bouvier's identification of the subintestinal ganglion. He discovered, apparently without being aware that Boutan and Béla Haller had anticipated him in this matter, the ganglion on the subintestinal nerve at the point where the latter turns rather sharply from right to left to course close below the surface on the dorsal side of the pedicle attaching the anterior part of the body to the visceral mass. His account of the relations of this ganglion and of the nerves given off from it is for the most part very exact, but he does not appear to have observed that the genital nerve (*loc. cit.* pl. i. fig. 1, *ns.*) almost immediately enlarges to form a ganglion of considerable size, closely attached to the oviduct (or sperm-duct). He further describes a structure which he hesitates to identify as the rudiment of the right ctenidium. "A cet endroit," he says, "il existe un organe creux, l'homologue, peut-être des mamelons découverts chez les patelles et d'autres prosobranches. Cet organe renferme un grand nombre de globules sanguins et semble, par conséquent, dépendre soit de l'appareil circulatoire, soit de l'appareil respiratoire. Il fait saillie dans la cavité branchiale et s'ouvre à sa base dans le sinus sanguin que nous venons de signaler." Further on (p. 312) he discusses the homology of this organ and suggests that it may represent the right ctenidium or the right osphradium, but gives no decided opinion on this point. A description and discussion of the significance of this organ will be found on p. 864.

Though he made, as he tells us, a careful search for it, Lenssen failed to discover the supra-intestinal nerve; but being cautious he does not venture to affirm that it does not exist. Nor am I ready to deny its existence, but after searching most carefully through several series of sections I am unable to discover a trace of it; and it is very possible that this nerve, extremely small in *Nerita* and the tropical species of *Neritina*, has actually disappeared in *N. fluviatilis*. In the descriptive part of this paper I shall have something to add to Lenssen's account of the left branchial ganglion and the osphradium. It is not necessary for me to refer at length to Lenssen's account of the circulatory, respiratory, and excretory systems. Though somewhat short, his descriptions of these systems are accurate so far as they go, and he is the first author to give a true and intelligible account of the kidney and reno-pericardial duct.

I make no separate reference to the literature bearing on the anatomy of *Septaria* (*Navicella*). This genus has not been studied in detail by any author, but Bouvier, Boutan, and others have described the nervous system in the works already quoted. As my interest in the Neritacea dates from some dissections of *Septaria* which I made for the purposes of my class, and as the secondary symmetry acquired by this genus makes it a very favourable object for describing and figuring the somewhat complex relations of the cœlom and genital ducts in the Neritacea, I will begin the account of my own work with a description of its anatomy.

### Genus Septaria Férussac.

The species of this genus available for my researches were *S. borbonica* Bory, *S. depressa* Lesson, both forming part of the collections of the Oxford Museum, and *S. bougainvillei* Récluz, from the British Museum. The number of specimens at my disposal was small, and I unfortunately dissected the only two specimens of *Septaria borbonica* that I possessed before I had made myself thoroughly familiar with the problems of Neritacean anatomy. A specimen of *S. depressa* was cut in horizontal and one of *S. bougainvillei* in transverse sections. Both these specimens proved to be females. There are some minor points of difference in the anatomy of the two species which will be referred to in due course.

A dorsal view of *S. borbonica* is given in fig. 1 *. The roof

* The figure-numbers 1–69 in this Memoir refer to the figures on Plates XLVI.–LXVI., which are described on pp. 885–887. There is only one text-figure (text-fig. 172, p. 855).

of the mantle-cavity has been cut through and largely removed to show the principal organs of the pallial complex. The head is relatively large; the tentacles short and swollen at their bases; the eyes, as in all Neritacea, borne on prominences at the outer sides of the bases of the tentacles. Owing to the abortion of the visceral spire the animal has acquired a secondary symmetry, which does not, however, extend to the more important systems of organs. The right and left columellar muscles, *cm.l* and *cm.r*, are subequal in size and symmetrically disposed right and left of the body. The visceral spire is reduced to a triangular mass at the posterior end of the body. To the right side of the mass is the ovary, *ov.*; the left side is occupied by the stomach covered over by the liver.

The mouth, situated on the ventral side of the head, is at the end of a very short snout, which can be scarcely retractile. The foot is large and oval, occupying nearly the whole of the ventral surface behind the snout: it is surrounded by a rudimentary epipodial ridge. The operculum is wedged in between the viscera and the upper surface of the foot, extending as far forward as the posterior end of the buccal bulb. It is functionless, at any rate as regards the closing of the aperture of the shell, but it seems to give support to the muscles of the foot, and retains a rudiment of the apophyses characteristic of the opercula of the Neritidæ.

On the dorsal side, after the removal of the roof of the mantle-cavity, the single bipectinate ctenidium, the post-torsional left, is seen lying obliquely across the mantle-cavity, its base attached to the left side and its free end pointing forward and to the right. As in most ctenidiate Neritacea, the proximal moiety of the ctenidum is attached by a suspensory membrane to the right and left walls of the mantle-cavity, in consequence of which arrangement the posterior half of the cavity is divided into an upper and a lower chamber.

The heart, enclosed in a spacious pericardial cavity, lies on the left side, just behind and below the posterior end of the left columellar muscle. It cannot be seen in a dorsal view, but its position is indicated by *pc.* The rectum, after traversing the ventricle, crosses obliquely from right to left just in front of the visceral mass, is partly embraced by the complex mass of accessory genital glands and ducts, *g.d*, and opens by the anus near the anterior end of the right columellar muscle. The kidney, *k*, lies between the rectum and the basal half of the ctenidium: it opens by a slit-shaped pore into the lower chamber of the mantle-cavity close to the right side of the base of the ctenidium, but the opening cannot be seen in the drawing. It is perhaps necessary to state here that the kidney is the post-torsional left, as has been fully recognized by recent authors on Molluscan anatomy. It is therefore the homologue, not of the large functional kidney of other Aspidobranchia, but of the so-called papillary sac of Trochidæ and Haliotidæ, and of the rudimentary left kidney of the Docoglossa.

### *The Alimentary Tract.*

Fig. 2 is an illustration exhibiting the macroscopic characters of the buccal bulb, œsophagus, stomach, and intestine. It would be possible to write at considerable length on the structure and histology of these various regions, but I purposely refrain from doing so, although my preparations have enabled me to study them with considerable accuracy. Allowance being made for small and unimportant differences in proportion and detail, the structure of the alimentary tract of *Septaria* is so closely similar to that of *Neritina fluviatilis* as described by Lenssen (**25**), that it is superfluous to give a description which would be little more than a repetition of his accurate observations. I need only call attention to one or two minor points. I find that in *Septaria*, as in *N. fluviatilis*, there are seven buccal cartilages, three pairs and one median and azygos. The smallest pair, discovered for the first time by Lenssen, does not strictly belong to the odontophore, but lies in the antero-inferior walls of the buccal bulb and serves as supports for a pair of pads, covered by a horny cuticle, against which the right and left halves of the anterior end of the radula work. In *Septaria* there is a small pair of glandular sacs, one on each side, opening into the lateral extensions of the subradular diverticulum of the buccal cavity. These have been noted by Thiele in *Nerita pica*, but are not recorded by Lenssen in *Neritina fluviatilis*. The œsophagus in *Septaria* passes to the left on leaving the buccal bulb and shows clear traces of the larval torsion so carefully described by Amaudrut (**1**). Just before its junction with the stomach it expands considerably and receives three large ducts from the liver. The œsophagus may be said to join the stomach tangentially; hence its aperture is prolonged backwards as a wide groove, bounded by thickened epithelial lips, which, while they differ slightly in detail, have the same relations as are described by Lenssen in *Neritina fluviatilis*. The stomach of *Septaria* consists, as is the case in all the Neritidæ I have examined, of a dilated œsophageal and a narrower pyloric moiety. In the former there is a large and prominent epithelial ridge, described by Lenssen as the "crête stomacale," conspicuous for its triangular appearance in section. Its extremely long columnar epithelial cells are always covered by a thick apparently cuticular product, which in appearance and composition seems to be similar to the cuticular lining continuous with the crystalline style found in so many Molluscs. In *Septaria* there is a small digitiform diverticulum of the œsophageal moiety of the stomach, situated between the lower end of the "crête stomacale" and the upper border of the œsophageal groove. This diverticulum, which is probably homologous with the spiral diverticulum of the stomach of *Haliotis*, appears to be absent in *Neritina fluviatilis*. The intestine and rectum do not call for any special mention. The histology of the different regions varies, and the variations have been sufficiently described by

Lenssen. The disposition of the coils of the intestine and their relations to the stomach, œsophagus, and radula-sac are indicated in fig. 2, as is also the position of the heart and the fact that the ventricle laps completely round the rectum. The radula-sac is large and usually of considerable length, but varies considerably in different specimens. When long it is involved in the coils of the intestine and its posterior part always passes ventrad of the œsophagus but dorsad of the stomach.

*The Nervous System.*

The main features of the nervous system have already been described by Bouvier (**9** & **10**) and Boutan (**7**). The latter author, correcting and amplifying the earlier account of Bouvier, describes a supra-intestinal nerve completing the streptoneurous condition of the visceral nerve, and gives an amended figure of Bouvier's drawing of the pleuro-pedal nerve-centres. In my earlier dissections I failed to identify the supra-intestinal nerve, but have been able to follow its course more or less completely in my serial sections, and am able to verify Boutan's statements as far as they go. In one particular I can add to them. Boutan traced the supra-intestinal nerve from its origin from the right pleural ganglion along the right side of the body, whence it turns over the gut towards the left side and courses, as he says, "dans la cavité branchiale, au niveau du tiers inférieur de la branchie." It is hardly correct to say that the nerve passes into the branchial cavity. After a considerable amount of trouble I have been able to trace the nerve as far as the osphradium, the precise character and position of the latter organ having been overlooked by Boutan. The supra-intestinal nerve on arriving at the left side of the body passes obliquely forward in the connective tissue underlying the integument on the dorsal side of the left columellar muscle. Near the anterior end of this muscle the nerve passes upward, and without any ganglionic enlargement on its course, it joins the elongated ganglion underlying the osphradium in the left anterior corner of the mantle-cavity. The osphradial ganglion is also supplied, as is the case in *Nerita* and *Neritina*, by the symmetrical left branchio-pallial nerve, emanating from the left pleural ganglion. This large nerve traverses the columellar muscle and passes almost direct to the osphradium, where it enlarges to form the above-mentioned ganglion. From the ganglion a branch passes along the anterior border of the left suspensory fold of the ctenidium and may be traced without difficulty nearly to the tip of the latter organ. Another branch passes backwards, nearly parallel to the columellar muscle. I have not been able to trace this nerve in its entirety, but have no doubt that it is the continuation of the supra-intestinal nerve, and joins the visceral ganglion in the vicinity of the uropore, thus completing the visceral loop. If this is the case the streptoneury is complete, as it is in *Nerita* and the larger tropical species of *Neritina*.

In order to avoid repetition of details I will pass briefly over the rest of the nervous system of *Septaria*. In all essential features it resembles the nervous systems of *Nerita* and the tropical Neritinæ, which I shall describe in greater detail in the subsequent part of this paper. I need only say here, because Béla Haller has thrown doubt upon these points in his description of the nervous system of *Nerita ornata*, that there is a well-defined labial commissure in *Septaria*, and that I can find no trace of transverse commissures, posterior to the main anterior commissure, between the pedal cords in this genus.

The position and structure of the subpallial sense-organ or osphradium in the Neritidæ has been correctly described by Bernard (**3**) and Thiele, but the latter author throws doubt on its homology with the true osphradium of other Mollusca, and other authors give doubtful or incorrect descriptions of it. In *Septaria* this sense-organ is easily distinguished in transverse sections as a prominent ridge of epithelium running forward from the anterior end of the left suspensory fold of the ctenidium along the roof of the mantle-cavity and ending only a short distance behind the thickened anterior edge of the mantle. It lies almost in the angle formed by the union of the mantle with the left columellar muscle, and its position at the inhalant side of the mantle-opening is consistent with the function usually attributed to an osphradium, that of a sense-organ for testing the quality of the water before it passes over the ctenidium. The cells covering this ridge are higher, their nuclei are more closely crowded together and stain more deeply than those of the adjacent mantle epithelium. Under a high power of the microscope the epithelial ridge can be resolved into three parallel strips. The two outer strips (*a–b* and *b–c* in fig. 17) consist solely of columnar epithelial cells with granular cytoplasm and rather large nuclei. The free ends of these cells bear cilia which in the groove shown on the lower side of fig. 17 are longer than elsewhere. The central strip (*b–b* in fig. 17) is largely composed of the same elements, but its character of a sensory epithelium is well shown by the presence of a number of attenuated sense-cells, interspersed between the larger columnar cells. The nuclei of the sense-cells are smaller and more elongated than those of the columnar cells; their cell-bodies stain deeply in carmine, and in many cases it can be seen that their inner ends are prolonged into fine fibrils which traverse the thin layer of muscle-fibres and connective tissue underlying the osphradium and pass into the osphradial ganglion. The size and position of this ganglion at the place where it is joined by the large branchio-pallial nerve are shown in fig. 17.

The respiratory and circulatory systems have been worked out in some detail by Lenssen in *Neritina fluviatilis*, and their arrangement is similar in *Septaria*, but allusion must be made to one or two points in which Lenssen's account is defective.

The ctenidium in *Septaria* is an elongated triangular organ, its free pointed extremity directed forward and to the right; its base attached to the body-wall on the left side. It consists of a flattened axial plate containing blood-spaces, with numerous gill-lamellæ running transversely across its dorsal and ventral surfaces. The ctenidium is therefore typically bipectinate. Unlike that of *N. fluviatilis* its posterior half is attached, on the left side to the mantle close to its union with the columellar muscle, on the right side to the lower surface of the kidney, by a membranous suspensory fold. Thus the posterior part of the mantle-cavity is divided into an upper and a lower chamber. A large blood-vessel runs along each edge of the axial plate, and in the upper and lower wall of each vessel there is a stout band of longitudinal muscle-fibres, which must serve as retractors of the gill and also assist in the circulation of blood through the gill-lamellæ. On the right-hand is the afferent and on the left the efferent branchial venous sinus. The two do not communicate with one another at the apex of the gill but only by the lacunar passages in the gill-lamellæ and the axial plate. The general course of circulation in the gill is as follows:—Blood is brought to the gills from the large venous sinus underlying the kidney by the afferent branchial sinus. This sinus does not communicate, as may be seen by inspection of fig. 20, with the cavities of the axial plate, except at very rare intervals, but it is in free communication above and below with the cavities of the gill-lamellæ, and its blood passes into these latter and circulates through them. The cavities of the gill-lamellæ and also that of the axial plate are broken up by numerous trabeculæ or partitions passing from wall to wall and are bounded by a thin layer of connective tissue containing a few muscular fibres. The margin of each gill-lamella is somewhat swollen and contains a cavity or vessel which, as far as I can ascertain, is continuous from one end of the lamella to the other, and also is in free communication with the irregular spaces below. At the opposite side of the gill these marginal vessels open into the efferent branchial sinus. The innermost cavities of the gill-lamellæ open from place to place into the system of lacunæ in the axial plate, and these, uniting to form a large lacuna near the left edge of the axial plate, also open at frequent intervals by large apertures into the efferent branchial sinus. It is obvious that the blood on entering the gill-lamellæ from the afferent sinus may either take a direct course to the efferent sinus by way of the marginal vessels of the lamellæ, or may traverse the lacunæ in the adaxial part of the lamellæ, pass into the system of lacunæ in the axial plate, and thence be discharged into the efferent sinus.

The distribution of ciliated epithelium on the faces of the gill-lamellæ is of some interest. Each gill-lamella is an extremely delicate plate of semilunar form, its straight inner margin attached to the axial plate, its curved margin free and, as described above, somewhat thickened. When one attempts to separate the lamellæ by the aid of needles one recognizes that their central portions adhere very closely together, whereas their lateral portions are readily parted from one another. When a single lamella is separated out, stained and examined under the microscope, it has the appearance shown in fig. 23, the dark central tract with diverging horns being the expression of numerous deeply stained and closely packed nuclei in this region. In short, the epithelium covering the lamellæ is not uniform. The following arrangement can be determined in section:—The lateral tracts of each face of each gill-lamella are clothed by a cubical epithelium containing isolated or grouped gland-cells of oval shape with clear contents. The epithelial cells of these tracts (if they are ciliated at all, which I am inclined to doubt) bear exceedingly short and fine cilia. The thickened margin of the lamella always bears three or four "frontal" cells at its extreme edge; these cells, as in the gills of Lamellibranchia, carry a tuft of short rather stiff cilia. External to them are a few cells devoid of cilia, and at the extreme ends of the lamellæ large gland-cells alternate with the epithelial cells of this region. Sections through the dark median band with its two horns show that this is a tract of more columnar cells, closely packed together, with deeply staining nuclei, each carrying a tuft of very long cilia which interlock with those of the adjacent lamella and are the cause of the adherence noted above.

There are no supporting rods or skeletal bars, such as those described by M. F. Woodward in *Pleurotomaria*, but, as shown in fig. 21, the connective tissue underlying the epithelial cells is thickened near the attachment of each gill-lamella to the axial plate. There is some resemblance between the arrangement of the lateral cilia in *Septaria* and other Neritidæ and in *Pleurotomaria*, and by parity of reasoning the ciliated tracts of the former genus must differ from those of Lamellibranchia in the same manner that Woodward has shown them to differ in the case of the latter genus. It is interesting to note the structural analogies of gastropod and lamellibranch gills. In the case of the Neritidæ the ciliated tracts fulfil the same functions as the ciliated discs of the Filibranchia. But their arrangement is different. The cell-mechanism is the same, but it cannot be doubted that it has been independently evolved in the two groups, affording a good instance of the evolution of similar but not identical structure in similar organs subject to similar conditions.

Lenssen, describing the gills of *Neritina fluviatilis*, has given an incorrect account of the epithelium. He figures an almost uniform covering of ciliated cells, and among them a few gland-cells. I have found the same arrangement in *N. fluviatilis* as in *Septaria*, and Lenssen would appear either to have altogether overlooked the ciliated tracts, or to have confused in a single drawing and description the ciliated cells of the one tract and the glandular cells of the other. It is curiously difficult to obtain good preparations of the gills of *N. fluviatilis*, and if my attention had not been called to the subject by the much more obvious arrangement of the cells in *Septaria*, I should have overlooked it. As it is I have identified a similar gill-structure in *Nerita plicata*, *N. variegata*, *Neritina gagates*, and *N. longispinosa*. The description given above is therefore characteristic for the ctenidium of the Neritidæ, and will not be repeated in dealing with other species.

The branchial nerve, derived from the ganglion underlying the osphradium, runs through the suspensory membrane and along the outside of the efferent branchial vessel in the free moiety of the gill. This nerve has been noted by nearly all previous authors, but only Bernard has described a nerve running down the other side of the gill, in connection with the afferent branchial vessel. Such a nerve, embedded in the dorsal longitudinal muscle, is present in *Septaria* and is shown in fig. 20, *br.n.* As far as I can determine from my sections it communicates with the nerve on the efferent side by a slender connection at the tip of the gill. It is thickest in the posterior part of the course, and passes into the right suspensory membrane in the direction of the visceral ganglion; but try as I might, I could not trace it through the suspensory membrane to the ganglion.

## *The Circulatory System.*

Lenssen's account of the heart and blood-vessels in *N. fluviatilis* is in all essential features applicable to *Septaria*. I need lay stress on a few points only. The ventricle in *Septaria* is thick and muscular and is completely wrapped round the rectum. I wish to emphasize this point, because some authors have stated that the ventricle is only partially attached to the rectum in Neritidæ, and have contrasted this with the conditions found in Haliotidæ and Trochidæ. Practically the supposed difference does not exist.

The blood from the efferent venous sinus passes directly into the left auricle, and at the point where the efferent sinus joins the auricle a large pallial sinus, bringing back blood from the numerous lacunæ of the roof of the mantle-cavity, opens into it. This pallial sinus has been recorded by Lenssen in *N. fluviatilis*, but I think he underrates its importance. In *Septaria*, at any rate, its diameter is nearly equal to that of the efferent branchial sinus, and it is connected with so extensive a system of blood-lacunæ in the mantle that there can be no doubt that the latter is a very important auxiliary organ of respiration. The blood, therefore, which reaches the ventricle by way of the left auricle has been oxygenated either during its passage through the ctenidium or through the mantle, but none of the pallial blood passes through the ctenidium. The importance of the pallial circulation in *Septaria* is further indicated by the relatively considerable size of the right auricle. This organ, the relations of which may easily be traced in sections or by simple dissection, passes from that part of the ventricle lying posterior to the rectum, across the pericardial cavity, and is attached to the left body-wall just at the level of the left posterior corner of the foot. Here it receives blood from two venous sinuses: the one bringing back blood from the left posterior region of the body-wall, the other from a considerable system of lacunæ in the posterior part of the foot. The former of these two sinuses runs in close connection with the posterior lobe of the kidney, and it would appear that we have here an arrangement whereby oxygenated blood from the mantle is also enabled to get rid of its waste nitrogenous products before it is returned to the heart. This is the reverse to what occurs in the case of the blood passed through the ctenidium, which is first purified of its nitrogenous waste matter during its passage through the sinuses of the anterior lobes of the kidney and is afterwards carried to the ctenidium by the afferent branchial sinus. The right auricle, like the left, is covered by the glandular tissue of the pericardial gland. As *Septaria* has undergone a considerable amount of detorsion, it is evident that the position of the right auricle, and its connection with the left and posterior part of the body-wall and foot, is a secondary phenomenon, due to its movement from right to left, in the direction of the hands of a clock, during the process of detorsion. In fact, one can only use the term "right" in a morphological sense, to indicate that this auricle would be on the right if the typical gastropod torsion had been maintained. In the genera *Nerita* and *Neritina*, as will be seen, the rudimentary auricle is more distinctly on the right side, but even in these forms posterior to the ventricle. The size of the right auricle varies much in the Neritidæ. It is always present, but in some of the typically marine forms such as *Nerita peloronta* it is so small and unimportant that it might easily be overlooked, and indeed its existence has been denied by Béla Haller. In the tropical Neritinæ, many of which are semi-aquatic in habit, spending no inconsiderable part of their lives on the roots of trees above low-water mark, or even above high-water mark of neap-tides, the right auricle is larger and receives the same blood-supply as in *Septaria*. The last-named genus is one that, according to all accounts, has progressed further than any other Neritid in the direction of a terrestrial life, living as it often does on stones in the vicinity of waterfalls where it is only wetted by spray. One might expect, therefore, that it would exhibit a more marked tendency to the replacement of a branchial by a pallial respiration, and such has been shown to be the case. It is of special interest to observe the connection between a more highly developed pallial respiration and the increased size and importance of the right auricle, for, as I shall show in the second part of this memoir dealing with the Helicinidæ, there is every reason to believe that in the last-mentioned family, in which the ctenidium is lost and the respiration is entirely pallial (or, as it is called, pulmonary), the single auricle that persists is the right and not, as has generally been supposed, the left.

The courses of the main efferent or arterial vessels proceeding from the ventricle, and the venous sinuses in the foot and visceral cavities, are so similar in *Septaria* to those described by Lenssen in *Neritina fluviatilis*, that it is not necessary to enter into any further description of them.

*The Hæmocœle and Cœlom.*

The cavities in which lie the buccal bulb, the œsophagus, radula-sac, and the coils of the intestine are, as is usually the case in Molluscs, a vast blood-space or hæmocœle. In most Neritidæ and in the Helicinidæ this space is largely filled up by a parenchymatous tissue, which from its structure and position appears to be metabolic in function and probably serves for the storage of reserve material. Where present it is aggregated along the courses of the chief arterial vessels, and a certain amount of it is to be found surrounding the anterior aorta in *Septaria*. This metabolic tissue, however, is never abundant in *Septaria*, and I postpone a description of it to the section dealing with the *Neritæ* and *Neritinæ*. In *Septaria*, and indeed in all Neritidæ, the large hæmocœlic cavity does not extend as a wide space into the visceral mass of the spire. In this region nearly the whole of the space contained within the body-walls is occupied by the ovary, the stomach, and the mass of the liver lying above and to the right side of the stomach. It is only on the left side that some distinct posterior prolongations of the hæmocœle are visible surrounding the intestine, the left and lower sides of the stomach, and the radula-sac. The great anterior hæmocœlic space surrounding the pharyngeal bulb and the greater part of the coils of the intestine is often referred to by writers on molluscan anatomy as the anterior body-cavity, and allusion is sometimes made to a sort of diaphragm or partition shutting off this anterior cavity from the visceral cavity behind. In fact, there is no definite diaphragm or dissepiment, and the appearance of one is due to a somewhat complex union of muscular membranes connected with the kidneys and genital ducts, but particularly to a large venous sinus with muscular walls passing from the right towards the base of the ctenidium. In this space lies the elongated visceral ganglion.

Theoretically the visceral hæmocœle is to be regarded as a continuous space, the hinder part of which is filled up by the stomach and liver. This can be understood by reference to fig. 41, illustrating a horizontal section through the ventral part of the body of *Neritina gagates*.

With regard to the cœlom, Lenssen observes with much truth that in *Neritina fluviatilis* it is the most extensive space in the whole body. "En avant," he says, "elle (la cavité péricardique) se prolonge jusqu'à la base de la branchie, et de là, s'élargissant de plus en plus en arrière, elle s'étend sur toute la largeur du corps et divise l'animal en deux portions bien nettes. Sa paroi supérieure se confond avec la base du rein et se prolonge sous l'utérus; elle sépare le rein du foie. Sa partie inférieure, chargée de pigment, enveloppe le massif formé par les circonvolutions de l'intestin et du sac radulaire dans la région antérieure du corps et se prolonge en arrière jusqu'à l'origine du rein." This description is tolerably exact, but the ramifications of the cœlomic cavity are extremely difficult to make out in *Neritina*, and a much clearer picture of the extent and relations of the cœlom can be obtained from the more symmetrical *Septaria*. In this genus, as may be seen in fig. 4, the cœlom is, relatively to the size of the body, a vast space extending from right to left across the entire width of the visceral mass.

Two divisions can be recognised, the pericardial and the gonadial cœlom. The former lies to the left; it is traversed by the bend of the rectum, contains the heart, and communicates by the reno-pericardial duct with the kidney. The gonadial division of the cœlom lies on the right, and may be described in general terms as intervening between the liver and ovary and the dorsal body-wall in the region of the visceral mass (fig. 4, *g.co.*). Near the anterior border of the visceral mass it forms a spacious cavity extending downward on the right side of the body to the level of the floor of the visceral hæmocœle, and here it enters into remarkable relations with the oviduct. As shown in figs. 3, 4, and 5, the oviduct, which pursues a nearly straight course forward from the ovary to the accessory genital apparatus, crosses the gonadial cœlom, and at this point opens into it by a distinct but short and narrow oviduco-cœlomic duct, the details of which are indicated in fig. 5. The duct is lined by a cubical epithelium bearing fine cilia, and this, near its opening into the gonadial division of the cœlom, is replaced by an epithelium containing closely crowded, deeply stained nuclei and bearing longer cilia. The similarity between this oviduco-cœlomic funnel and duct and the reno-pericardial canal of the left side is obvious, and affords evidence of the former existence of a right kidney, into which, as in other Rhipidoglossa, the ova were discharged to find their way to the exterior by the right uropore. The full significance of these relations will be dealt with further on: it need only be said here that the existence of an oviduco-cœlomic funnel, opening into a special division of the cœlom, is not parallelled in any other adult Gastropod, except the allied genera *Nerita* and *Neritina*.

The pericardial division of the cœlom is of large size: it extends forward to the base of the ctenidium and is continued for some little distance along the left edge of the latter, parallel to the efferent branchial vessel, as a narrow diverticulum. Posteriorly the pericardial cavity extends along the left side of the stomach nearly to the pointed extremity of the visceral mass. The gonadial division of the cœlom is a more irregular cavity. In the anterior part of the visceral mass, immediately behind the accessory genital organs, it is of considerable vertical depth, reaching from roof to floor of the visceral sac in front of the liver and ovary. A little further back it extends over the liver and ovary and to the right of the latter as far as the floor of the visceral sac, but on the left it appears in sections only as a narrow cleft reaching as far as the rectum. Posteriorly the gonadial cœlom gradually becomes smaller and smaller, as the liver and ovary project further into it, and eventually it is reduced to a comparatively narrow space between the rectum above and the radula-sac and liver below. In the region of and behind the ventricle the two divisions of the cœlom communicate freely with one another by a large slit-like passage which, as shown in fig. 4, *c.ap.*, lies dorsad of the stomach. The pericardial floor leading to it is deeply pigmented.

### *The Excretory System.*

The kidney in *Septaria* is more easily studied than in any other member of the Neritidæ, and my investigations confirm the correctness of Lenssen's somewhat brief account of this organ in *Neritina fluviatilis.* The kidney of *Septaria* is an elongated organ lying transversely across the posterior third of the body, closely attached to the left and anterior side of the rectum where the latter passes across from the pericardium to join the complex mass formed by the accessory genital organs (fig. 1, *K.*). The left and posterior end of the kidney lies close below the dorsal body-wall (fig. 4, *K.*); its right and anterior moiety passes into the dorsal wall of the mantle-cavity. Throughout the whole of its extent it is in close relation to the pericardial division of the cœlom. The kidney may be described in general terms as a tubular organ bent upon itself in such a way that its two ends are anterior and open respectively into the mantle by the uropore and into the pericardial division of the cœlom by the reno-pericardial duct. Only the dorsal limb of the tube is glandular, its cavity being traversed by a number of deep infoldings of its lateral walls, which in turn give off secondary folds (fig. 18, *K.*). There is no question of an acinous structure such as has been described in *Nerita ornata* by Béla Haller (**20**). As Lenssen describes for *Neritina fluviatilis*, the partitions which cross the cavity of the glandular part of the kidney of *Septaria*, though they may sometimes appear in sections to cross from wall to wall, are really infoldings of the lateral walls terminating in free edges within the cavity of the kidney. The whole of the glandular part is surrounded by a system of blood-sinuses (fig. 19, *b.si.*), connected with smaller sinuses running in the partitions, and a distinct sinus or vessel may often be recognized along the free edges of the latter. The epithelium clothing the walls and partitions of the glandular part of the kidney is non-ciliated, but is not of uniform character throughout. In the right and anterior moiety of the kidney the cells are dilated by the presence of a large transparent vacuole at their free ends; the nucleus lies in the basal part of the cell, stains faintly, and is surrounded by a small amount of cytoplasm. In the left and posterior moiety of the kidney the cells are more prismatic, are less vacuolated, their nuclei stain more deeply and are situated nearer to the middle of the cell-body. The different appearance of these two regions of the glandular part of the kidney, as seen under a low power of the microscope, is represented in fig. 18. It may be thought that this apparent distinction is due to a difference in the secretory activity of the cells, but I have found it to be so constant a feature in the different species of *Nerita* and *Neritina* that I have studied that I think there must be some functional differentiation between the two regions. The glandular part of the kidney opens posteriorly into the non-glandular part or bladder, the latter being a large flattened sac of irregular form running forward between the glandular part and the pericardium. It is this sac which Perrier described as a closed cavity interposed between the kidney and the pericardium, and Béla Haller was scarcely more correct in identifying it as the reno-pericardial duct. Anteriorly the bladder expands towards the right (fig. 19) to form a diverticulum lying below and behind the venous sinus in which the ascending portion of the sub-intestinal nerve is contained. The tough membranous walls of this diverticulum of the kidney-sac and of the venous sinus form together with the anterior wall of the gonadial cœlom the so-called diaphragm referred to on p. 834. The left anterior corner of the bladder passing below the glandular part turns upward as a narrow passage lying between the latter and the base of the ctenidium, and twisting over to the right opens into the lower chamber of the mantle-cavity by the uropore below and to the left of the afferent branchial sinus. By far the greater part of the bladder is lined by a non-ciliated flat epithelium, but in the duct leading to the uropore this is replaced by a ciliated epithelium composed of very long attenuated and transparent ciliated cells. The reno-pericardial canal, as is the case in all Neritidæ, is very large. It opens, as shown in fig. 18, *rp.c.*, into the anterior end of the glandular part of the kidney; thence running to the left and posteriorly, it becomes closely attached to the wall of the duct of the bladder in the vicinity of the uropore, and twisting downwards and inwards it describes an S-shaped curve and opens by a wide ciliated aperture into the base of the anterior diverticulum of the pericardial cavity referred to above as extending forward alongside the efferent branchial sinus. The epithelial cells of the reno-pericardial duct are very large and each bears a tuft of long stiff cilia. Lenssen has given a figure of this characteristic epithelium in *Neritina fluviatilis*, and describes it as a good example of a discontinuous epithelium. His figure is a good representation of the appearance usually seen in sections, but from what I have seen in some well-preserved specimens I think that the apparent discontinuity is due to contraction produced by reagents.

It follows from the above description that the kidney of *Septaria* (the kidney of other members of the Neritidæ is similar) is not a simple glandular sac, but is composed of a glandular and non-glandular part the relations of which are very similar to those observed in the lamellibranchiate kidney. In *Septaria bougainvillei* there is no communication between the anterior ends of the glandular and non-glandular parts. The exception is shown in fig. 19, representing part of a horizontal section through *Septaria depressa*. In this the terminal portion of the non-glandular part is seen to communicate with the glandular part by a small but perfectly distinct orifice in the vicinity of the renal aperture of the reno-pericardial duct. I can find no trace of such an orifice in *S. bougainvillei*, but it occurs in several other Neritidæ. It is not an accidental rent in the wall, the epithelium passing in unbroken continuity round the lips of the orifice.

It is now so generally understood that the kidney of the Neritidæ is the post-torsional left, that it is not necessary for me to insist upon the further evidence in support of this opinion derivable from the facts just mentioned. But it is perhaps necessary to allude to the question as Fleure (**17**) in a comparatively recent paper has attempted to prove that the single kidney of the Neritidæ and Pectinibranchia is the left post-torsional and corresponds with the large functional left kidney of most Rhipidoglossa. Unfortunately for his argument his paper is followed by that of Miss Drummond (**13**), in which the fact previously insisted on by von Erlanger (**14**) is placed beyond all doubt, namely that the existing kidney of *Paludina* (and presumably of other Pectinibranchs) is the post-torsional left. The rudiment of the post-torsional right kidney becomes converted into the genital duct in the course of embryonic development It is clear, from the presence of the oviduco-cœlomic funnel, that the same thing has happened in the Neritidæ.

*The Generative Organs.*

Gilson (**18**) was the first to give an intelligible account of the female generative organs of *Neritina fluviatilis*, and their structure was subsequently worked out in great detail by his pupil Lenssen. More lately Thiele has described these organs in several species of Neritidæ, including *Septaria* (*Navicella*) *parva* and *suborbicularis*. A further description would therefore seem superfluous, were it not that *Septaria* differs in some not unimportant particulars from *Neritina*, and Thiele's account of the former genus is little more than a brief note, omitting histological detail, and, moreover defective in at least one very important particular. Moreover, as a result of a comparison of Lenssen's and Thiele's work with my own and of an attempt to homologize the different cavities, ducts, and glands in the different forms that I have examined, I have come to conclusions somewhat different from those of the two authors named, and have to suggest a new nomenclature for the different parts. Gilson and Lenssen have shown that the female ducts of *Neritina fluviatilis* are diaulic; Thiele has made the same statement for *Nerita* and *Septaria*. A reference to the diagram (fig. 3) will show that the female ducts of *Septaria* are triaulic There is the large *ovipository aperture* (*Ov.ap.*), through which the eggs enclosed in their egg-shells are extruded; the copulatory or *vaginal aperture* (*vag.ap.*), through which the sperm of the male is received; and a third minute aperture (*ap.de.*) situated further back, whose function I cannot determine: I shall refer to it as the aperture of the *ductus enigmaticus.* This third aperture is not present in *Neritina fluviatilis* nor in the marine species of *Nerita*, but is present in all the fresh- or brackish-water tropical species hitherto classed as *Neritina*. To begin with a description of the diagram, fig. 3. The ovipository aperture leads into a vast pouch with thick glandular walls. This has been called the "uterus" by Gilson and Lenssen, the "shell-gland" by Thiele. As there is no doubt that the egg-shell is formed from the secretion of the glands opening into this cavity the latter name is appropriate, but it will avoid confusion if I borrow a name from an analogous structure in the Platyhelmia and call it the "ootype."

A flattened saccular diverticulum (*cry.s.*), lying on the right side of the terminal part of the ootype, opens into the latter not far from the ovipository aperture. In the species I examined it is of small size and does not contain concretions or foreign bodies, but it is clearly homologous with the "poche à cristaux" of Lenssen, and I shall refer to it as the *crystal-sac.* In *Nerita* and *Neritina* it is relatively large and filled with spherical crystalline bodies. Thiele calls this sac the uterus, but the name is inappropriate, for there is no evidence whatever that the ova are passed into it.

The relations of the ootype may be studied in the series of transverse sections (figs. 6–12). Anteriorly it lies above and partly embraces the rectum. In this region its walls are very thick and glandular, its cavity large, crescentic, and simple. Further back it lies to the right of and apart from the rectum, and its cavity becomes more complicated in form. The whole organ is spirally twisted, so that the concavity of the crescent, which was at first directed downwards, is in fig. 9 directed upwards. In fig. 10 the left-hand corner of the cavity is seen to be prolonged into a diverticulum, which in fig. 11 turns sharply to the right and runs back parallel to its former course. From this, which may be described as the terminal part or fundus of the ootype, two passages are given off in different directions. The one, which I shall call the *egg-duct*, leads to the oviduct and through this to the ovary. The other establishes a connection with the vagina and ductus enigmaticus and serves for the admission of spermatozoa to the fundus of the ootype.

The egg-duct (*eg.d.* in figs. 10–13) is characterized by the different forms of glandular tissue constituting its walls. Its opening into the cavity of the ootype is embraced by a glandular thickening distinguishable from the fact that its cell-contents do not stain in any of the ordinary dyes: this I call the *clear gland.* As shown in figs. 11, 12, 13, it is largely situated in a tongue-shaped projection of the right-hand wall of the fundus, which appears to function as a valve guarding the passage from the fundus into the egg-duct. The dorsal side of the egg-duct is capped by a considerable glandular mass (*m.gl.*), whose contents stain deeply in hæmatoxylin: it may therefore be identified as a *mucous gland.* Beyond this is a narrow ring of glandular tissue whose cell-contents stain bright rose-red colour in eosin and carmine dyes: for this reason I shall refer to it as the rose-coloured gland (figs. 12–14, *rc.gl.*). Beyond the rose-coloured gland the egg-duct dilates to form a distinct chamber with thick glandular walls. This chamber corresponds to the "première ampoule" of Lenssen; I shall call it the *thalamus* (figs. 14, 15, 16, *th.*). It occupies the right-hand posterior corner of the genital complex, and the gland surrounding it may from its position and staining-properties be identified as the *vitelline gland.* The *oviduct*, a narrow tube lined by a columnar ciliated epithelium, emerges from the lower left-hand corner of the thalamus, runs towards the left, is thrown into a few convolutions, then turns sharply backward and downward and enters the connective-tissue layer forming the floor of the large right extension of the gonadial cœlom. In its passage below this cœlomic space it gives off a short branch to the right, which immediately opens into the cœlom by a ciliated oviduco-cœlomic funnel (figs. 3 & 4, *od.c.f.*). Beyond the oviduco-cœlomic funnel the oviduct branches repeatedly; the branches subdivide and end in a number of claviform acini lined by a germinal epithelium and containing ova in all stages of development. The ovary, thus constituted, is a fairly extensive organ lying to the right of the liver and spreading for some distance over its dorsal surface.

The second passage leading out of the fundus of the ootype is a narrow thin-walled tube which passes to the right and immediately dilates to form a sac of considerable size lying between the posterior end of the ootype and the rectum. As this sac always contains free spermatozoa in greater or less abundance, it may be called the *sperm-sac.* Its walls are thin, usually much folded, and lined by a simple cubical ciliated epithelium without any trace of glandular structure. In longitudinal section it is seen to be **U**-shaped.

From the bend of the **U** a short duct is given off posteriorly. It has thick muscular walls, and ends in a thick-walled dilatation, filled with spermatozoa. This is the *receptaculum seminis* (=spermatheca of Gilson). The limbs of the **U** are prolonged forward as two narrow ducts, which acquire thick muscular walls and open separately into the mantle-cavity. The outer or right-hand duct corresponds to the "connecting duct" of Gilson and Lenssen. I shall call it the *vaginal canal.* The inner or left-hand duct is not represented in *Nerita* or in *Neritina fluviatilis*, and as its function is obscure I have named it the *ductus enigmaticus.* The two ducts run forward close to one another and to the rectum. The ductus enigmaticus is relatively short and straight, and eventually opens into the mantle-cavity by a minute pore situated on the ventral side of the genital complex and some distance posterior to the anal and ovipository apertures (fig. 6, *ap.de.*). The vaginal canal runs parallel to the ductus enigmaticus as far as the opening of the latter, and then bends abruptly backward. Its lumen becomes very narrow, and its muscular wall relatively thick; after a short course backward it opens by a minute pore into a sac (*sp.s.*), which corresponds to the copulatory vesicle of Gilson and Lenssen, the receptaculum seminis of Thiele. As may be seen in the diagram, it is the dilated posterior end of the *vagina* (*vag.*), and is of small size in *Septaria borbonica* and *bougainvillei*. But in the tropical *Neritinæ*, in *Nerita*, and, according to Thiele, in *Septaria parva* it is relatively of enormous size and invariably contains a number of spermatophores of complex structure. Hence I shall call it the *spermatophore-sac*, although I have not found a trace of spermatophores in any of the specimens of *Septaria* that I have examined. The lumen of the spermatophore-sac gradually diminishes anteriorly and passes without sensible alteration of structure into the *vagina*, which opens into the mantle-cavity by the vaginal aperture situated on a prominent papilla some little way in front of the anus.

Gilson has given a clear account of the process of fertilization in *Neritina fluviatilis*. Owing to the small size of the spermatophore-sac it must be somewhat different in *Septaria borbonica* and *bougainvillei*. The spermatozoa must be deposited by the male in the vagina and must travel by way of the vaginal canal to the receptaculum seminis, where they are disposed, just as Gilson describes, in a very regular manner, all heads turned towards the centre of the vesicle and all tails directed outwards. At the time of impregnation the spermatozoa must be passed, by contraction of the muscular walls of the receptaculum and its duct, into the fundus of the ootype and thence into the egg-duct, where the ova are fertilized. The function of the ductus enigmaticus can only be guessed at. It may serve to admit water into the cavity of the sperm-sac, or contrariwise may serve for the expulsion of fluids accumulating in the sperm-sac.

### *Histology of the Genital Ducts.*

From what precedes it will have been gathered that there are five different kinds of glands on the course of the ootype and egg-duct, viz., the vitelline gland, the rose-coloured gland, the mucous gland, the clear gland, and the ootype or shell-gland. Similar glands occur in the same positions in all the Neritidæ I have studied, including *Neritina fluviatilis*. The histology of the shell-gland of the last-named species has been correctly described by Lenssen, but he gives a very summary, and, in the case of the vitelline gland at least, a somewhat incorrect account of the remainder. The important thing is that all the glands are of the same fundamental structural plan, and only differ from one another in the proportions and staining-properties of the cells and the secretions produced by them. It may therefore be inferred that the community of structure is due to community of origin; and if it can be shown that there is a transition between the secretory epithelia of the glands and the epithelia of other regions, there is a presumption in favour of the view that the glands are derived from those other epithelia. A transition can be demonstrated between the epithelium of the mantle-cavity and that of the shell-gland. The epithelium lining the mantle-cavity differs considerably in different parts, but in the neighbourhood of the ovipository aperture it consists of fairly high columnar ciliated cells, among which are numerous gland-cells with granular contents, which in *Septaria* stain bright green in picro-indigo-carmine. This epithelium is continued over the lip of the ovipository aperture into the terminal part of the lumen of the ootype, and, extending further down on the right side than elsewhere, forms the lining of the crystal-sac. Elsewhere it quickly undergoes a change: the gland-cells disappear, and the ciliated cells increase in length, become attenuated, and are separated by considerable intercellular spaces (fig. 24). This simple ciliated epithelium is continued downward for some little distance, and only gradually becomes complicated by the appearance at first of a few club-shaped gland-cells lying between the ciliated cells. The gland-cells contain large granules, highly eosinophilous, or staining bright green in picro-indigo-carmine. The gland-cells soon become more abundant, and some of them, while retaining their connection with the surface, tend to take up a deeper position. Their swollen inner ends, containing the nucleus and most of the cytoplasm, pass through the thin layer of muscle-fibres underlying the ciliated epithelium and embed themselves in the surrounding connective tissue, their distal ends being drawn out into fine tubes which pass between the ciliated cells and open into the cavity of the ootype. In good preparations the walls of these tubes are quite distinct, and each tube contains a single row of eosinophilous granules, but swells out in the intercellular space between the ciliated cells, so that it appears to terminate in a claviform vesicle distended with granules (fig. 25). A little further down the gland-cells increase in number and form groups, and these groups passing into the surrounding connective tissue form at first shorter, but in the greater part of the ootype relatively long, club-shaped masses surrounding its cavity. The club-shaped masses have the appearance of and have been described as crypts, but are not to be regarded as such, for what appears to be the cavity of the crypt is occupied by the tubes, and there is no lumen into which the secretion is discharged, but each cell has its own duct opening on the surface. This may readily be seen in transverse sections of the so-called crypts in good preparations. It would be more correct to describe each group of cells as a bunch, the deeper cells having very long hollow stalks and the more superficial cells shorter stalks; all the stalks pass between the ciliated epithelial cells, become slightly swollen, and open on the surface. The manner in which this somewhat elaborate arrangement is derived from a comparatively simple mixed ciliated and glandular epithelium is very well shown in the terminal chamber of the male ducts of *Nerita* (fig. 52). Precisely the same fundamental structure is found in all the glands on the course of the female ducts. In the ootype gland the cell-bodies are coarsely granular and stain deeply in hæmatoxylin, the granules of secretum are highly eosinophilous, and the ciliated cells are moderately long. In the "clear gland" the cytoplasm of the gland-cells is scarcely granular, is not stained appreciably by any of the ordinary dyes, the "stalks" or ducts of the cells are relatively large, their contents clear and unstained by reagents. The ciliated cells are somewhat widely spaced, and conspicuous because they are not hidden by granules in the secreting ducts (fig. 27).

In the "mucous gland" the bunches of glandular cells are large; the gland-cells are dark and granular and their cytoplasm stains deeply with hæmatoxylin and picro-indigo-carmine. The secretory granules are not so large as in the uterine gland, are of unequal size, and as they are not eosinphilous, but stain blue with picro-indigo-carmine and deeply with hæmatoxylin, they are probably mucinogenous. The ciliated epithelial cells between which the unicellular ducts run are very much elongated.

In the "rose-coloured gland" the bunches of gland-cells are rather small; their cytoplasm stains rose-pink with picro-indigo-carmine, carmine, or eosin; they are not granular, and their ducts contain a non-granular coagulum which is highly eosinophilous. The ciliated cells are short.

In the "vitelline gland" (fig. 28) the cell-bunches are of moderate size; the gland-cells have a reticular cytoplasm staining faintly with picro-indigo-carmine or hæmatoxylin; the secretory granules are small, of equal size, and faintly stained by the reagents mentioned; the ciliated cells forming the boundary epithelium are clearly defined and of moderate length.

It is evident that, although it is not possible to attribute precise functions to the different glands, they are to be regarded morphologically as differentiations of a tract of mixed glandular and ciliated epithelium, the histological characters of which are such that it is in the highest degree probable that it has been formed as an invagination of the mantle-epithelium—that is to say, of the ectoderm. The histology of the vagina, vaginal duct, sperm-sac, and ductus enigmaticus is quite different. These organs are non-glandular, and are all lined by a very similar ciliated cubical epithelium, which at first sight does seem to be very similar to the epithelium of the oviduct, and different from that of the mantle-cavity. But a careful examination with high powers of the microscope shows that they are different. In the oviduct the cytoplasm of the cells is differentiated to form a distinct refractive external border, the cilia are longer and stouter, the nuclei are more elongated and stain more intensely than is the case in the bursa copulatrix and the ducts leading from it. Moreover, when the vaginal duct is traced to its aperture, which in *Septaria* lies some way in front of the anal and ovipository apertures, the epithelium of the duct is seen to pass without any distinction of histological character into the epithelium of the adjacent part of the mantle-cavity, which latter is not in this place glandular, as it is close by the anal and uterine orifices, but is a simple ciliated columnar epithelium resembling the epithelium of the terminal portion of the vaginal duct in the minutest particulars. The ductus enigmaticus opens into a region of the mantle in which the epithelium has been greatly modified by the abundant development of long beaker-shaped mucous cells, and in this case the transition from the epithelium of the duct to that of the mantle is abrupt (fig. 6). From a consideration of these facts I am inclined to the opinion that the whole of the sperm-sac and its two ducts is also formed as an invagination of the mantle-epithelium, and that therefore the whole of the accessory organs contained in the genital complex, with the exception of a short length of the oviduct, are ectodermal structures secondarily attached to the oviduct; and in this I differ from Thiele (**39**), who regards the whole of the vagina and sperm-sac (which he calls the receptaculum seminis) as the representative of the right kidney of the Neritidæ. There can be no doubt that the distal portion of the oviduct represents a part, probably the terminal part or duct, of the right kidney. The existence of the oviduco-cœlomic funnel is sufficient evidence of this homology. But in my opinion the limit between kidney derivative and ectodermal derivative is indicated in *Septaria* by the opening of the oviduct into the thalamus. Here there is an abrupt change in the histological character of the epithelium, and a reference to figs. 3, 13, & 16 shows that the thalamus and the egg-duct intervene between the oviduct and the sperm-sac. I have given strong reasons for believing that all the glands of the thalamus and egg-duct are derived from the ectoderm; and if I am right this circumstance militates against Thiele's view that the spermatophore-sac represents the right kidney, for it can hardly be maintained that ectodermal structures have pushed their way into the primitive kidney and divided it into two widely separated parts, one opening to the exterior, the other communicating with the cœlom by a ciliated funnel.

I am unable to give a description of the male organs of *Septaria*, as all the specimens that I have examined by means of sections were females.

From an inspection of fig. 4 it might be inferred that the extensive tubular gland lying in the dorsal body-wall to the right of the rectum, and therefore occupying on the right side of the body a position similar to that occupied by the kidney on the left, is a representative of the glandular part of the right kidney. Such an inference, however, cannot be sustained. The histological characters of the gland in question are indistinguishable from those of the hypobranchial mucous gland of other Rhipidogloss (e. g. *Fissurella*). The anterior lobe of the gland lies immediately behind the genital complex—some of its tubules are seen in figs. 15 & 16,—and its duct issues from the anterior lobe, passes ventrad of the receptaculum seminis, and opens into the right-hand side of the mantle-cavity just below and to the right of the oviduco-cœlomic funnel. It will be observed that the gland in *Septaria* lies on the right side of the rectum, and cannot therefore be the exact homologue of the hypobranchial gland of the Trochidæ, which lies to the left of the rectum, between the latter and the left ctenidium to which it is related. It must rather be regarded as the homologue of the right hypobranchial gland of the dibranchiate Rhipidoglossa, and it seems probable that it represents the additional gland of the right side described by M. F. Woodward (**41**) in *Pleurotomaria*. The right hypobranchial (or additional hypobranchial) gland should be related to the right ctenidium, but this has apparently disappeared in the Neritidæ. I cannot find any vestige of it in *Septaria*, but in various species of *Nerita* and *Neritina* there is a small vascular organ projecting into the mantle-cavity close to the aperture of the hypobranchial mucous gland. This has been described in *Neritina fluviatilis* by Lenssen under the name of the "organe creux," and I shall show in the latter half of this paper that partly on account of its relation to the hyprobranchial gland there are good reasons for regarding it as the vestige of the right ctenidium.

### Genera Nerita Adanson and Neritina Lamarck.

It would be possible to give a detailed account of numerous minute differences in the alimentary tract, minor branches of the nervous system, excretory organs, &c. in the various species of *Nerita* and *Neritina* that I have studied; but the enumeration of these details would be not only tedious but unprofitable. I have satisfied myself that in all essential features of the anatomy of the alimentary tract, nervous system, respiratory and circulatory systems, and excretory organs, the various species enumerated below are so similar to one another that they may be included in a single description. Moreover, their main anatomical features are so like those of *Septaria* that I may spare the reader the trouble of perusing a mass of detail which would differ only in unessential matters from what has already been described in the last-named genus. It is otherwise with the generative ducts, especially the female ducts. I shall have to point out that the specimens I have had the opportunity of examining fall into three groups, defined by the constitution of the genital ducts. The first group comprises the marine species unquestionably belonging to the genus *Nerita*, as defined in conchological works. The second group comprises the tropical species hitherto classed in the genus *Neritina* and the genus *Septaria*. The third group comprises the European *Neritina fluviatilis*, and to this must probably be added the various European species of *Neritina*; but I cannot say anything definitely on this subject, for I have not yet had the opportunity of studying the anatomy of the European species other than *fluviatilis*.

I was at first disposed to arrange these three groups as different genera, but have hesitated to do so, because I have perceived that it is impossible to make a reconstruction of the family Neritidæ on the basis of the slender amount of material at my disposal. I can only indicate the conclusions I have come to and express an opinion upon the probable relationships within the family, leaving to future workers in this field the task of testing the validity of my suggestions.

I am inclined to think, with Moquin-Tandon (**28**), that the species hitherto classed in the genera *Nerita*, *Neritina*, and *Septaria*, agreeing as they do in all fundamental anatomical features, should be grouped together in a single genus *Nerita*. In this genus I recognize four sections—as a result of further investigations more will probably have to be added,—*Nerita*, s.s., *Paranerita*, *Septaria*, and *Neritina*. The section *Nerita* comprises (so far as the present state of our knowledge permits a definite statement) all those truly marine species hitherto classed in the genus *Nerita*. The section *Paranerita* includes the tropical brackish- and fresh-water forms hitherto classed in the genus *Neritina*, but which differ from *Neritina fluviatilis* in the arrangement of the female ducts, in the presence of a distinct supra-intestinal nerve, and other minor features. The section *Neritina* includes *Neritina fluviatilis* and probably all the European, Mediterranean, and Western Asiatic species of *Neritina* included in the section *Theodoxus* of Montfort. The subgenus *Septaria* is equivalent to the genus *Septaria* of Férussac. Though I do not regard this as more than a provisional arrangement, I shall make use of it, for clearness' sake, in the following part of this paper. It will be found, I believe, that as our knowledge of the Neritidæ advances, the various species will fall into a number of geographical groups and subgroups, each group including marine, estuarine, and fluviatile forms, but the consideration of this suggestion must be left to the latter part of this paper.

Adopting the provisional nomenclature suggested in the preceding paragraph, the material at my disposal has been as follows:—

*Nerita*, s.s.

*N. peloronta* Linn. This, the well-known "Bleeding-tooth," is a West Indian species.

*N. plexa* Chemnitz. This species is widely distributed in the Indian Ocean.

*N. lineata* Chemnitz. From the Malaysian Islands and N. Australia.

(The above formed part of the spirit-collections of the British Museum of Natural History, and I am indebted to Mr. E. A. Smith for the opportunity of studying their anatomy.)

*N. plicata* Linn. This species is widely distributed in the Indian and Pacific Oceans. My specimens were obtained, through the kindness of Mrs. G. B. Longstaff, from Ceylon.

*N. melanotraga* E. A. Smith. Specimens of this Australian species were kindly collected for me by Mr. Geoffrey W. Smith, of New College, Oxford.

*Paranerita.*

*N. variegata* Lesson. From the East Indies and Polynesia. I am indebted to Mr. E. A. Smith for specimens of this species, which is synonymous with *N. gagates* Mörch.

*N. gagates* Lam. From Mauritius.

*N. longispina* Récluz. From Mauritius. My specimens of the last-named two species formed part of the collections of the Oxford Museum, and in the same collections I found a number of fairly well-preserved spirit-specimens of an unknown species from Fiji, which I could not determine because the animals had been extracted from their shells and were not accompanied by any note of identification.

*Neritina.*

*N. fluviatilis* Müller is common in the Isis and Cherwell and in the smaller streams near Oxford.

In dealing with the general anatomy of these species I shall chiefly occupy myself with a description of those features in which they differ from one another, but it will also be necessary to enter into some details about organs in which they resemble one another, but in respect of which there is disagreement among previous authors.

*External Features.*

*Septaria*, as has been shown, has undergone so much reduction of the visceral spire that it has acquired a secondary external symmetry, but the three sections *Nerita*, *Paranerita*, and *Neritina* retain to a much greater extent the primitive gastropod asymmetry. It is obvious, however, that they are tending towards a secondary external symmetry, the visceral spire being relatively small and making scarcely more than half a turn. The shell-muscle or columellar muscle is a striking feature in the Neritidæ. It is always paired and subsymmetrical. Both muscles are coarsely fasciculated; that of the right side is somewhat the stouter, that of the left side somewhat longer in an antero-posterior direction. The two muscles are attached to the right and left inner surfaces of the shell within the area, and their impressions are not easy to see in those shells in which the area is strongly toothed or highly developed. The muscle-fibres of each side converge downwards and inwards from their surfaces of attachment to the shell and pass into the powerful muscular mass forming what is really the anterior end of the opercular lobe, but in contracted specimens this end always appears to be posterior in position. The subequal development of the right and left columellar muscle is without doubt related to the peculiar development and functional importance of the semilunar operculum, the straight and morphologically anterior edge of which works against the anterior edge of the so-called area in a hinge-like manner. When the animal is fully extended the operculum is turned back and pressed close to the flat surface of the area; and an examination of a relaxed specimen or of a living *Neritina fluviatilis* shows that it is a mechanical necessity that there should be an equal pull at both ends of the semilunar operculum in order to bring about an effective closure of the aperture when the animal retreats into its shell. There can be no doubt that the operculum is a very important factor in the economy of the Neritidæ, and that, in the course of evolution, its growing importance has had much to do with the tendency to reduction of the visceral spire exhibited by members of this family. It can hardly be doubted that the physiological effect of a well-developed left shell-muscle, exerting a pull upon the organs of the left side every time that the animal withdraws itself into its shell, will be to draw those organs over from right to left and thus to uncoil the typical gastropod spiral in opposition to the action of the right muscle. When both muscles are equally developed and inserted symmetrically on the interior of the shell, as is the case in existing Neritidæ, their joint action must tend to the establishment and maintenance of a symmetrical arrangement of such organs as are affected by their action, and we find, in fact, that the disposition of the two muscles produces an appearance of symmetry in the region of the head and foot, which to a certain extent affects the organs of the pallial complex and of the proximal part of the visceral mass. It is known that in *Fissurella* the secondary symmetry of the adult is acquired in the course of development by the relatively great growth of the foot, the formation of a shell-muscle on the left as well as on the right side of the body, and the subsequent rapid growth of the right side, causing a shifting back of organs from right to left. But in this case the increased functional importance of the sole of the foot and the loss of the operculum and opercular lobe have been the main factors in determining the final relations of foot, shell, and visceral mass. In the Neritidæ different conditions have prevailed. The sole of the foot remains relatively small; the operculum and opercular lobe become large and important, and by their presence prevent any posterior union of the right and left shell-muscles; the visceral spire remains connected with the cephalo-podial regions by a relatively narrow pedicle. The different lines of evolution are well illustrated by *Septaria*, in which the sole of the foot has enlarged so much that it rivals that of a *Fissurella*, a *Patella*, or a *Capulus* in size and importance, and the shell has become almost patelliform, but the operculum, though functionless, retains its place between the posterior part of the foot and the visceral mass, and the last-named is interposed between the hinder ends of the elongate and perfectly symmetrical right and left shell-muscles. Of course, the analogy between the Fissurellidæ and Neritidæ is incomplete in many respects. The ancestor of the latter family must have suffered great reduction in the organs of the post-torsional right side, such as the ctenidium, before any tendency to detorsion manifested itself. All that I wish to point out here is that, in any discussion of the causes of torsion and detorsion in gastropod molluscs, the action of the muscles should be considered more carefully than has hitherto been the case. I do not propose to pursue the subject further in this place, as it would involve a long and detailed comparison of the regional anatomy of many different gastropods, but before leaving it I must guard myself against the imputation of giving a Lamarckian explanation of a particular course of molluscan evolution. I have suggested a physiological explanation, and this is necessarily Lamarckian in form. The reader can easily translate my suggestion into terms of Natural Selection, and it would be no compliment to his intelligence if I were to occupy an additional page of print in doing so.

Of other external features, I need only allude to the following. The snout is so short that it can hardly be said to exist; there is neither pretentacular nor postentacular elongation in the cephalic or postcephalic regions in the sense indicated by Amaudrut (**1**). The opercular lobe is relatively very large and muscular; its outline is semilunar, the left corner deeply indented to receive the apophyses of the operculum (fig. 29). The epipodium is represented by a low ridge, devoid of any tentacles or outgrowths, extending from behind the tentacles to the posterior end of the operculum on each side. It is somewhat enlarged in the opercular region, but is inconspicuous in contracted specimens, because it is compressed between the hind end of the foot and the opercular lobe.

The anterior border of the mantle is muscular, and in marine species (*Nerita*) more or less frilled. The remainder of the mantle is extremely thin.

The tentacles are conical, commonly decorated with alternate stripes of black and white, and are short in all the fresh-water species (*Paranerita* and *Neritina*) that I have examined, but long and slender in the marine species (*Nerita*).

Various accounts have been given of the so-called cephalic penis in the Neritidæ. It was figured by Quoy and Gaimard (**35**), referred to in somewhat doubtful terms by Moquin-Tandon (**28**), overlooked by Claparède (**12**). Bouvier (**9**) gives a remarkable figure of this organ in *Neritina cariosa*, and Thiele makes a very short reference to it and gives a small figure of its appearance in transverse section. The organ in question is without doubt a modification of the inner part of the base of the right tentacle and is a good external indication of the male sex. Its position and appearance are illustrated in fig. 30 (*Neritina fluviatilis*), fig. 31 (*Nerita melanotraga*), and fig. 32 (*Paranerita gagates*). It differs somewhat in size and shape in the other species I have examined, but I have never seen it bifurcated as described by Bouvier, nor of the shape figured by him for *N. cariosa*.

In all the species I have examined it is a solid muscular outgrowth of the base of the right tentacle, innervated, so far as I am able to determine from sections, by a slender branch of the right tentacular nerve. Its external side, that is the side nearest the tentacle, is deeply grooved; the lower lip of the groove is swollen and prominent and clothed with a layer of long cylindrical epithelial cells, among which are numerous sense-cells. Elsewhere the surface of the organ is covered by a moderately high ciliated cylindrical epithelium, the cilia being specially well developed along the lower surface, but the groove itself is lined by a simple non-ciliated cylindrical epithelium. The hinder end of the groove opens almost behind and above the base of the right tentacle, and there is no sign of any furrow or ciliated tract leading from the groove to the aperture of the male duct. The male opening lies close to the base of the right eye-stalk, but rather in advance of it, and it is not easy to understand how any connection can be established between it and the penial groove. Communication on the ventral side of the tentacle seems to be hindered by the presence of the epipodial ridge. It is, however, difficult to judge from the examination of contracted specimens. The organ is probably very extensile, and its shape seems adapted for grasping and conveying the complicated spermatophores of *Nerita* and *Paranerita* to the vaginal opening of the female; but I must confess that I have been unable to find any proof of this. I have found no trace of spermatophores either in the male ducts or in the groove of the penis in any species, and I have failed to observe the act of copulation in the numerous *Neritina fluviatilis* that I have kept in aquaria.

The relative positions of heart, rectum, kidney, and ctenidium, as seen in an external view of the entire animal, are shown in fig. 29 and need no further comment.

In the marine species (*Nerita*) there is a well-developed opercular gland opening by a median aperture just in front of what is morphologically the anterior edge of the operculum, between it and the posterior edge of the mantle-flap. (In a contracted specimen, such as that drawn in fig. 29, the anterior edge of the opercular lobe appears to be posterior.) This gland is very large in *Nerita plicata*, *melanotraga*, and *peloronta*; smaller but still conspicuous in *lineata* and *plexa*. In freshwater species (*Paranerita* and *Neritina*) it can scarcely be said to exist, being represented only by a glandular area, sometimes produced internally into a few crypts, in the angle between the mantle and the opercular lobe. The gland in *Nerita* is clearly an invagination of this glandular area, and there is a gradual and interesting transition from the external epithelium to the highly modified epithelium forming the bulk of the gland. The duct is short and wide, and as it enters the hæmocœle is accompanied by a stout strand of muscle, from which flat muscular partitions radiate in all directions. The lumen of the duct enlarges greatly, and forms a sort of sac the cavity of which is broken up into a labyrinth, formed by the ingrowth of the muscular partitions carrying before them the highly modified glandular epithelium of the sac. The whole forms a large and compact organ lying below the viscera, and very conspicuous when the animal is dissected. The structure of the epithelium is peculiar (fig. 34) and sections of it are not easy to interpret. Judging from the transitional epithelium lining the duct, it appears that the ordinary cylindrical epithelial cells become very slender and are compressed by the excessive development of the gland-cells lying between them: they lose their cilia; their nuclei, reduced to a small size, stain very deeply and are shifted to the external ends of the cells, the cytoplasm radiating outwards from the nuclei to form a cover over the distal ends of the adjacent gland-cells. They have in fact undergone a modification similar to that of the cover-cells of the testis of *Hydra*. The gland-cells appear to be of two kinds: clear cylindrical cells with finely granular contents staining faintly in hæmatoxylin, and cells of similar shape but filled with irregular and highly eosinophilous globules. I have satisfied myself, however, that these are only different phases in the secretory activity of the same kind of cell. The pale, finely granular cells represent the resting condition. Their nuclei are very small and deeply staining and are either close to the base and on one side of the cell or somewhat higher up and close to one side. Some of these cells are vacuolated, their contents stain lightly in eosin, and their granular contents begin to aggregate into globules, this process generally commencing at the basal end of the cell. In later stages the whole cell-body is filled with eosinophilous globules of irregular size, and these are finally discharged, by rupture of the cover-cells, into the lumen of the gland. The space between the hinder flap of the mantle and the opercular lobe is commonly full of the sticky coagulated secretion of the gland, but what its function is I am unable to guess. From its large size, the opercular gland must be of considerable physiological importance, but it is remarkable that it only occurs as a highly developed and differentiated structure in marine forms. Possibly its secretion is useful in assisting the animals to retain their hold on rocks washed by the waves.

### *The Alimentary Tract.*

This may be treated very briefly, as the structure of the buccal bulb, œsophagus, stomach, and intestine is very constant throughout the family, and the details in which the various species differ from one another are so small and unimportant that they may be passed over. A sketch of the alimentary canal of *Paranerita* *longispina*, with the coils of the gut unravelled, is given in fig. 35, and the relative positions of buccal bulb, intestine, and stomach, and the division of the last-named into œsophageal and pyloric moieties, are indicated in fig. 41. The characters of the epithelial lining of different portions of the gut, and the ridges and folds into which the lining of the stomach is thrown, are remarkably similar in all the species I have examined, and Lenssen's description of the digestive system of *Neritina fluviatilis* may be taken as typical for all the Neritidæ. Such small differences as occur chiefly affect the relative size and length of the radular sac, and the length and consequently the complexity of the coils of the intestine. Marine species pass a considerable quantity of sand through their bodies, and their intestine is longer and thicker-walled than is the case in freshwater species. The radular sac is also longer, and the radular teeth coarser and more powerful, in marine than in freshwater forms. The relative size of the pharyngeal bulb also differs. It is, for example, very large in *Nerita peloronta* and *plexa*, relatively small in *Paranerita variegata* and *gagates*, but in every case the essential structure and relations of the cartilages of the odontophore, the salivary glands, and diverticula of the pharyngeal cavity are the same. There are seven buccal cartilages in all Neritidæ, as described by Lenssen, and the differences in size observed in the pharyngeal bulb are due to the greater or less size of these cartilages and the more or less powerful development of the intrinsic muscles attached to them. In all cases I have found the pair of lateral glandular sacs opening into the lateral extensions of the sub-radular diverticulum as described by Thiele. In some species the walls of these sacs are pigmented and their lumina contain dark-coloured concretions. I must add that I have in no case been able to find salivary glands with long ducts such as are described by Béla Haller in *Nerita ornata*. ("In diesen münden dorsalwarts an der gewöhnlichen Stelle mit sehr langen, wohl differenzirten Ausfuhrungsgängen, zwei compacte acinöse Buccaldrüsen," *loc. cit.* p. 131, Taf. xi. fig. 123.) These salivary or buccal glands always have the structure and relations described by Lenssen. They are closely applied to the hinder end of the pharyngeal bulb and pass round to its lower surface, embracing the origin of the radular sac. They have no ducts, properly speaking, but are large saccular diverticula of the anterior end of the œsophagus, and are comparable with the œsophageal pouches of other Rhipidoglossa.

## *The Nervous System.*

I have already given on pp. 819–821 an analysis of the different accounts of the nervous system given by different authors, from which it may be gathered that while there is agreement on the main points, there are still questions about which there is considerable difference of opinion. Having nothing to add on the subject of the cerebral ganglia, the labial commissure, the buccal commissure, and the pedal centres to the excellent figures and descriptions of Bouvier, I will pass on at once to the disputable points.

It has been clearly demonstrated by Bouvier (**10**), Boutan (**7**), and Haller (**20**) that the marine *Neritæ* (*Nerita*) and *Septaria* are typically streptoneurous, the supra-intestinal branch of the visceral commissure existing as an extremely fine nerve whose relations are normal. Lenssen (**26**) has shown that with one exception the general character of the nervous system is the same in *Neritina fluviatilis*, but this exception is important. He could not find any trace of the supra-intestinal nerve, nor of any connection between the visceral and branchial ganglia. I have taken great pains to discover this nerve in the same species, but have not succeeded in discovering it either in sections or by dissection.

Though it would seem on *à priori* grounds improbable that the nervous system of *Neritina fluviatilis*, so similar to that of *Nerita* in all other details, should differ from it in the deficiency of so characteristic a nerve, I can only add my testimony to that of Lenssen, and state that I believe that it does not exist. If we are right in this conclusion, it affords an additional reason for separating, as I have done, *Neritina fluviatilis* from the tropical freshwater forms which I have classed together under the name *Paranerita*. In the latter there is no question of the completeness of the crossed visceral commissure. I have found it in all my specimens, and its course is very correctly described by Bouvier. In this, as in other respects, I find that the nervous systems of *Nerita* and *Paranerita* are practically identical.

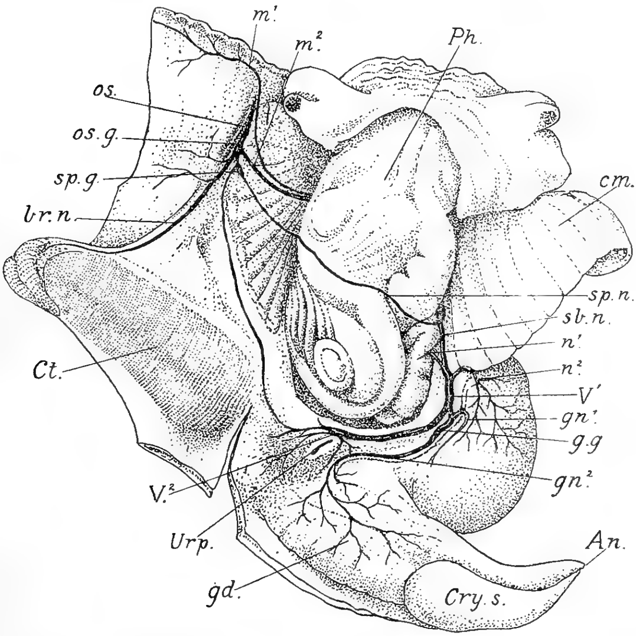
But in spite of all the labour that has been bestowed upon the subject there is still an uncertainty or deficiency in the descriptions and figures hitherto given of the ganglia on the visceral commissure. I have devoted a considerable amount of time to this question, working both by means of sections and dissections and hope to elucidate some points that have hitherto been obscure.

Not being satisfied with existing figures of the pleuropedal centres, I have given in fig. 36 a drawing founded on the combined results of dissections and reconstruction of serial sections. As the drawing is fully lettered, I may spare the reader the trouble of a detailed description of the nerves issuing from the pedal and pleural ganglia. I have made use of the same lettering as Bouvier to designate the different nerves, so that my drawing can be more easily compared with his. I will only call attention here to the branch of the cerebro-pleural connective labelled *s*, and to the nerves labelled *op*. The former diverge gradually from the connective, pass to the outside of the anterior extrinsic muscles of the pharyngeal bulb, and are distributed to the walls of the cephalic region behind the tentacles. They are quite distinct nerves, but do not appear to have been noticed before. The nerves *op.* pass under the pleural ganglia and take their origin from the swollen anterior ends of the pedal cords. They are slightly asymmetrical, but are distributed on both sides of the body to the opercular lobe.

As I have already pointed out, authors differ in their identification of the subintestinal ganglion. The conical enlargement of the origin of the subintestinal nerve—it has in all species the shape represented in fig. 36, and is not a rounded ganglion as figured by Bouvier—was identified by de Lacaze-Duthiers as the subintestinal ganglion; and Bouvier and Lenssen have accepted this view. Boutan and Haller, on the contrary, claim that the subintestinal is represented by an elongated ganglionic swelling on the right of the visceral commissure just where the latter turns towards the left to run through the large blood-sinus leading in the direction of the uropore. Concerning this ganglion I have something to say. As is shown in the accompanying text-figure (172), it is an elongated and rather diffuse ganglion from which three main nerves are given off. The most anterior ($n^1$) passes inwards, forwards, and ventralwards and supplies (as far as I am able to determine) the coils of the intestine lying below and to the side of the anterior part of the radular sac. Lenssen has described a similar nerve in *N. fluviatilis*, but in this species it is given off some distance in front of the ganglion, and, curiously enough, he says that some of its branches are distributed to the stomach; as a matter of fact, they pass in an opposite direction. The second nerve ($n^2$) is rather stout and passes outwards into the tissue overlying the posterior part of the right columellar muscle. It does not penetrate the muscle, but turns sharply backwards, and I was able to trace it in sections as far as the pedicle of the visceral mass, and thence alongside the oviduct to the ovarian follicles. Lenssen has described a similar nerve in *N. fluviatilis* arising like the first well in front of the ganglion; this he calls a columellar nerve, but I am of the opinion that it has the same distribution as that just described, though I could not follow it very well in my sections. The third nerve has been quite incorrectly described by previous authors. As shown in the text-figure, it is very short and stout, and passing downwards enters at right angles a stout and relatively long nervous cord (*g.g.*), which is thickly coated with nerve ganglion-cells. This cord may properly be described as a genital ganglion. It is closely attached to the gonaduct, and its lower end ($gn^1$) turns sharply backward and passes to the spermatophore-sac (or epididymis in the male), on the surface of which it breaks up into a number of fine fibres. Its upper end ($gn^2$) accompanies the gonaduct in its course towards the complex of accessory genital glands, and on its arrival into the complex breaks up into a number of fine branches whose further course I was unable to follow, but there is no doubt that they are distributed to the different genital glands. This nerve corresponds, without doubt, to the recto-genital nerve of other Streptoneura, and the large ganglionic enlargement on its course is associated with the great importance and complexity of the accessory genital organs in the Neritidæ.

Beyond this recto-genital nerve the visceral commissure in its course from right to left is somewhat thinner than it is in the region of the ganglionic swelling just mentioned, but it remains invested with a coating of nerve-cells, and is only gradually and slightly enlarged in front of the uropore to form the visceral ganglion described and figured by all previous authors. I must

Text-fig. 172.




A dissection of *Nerita plexa*, showing the course and distribution of the visceral nerves and the visceral, branchial, and osphradial ganglia: semidiagrammatic.

*An*, anus. *br.n*, branchial nerve. *cm.r*, right columellar muscle. *Cry.s*, crystal sac. *Ct*, ctenidium. *gd*, complex of genital ducts and glands. *g.g*, genital ganglion. $gn^1$, nerve passing to the spermatophore-sac. $gn^2$, nerve passing to the organs of the genital complex. $m^1$, anterior (pallial) branch of the branchio-pallial nerve. $m^2$, posterior (branchial) branch of the branchio-pallial nerve. *os*, osphradium. *os.g*, osphradial ganglion. *Ph*, pharyngeal bulb. *sb.n*, subintestinal nerve. *sp.g*, supra-intestinal ganglion (identified as a separate ganglion only in *Nerita plicata* and *Paranerita gagates*). *sp.n*, supra-intestinal nerve. *Urp*, uropore. $V^1$, right-hand enlargement of the visceral ganglion. $V^2$, left-hand enlargement of the visceral ganglion. These two enlargements are much closer together than represented in the figure; the tissues lying between them have been stretched by turning back the genital complex, and the middle part of the visceral ganglion is represented as if stretched to a corresponding amount. It is almost invariably broken in actual dissection.

add that, contrary to Lenssen's statement, the genital nerve in *N. fluviatilis* is given off from and not in front of the first ganglionic swelling, and that the characters of the genital ganglion &c. are practically identical with those described above. The nerves given off from the enlargement of the visceral commissure in the vicinity of the uropore are distributed, as all previous authors have described, to the kidney and pericardium.

If I have described the origin and distribution of these nerves at some length, it is because they are of importance in determining the homologies of the first ganglion on the visceral commissure which Boutan and Haller have identified with the subintestinal ganglion. Now this ganglion, whatever its size and position, never gives rise to nerves supplying the viscera and gonads. It is essentially the ganglion of the right side of the mantle, and in the primitive dibranchiate Aspidobranchia supplies the nerve going to the post-torsional right ctenidium and osphradium. When these disappear, as in the Trochidæ and Pectinibranchia, either there is no definite subintestinal ganglion or it tends to approximate itself to the left pleural ganglion as in the Cerithiidæ, or, as is more often the case, it may enter into close relations with the right symmetrical pallial nerve and innervate the right side of the mantle. On the other hand, the genital and visceral nerves always issue from the visceral ganglion (or ganglia if more than one is present) at the hinder end of the visceral commissure, and this original connection is maintained with great persistence even in the short-looped euthyneurous forms. Hence it would be contrary to what is observed in other gastropods if the genital, intestinal, and stomach nerves issued from the subintestinal ganglion; and the conclusion is that Boutan and Haller were wrong in their identification, and that the ganglion in question is a member of the visceral series. This is the more likely when we consider that in other Rhipidoglossa—in *Trochus*, for instance—the abdominal ganglion is an elongated and ill-defined enlargement occupying a considerable section of the posterior part of the visceral commissure. As I have stated, there is a continuous and thick cortex of nerve ganglion-cells investing all that part of the visceral commissure of the Neritidæ lying between the ganglion from which the genital nerve proceeds and the ganglion adjacent to the uropore. The whole of this thickened section is to be compared with the elongated visceral ganglion of *Trochus*, and the swellings at its two ends, which do not in fact form such distinctly separate ganglia as might be inferred from figures and descriptions, may be regarded as concentrations of nerve-cells—in other words, incipient but not yet separate ganglia at the two ends of a long and ill-defined tract of ganglion-cells. This view is strengthened by the fact that the swelling at the right end from which the genital and other nerves proceed bears the same relations to the oviduco-cœlomic funnel (which is evidently a relic of the right kidney) as the swelling from which the renal and pericardial nerves proceed bears to the reno-pericardial funnel of the left kidney. The great elongation of the ganglionated posterior tract of the visceral commissure is readily explicable when it is borne in mind that, as I have already described for *Septaria* and shall describe further on for *Nerita*, the embryonic condition of the cœlom has been retained in this family and its cavity stretches across the body from left to right, the two primitive kidneys being separated by a considerable space, and opening at widely separate points into the cœlom. In short, this region of the body is broader from right to left than is usual in Gastropoda, and the visceral ganglionic swelling is elongated accordingly.

I must admit that it may be urged against this view that if the "organe creux" described by Lenssen in *N. fluviatilis*, and found by me in a corresponding position in the various species examined, is really a vestige of the right ctenidium, the swollen right end of the ganglionic enlargement bears the same topographical relation to it that the subintestinal ganglion bears to the right ctenidium in dibranchiate Rhipidoglossa. I confess that I was at first inclined to agree with Boutan and Haller in identifying what I now regard as a specialized part of the visceral ganglion as the subintestinal, and was inclined to argue that the outgrowth must represent the right ctenidium because of its relation to the ganglion, and that the ganglion must be the subintestinal because of its relation to the relic of the ctenidium. This was so flagrant an example of the *circulus in definiendo* that I was led to reconsider the question, and I am satisfied that the origin of the genital nerve and the relationship to the oviduco-cœlomic funnel and to the right side of the cœlomic cavity outweighs all other evidence.

If, then, Boutan and Haller were wrong, de Lacaze-Duthiers and Bouvier were right in their identification of the subintestinal ganglion. To test this point, I have made a careful study of sections through the pleuro-pedal centres. These go to show that the enlargement from which the subintestinal nerve proceeds is really a nerve-centre, and is therefore the representative of the subintestinal ganglion. To make this point clear, the question must be asked, what do we mean when we speak of a ganglion? It is a swelling caused by the presence of the nerve ganglion-cells investing a central core of nerve-fibrils. It is something more than this, it is a nervous relay, in which some of the fibres enter into nerve ganglion-cells, and in which the dendrites of the ganglion-cells are intermingled and in contact with one another. As far as I am aware, nobody has yet attempted to work out the courses of the nerve-fibres and to trace them to their connection with groups of nerve-cells in the Mollusca. I am unable to do more than touch the fringe of a subject that offers a large field for future research, as my preparations were not made with this purpose and are inadequate to disentangle the complex of nerve-fibres and cells. I have, however, ascertained the following facts:—Each nerve-centre consists of a core of nerve-fibres and dendrites surrounded by a cortex of nerve ganglion-cells. There are three kinds of ganglion-cells: (1) Small bipolar cells, very numerous, closely crowded together, and with deeply staining nuclei. They occur in great numbers in all the nerve-centres and are the only cells extending from the centres along the nerve-trunks. (2) Large apparently unipolar cells, with larger and less deeply staining nuclei than in 1. These are scarce and locally aggregated in the nerve-centres. (3) Large multipolar cells more numerous than the second kind and with similar nuclei. They are localized chiefly at the sides of the centres, and in the pedal cords their axial processes can often be distinctly traced into nerve-fibres.

The presence of the larger cells of the second and third kind is characteristic of a separate nerve-centre or ganglion. These facts are illustrated, but on a very small scale, in figs. 37–40.

Fig. 37 is a section, taken somewhat obliquely, through the pleural and pedal centres, just behind the union of the former with the latter, and including the connection between the two pleural ganglia. The details of the pedal centres need not concern us; it is sufficient to allude to the fact that they give evidence of a considerable degree of complication. In the pleural centres it is evident that there are two principal groups of nerve-cells in each ganglion: a dorso-lateral and a ventral. A bundle of nerve-fibres, originating from the dorso-lateral group of the left ganglion, runs across to the right and turning downwards traverses, but does not enter into connection with, the ventral group of cells of the right ganglion and is joined by another band of fibres originating from a distinct group in the lateral region of the right ganglion. These two bundles unite to form the root of the subintestinal nerve. Fig. 38, representing a section somewhat posterior, shows the subintestinal root still small and traversing the ventral cell-group of the right ganglion. Fig. 39 passes through the base of the conical subintestinal ganglion and shows the same bundle of fibres as in the last section, now considerably larger; and above it a new bundle surrounded by a very thick mass of ganglion-cells, among which is a relatively large number of the larger kinds. The intervening sections would show that the fibres of the upper bundle pass into or take their origin from the thick dorsal and lateral mass of nerve-cells. Fig. 40 is a section taken some way further back through the subintestinal nerve and shows the two bundles of fibres still distinct and surrounded by a thin layer of small nerve-cells. Eventually when the layer of nerve-cells dies out the two bundles of fibres can no longer be distinguished from one another. There can be no doubt that the bundle *h* in fig. 37 is the origin of the subintestinal nerve from the left pleural ganglion, and that the bundle *z* represents the much-abbreviated zygoneurous connection of the subintestinal with the right pleural ganglion. The mass of cells *sb* in fig. 39 is the subintestinal ganglionic centre, and the uppermost of the two bundles of fibres marked *h* is formed by fibres of the subintestinal nerve originating in that centre. It is possible that the two bundles represent afferent and efferent fibres, but there is no proof of this. The facts enumerated, however, are sufficient evidence that Bouvier was right in his identification of the subintestinal glanglion. The sections show further that the commissure between the two pleural ganglia signifies much more than a zygoneurous connection between the right pleural and the subintestinal. The bulk of the commissure is made up of two stout bundles of fibres (1 & 2 in figs. 37 and 38), running transversely and connecting respectively the dorso-lateral and the ventral cell-groups of the right and left pleural ganglia. The upper bundle is related to the origins of the cerebro-pleural connectives, the lower bundle to the origins of the right and left pallial and columellar nerves. It is evident that the shortening of the anterior part of the visceral loop and the approximation of the subintestinal ganglion to the pleural centres is connected with a crossing over of nerve-tracts belonging to the symmetrical pallial centres, and that this transference is quite independent of the zygoneurous or dialyneurous connections of the visceral commissure. It is suggestive that this intimate union between the right and left pallial centres occurs in a group of Rhipidoglossa in which there are two subequal and sub-symmetrical shell-muscles, innervated from the pleural ganglia. I have given reasons for believing that the development of the left muscle is correlated with the development and increased functional importance of the operculum, and that when once it is established its action must produce a tendency towards the secondary symmetrical disposition of the organs connected with or influenced by it. This tendency is manifest in the nerve-centres. The asymmetrical centres become of less, the symmetrical centres of greater, functional importance. The two shell-muscles, acting together as a pair, must be subject to nervous co-ordination. This has been effected by the development, in conformity with the physiological needs of the organism, but through the operation of natural selection, of transverse connections between the pleural centres, and these, be it noted, are of two kinds. There is a connection by way of the cerebro-pleural connectives, providing, as one may legitimately infer, for the co-ordination of sensory impulses arriving from the cephalic sense-organs. And there is a connection by way of the symmetrical pallial and columellar nerves providing for the co-ordination of sensory impulses arriving from the anterior borders of the mantle and of motor impulses travelling outwards to the two shell-muscles.

These considerations suggest a fruitful field of enquiry into the causes which have led, firstly, to the separation of pleural from pedal centres; secondly, to the various degrees of approximation or separation of pleural and cerebral centres; and, thirdly, to the approximation of the asymmetrical to the symmetrical pallial centres with the concomitant shortening or partial suppression of the visceral commissure. I have many indications that an enquiry on these lines would help to elucidate a number of doubtful problems in gastropod morphology; but the subject is a large one, requiring much comparative study of different forms of nervous systems and must be left for a future occasion.

Respecting the supra-intestinal ganglion and its connections, my observations serve to bring together and harmonise the scattered descriptions of previous authors. The text-figure on p. 855 shows the relations of the supra-intestinal ganglion, the symmetrical left branchial and pallial nerves, the osphradium, and the osphradial ganglion. The supra-intestinal ganglion is always very small and hard to discover, but I have determined its presence in *Nerita plicata* and *Paranerita gagates*. It is connected by a very short branch with a long cord of nerve-fibres ensheathed by nerve ganglion-cells which underlies the osphradium. This cord must be regarded as a diffuse osphradial ganglion. It receives the bulk of its nerve-supply from the left symmetrical branchial nerve, and this connection has been noted by several authors; Thiele (**39**) in particular gives a good figure of it as seen in section. The posterior end of the osphradial ganglion is continued into the clearly defined nerve which passes along the edge of the right or anterior suspensory membrane of the ctenidium and is continued along the afferent side of the gill. I can confirm Bernard's statement that this nerve is continued round the apex of the gill and down its efferent side. The position of the osphradium has been correctly described by Bernard (**3**). It lies, as indicated in the text-figure, in front of the attachment of the suspensory membrane of the ctenidium to the roof of the mantle-cavity, and may be distinguished by the naked eye as a small furrow bounded by two ridges of thickened epithelium. Its minute structure does not differ in any important particular from that of *Septaria*.

### *The Respiratory and Circulatory Systems.*

The ctenidium, heart, and blood-vessels require little or no description. They are constructed on the same plan throughout the Neritidæ, and as Lenssen has treated the subject very fully in his memoir on *Neritina fluviatilis* and I have already written all that I have to add to his account in dealing with *Septaria*, there is no more to say. The right auricle is always present, its position in *Paranerita gagates* being indicated in fig. 42. It is somewhat less well-developed in marine forms (e. g. *Nerita peloronta*) than in the freshwater forms, but always carries blood back to the ventricle from lacunæ in the posterior and left side of the body-wall. It is separated by the whole width of the visceral pedicle from, and has no connection with, the little hollow organ lying in the right-hand posterior corner of the mantle-cavity which I have referred to as possibly being a relic of the right ctenidium, and this fact must be admitted as evidence against the suggested homology. The gill-lamellæ of the ctenidium of all species much resemble those of *Septaria*, but the extent and shape of the ciliated tracts vary slightly in different species —not to such an extent, however, as to make it worth while to write a separate description for each.

### *The Hæmocœle and Cœlom.*

The only noteworthy feature about the hæmocœle is that it tends to be filled up by an abundant development of vesicular connective tissue, which penetrates into all the spaces between the viscera, except the cœlomic spaces, and is specially accumulated round the blood-vessels. It is naturally much altered by the action of reagents in tropical specimens long preserved in spirit, but may conveniently be studied in *Neritina fluviatilis*. As I have not yet been able to obtain Paravicini's memoir on the connective tissue of Gastropods, nor have I had time to make a comparative study of this tissue in freshly killed specimens, I will only shortly mention the appearance presented by this tissue in *Neritina*. In starved specimens which have been kept for a long time in aquaria, the connective tissue consists chiefly of a number of stellate cells united by their processes, or, if one prefers to express it so, of a reticulum of protoplasm with nuclei at the nodes. These nuclei (fig. 59, *ret.*) are small, oval, and deeply staining. In well-nourished specimens recently taken from the river the meshes of the reticulum are filled with vesicular cells ("Langer's cells") with larger faintly staining nuclei. These cells are filled with granules which stain bright yellowish green in picro-indigo-carmine. They accumulate round the blood-vessels, and are often so abundant as to obscure the network of connective tissue. Apparently they are derived from small amœboid cells which contain similar large nuclei such as that marked *am.* in fig. 59. There can be little doubt that these cells are metabolic in function and serve to store up reserve material, though I have not been able to demonstrate the presence of glycogen in them as Blundstone (**5**) has in other molluscs. Masses of fatty-looking tissue of this nature surround the intestines, liver, nerve-cords, and even the accessory genital organs of tropical species of *Nerita* and *Paranerita* and their presence is a great hindrance to dissection. I have found that this tissue blackens slightly with osmic acid in *Paranerita*, indicating the presence of fat; and this is worth noticing, for fat-cells are said to be absent from the connective tissue of Gastropods. The vesicular cells of *Neritina* are not blackened by osmic acid.

The cœlomic cavity is fully as extensive, and has much the same relations as in *Septaria*, but owing to the retention of the spiral coil of the visceral mass, and the complications arising from the excessive development of the spermatophore-sac of the female or the epididymis of the male, it is difficult to give an intelligible account of it; but I hope that with the assistance of the diagram, fig. 58, the reader will be able to understand the following account of it. For descriptive purposes and without prejudice to any theoretical conclusions, the cœlom may be regarded as consisting of a left or pericardial division (figs. 29, 42, 58, *pc.co.*) and right or gonadial division (figs. 41, 43, & 58, *g.co.*). The pericardial division lies on the left side of the body and is of considerable vertical depth. Anteriorly it extends to the base of the ctenidium, posteriorly to the union of the pyloric and œsophageal divisions of the stomach (fig. 42). Its outer wall is very thin; its inner wall tough and muscular. Its posterior end is traversed by the rectum, and in it lie the ventricle and the two auricles of the heart. On the inner or right side the pericardial cœlom is continued into a wide passage (*c.ap.*) which runs under the kidney, above and in front of the anterior lobes of the liver. From this passage a diverticulum is given off on the left side, which passes under the non-glandular part of the kidney and stretches forward towards the uropore (fig. 43), below which it ends in a dilatation and receives the cœlomic opening of the reno-pericardial canal. To the right the passage widens out to form the gonadial cœlom, a flattened sac of irregular form lying between the base of the genital complex and the liver. Its right-hand corner is produced into a diverticulum extending as far as the posterior end of the right columellar muscle, and here it comes into close relation with the gonad, but it does not surround any portion of the latter organ, as is the case in *Septaria*. The oviduco-cœlomic funnel opens into the right-hand corner of the gonadial cœlom (fig. 41, *od.c.f.*) at the base of the diverticulum just mentioned and not far from the columellar muscle. In the male the sperm-duct runs very close to the wall of the same part of the cœlom, but after an assiduous search through many series of sections I have been unable to find any trace of a spermiduco-cœlomic funnel. The cavity of the gonadial division of the cœlom is largely obliterated by the spermatophore-sac of the female or the epididymis of the male, which projects into it like a hernia from the posterior end of the genital complex, and, carrying the posterior wall of the cœlomic cavity in front of it, lies enclosed in a cœlomic pocket in the position shown in figs. 44, 49, and 58. It is clear that these relations are similar to those described for *Septaria*, the difference being that in the latter genus the straightening out of the visceral spire has allowed the gonadial cœlom to extend much further along the right side of the body, so that its relation to the gonad is obvious. There can be no doubt, however, that in the more spirally coiled *Nerita*, *Paranerita*, and *Neritina* the gonad has been derived from the wall of the right corner of the gonadial cœlom. The oviduco-cœlomic funnel of the female is evidence of this primitive connection; and as the cavity of the gonad is morphologically a part of the cœlom, the latter must be regarded as co-extensive with the gonad, and therefore as occupying the whole of the apex of the visceral spire. If, as a result of the large development of the liver and intestines, the visceral spire were elongated, the gonad would remain at its apex, and the gonaduct would be correspondingly elongated. This, in fact, is the typical position of the gonad in multispiral gastropods, and the primitive connection of gonad with cœlom is well illustrated by the Neritidæ.

### *The Excretory System.*

The kidney in *Nerita* and *Paranerita* has essentially the same structure and relations as in *Septaria* and *Neritina fluviatilis*. It consists of a glandular and a non-glandular part or bladder communicating posteriorly behind the rectum. The bladder is a very wide sac (fig. 43, $K^1$) lying between the glandular part and the pericardium. Anteriorly it twists under the glandular part and leads into a small thick-walled chamber (fig. 47) which opens to the exterior by the uropore (fig. 45, *Urp.*). As in *Septaria* the posterior moiety of the glandular part seems always to differ somewhat in histological character from the anterior moiety; this difference is indicated in figs. 43, 44, & 46. The only direct connection between the glandular and the non-glandular parts of the kidney is at the posterior end, but there is an indirect anterior connection, similar to that described in *Septaria depressa*. The reno-pericardial funnel opens, as explained above, into a diverticulum of the cœlom which passes below the non-glandular part of the kidney (fig. 46). Its further course is that of an **Ƨ**, and for some distance it projects into the bladder, and eventually becomes attached to the wall of the chamber which opens to the exterior by the uropore (fig. 45). Passing up the wall of this chamber it opens into it by a small but distinct ciliated passage (fig. 47, *cil.p.*), and continuing its course up the wall of the uropore-sac dilates to form a canal of considerably wider diameter which divides into two branches. The main branch passes to the left over the uropore-sac, and opens into the glandular part of the kidney; the smaller branch passes to the right and is connected with some small detached renal lobes lying in the blood-sinus leading to the afferent branchial vessel. The characteristic epithelial lining of the reno-pericardial canal, described in detail by Lenssen and Thiele, is confined to the section lying between the cœlomic opening and the ciliated connection with the uropore-sac. This section is very long; I have calculated that it is at least ·9 mm. long in a specimen of *Paranerita gagates* measuring 13 mm. in length. The transition from the characteristic epithelium of the duct to an ordinary columnar ciliated epithelium, and from the latter to the glandular epithelium of the kidney, is shown in fig. 47.

The wide thin-walled sac which I have described as the bladder or non-glandular part of the kidney is generally named the ureter. I have not used this term because in those Gastropods in which a long ureter is present running alongside of the rectum (e.g. *Paludina*) there is evidence that it is formed from the mantle and therefore lined by an ectodermic epithelium. I believe that the homologue of such an ectodermal ureter is to be found in the structure which I have referred to as the uropore-sac. As shown in fig. 45, the mantle-epithelium surrounding the uropore is modified, consisting of high columnar ciliated cells. This epithelium passes round the lips of the uropore, and appears to line the uropore-sac, which, however, should be described as a recess rather than a sac, for it is widely open below into the non-glandular part of the kidney, and only has the appearance shown in fig. 47 in sections passing through its upper part. For some reason the epithelium lining this recess is very much macerated in all my specimens and I cannot give a clear account of it; but the thick wall appears to be made up of a number of glandular crypts, or, rather, of bunches of gland-cells, which have passed through the basement-membrane into the subjacent connective tissue, as is the case with the various accessory genital glands. The ciliated epithelial cells retain their position on the outside of the basement-membrane. Lower down, in the vicinity of the uropore, the glandular structure gradually disappears, but the columnar ciliated cells are continued as a broad band running back for some distance along the anterior and inner wall of the bladder (fig. 46, *ci.ep.*). The histological characters of this ciliated band leave little doubt that it is an ingrowth of the ectoderm, and its function is obviously to create a powerful ciliary current in the direction of the uropore.

The position of the little folded organ which has been referred to as possibly representing the right ctenidium is indicated in fig. 43, *R.ct.* In some specimens it is only represented by a thickening and modification of the mantle-epithelium exactly like that round the uropore. In other specimens the epithelium is thrown into folds, but this may be due to contraction in spirit. The mantle-wall is thickened by a special development of muscular strands below the patch of modified epithelium, and in connection with these is a blood-space, which is nothing more than a diverticulum of the large transverse blood-sinus enclosing the visceral ganglion. The organ in question has, therefore, the same relations on the right that the functional ctenidium has on the left to the transverse blood-sinus. Furthermore, its position with regard to the hypobranchial mucous gland is precisely that of the right ctenidium to the right hypobranchial gland in dibranchiate Rhipidoglossa. Hence, in spite of its distance from the rudimentary right auricle and the fact that, so far as I am able to determine, it receives no special nerve-supply, I regard it as a vestige of the right ctenidium. The hypobranchial gland varies considerably in size in the different species of *Nerita* and *Paranerita*, but its position is always the same. The mass of secreting tubules forming the body of the gland lie in the roof of the right-hand side of the mantle-cavity, and chiefly in the posterior part of the swelling formed by the genital complex. Their position in the male of *Paranerita gagates* is shown in fig. 48, *Hy.g.*, and in the female in figs. 62 & 63, *Hy.g.* The duct of the gland opens into the right-hand posterior corner of the mantle-cavity by a fairly large pore situated below the posterior end of the swelling formed by the genital complex, and at the base of the vestigial right ctenidium (fig. 49, *Hy.g.a.*). As a consequence of the great size of the spermatophore-sac and epididymis in *Paranerita*, the hypobranchial gland is carried back with it and some of its tubules may lie at the posterior end of the body, apparently among the viscera, but really in the tissue surrounding the spermatophore-sac (figs. 62 & 63) or its equivalent in the male. The tubules are lined by a simple columnar glandular epithelium, the cells of which have small nuclei and clear contents. The hypobranchial gland attains relatively enormous dimensions in the Helicinidæ, penetrates among the viscera, and forms a considerable part of the mass of the visceral spire.

### *The Generative Organs.*

The position of the gonad is the same in both sexes, and the oviduct or sperm-duct formed by the union of the ducts of the numerous ovarian or spermatic follicles passes up on the right-hand of the spire towards the posterior end of the right columellar muscle and then turns inward to pass into the base of the genital complex. It is not necessary to add anything to the account given by Lenssen of the structure and histology of the ovary and testis in *Neritina fluviatilis*. It holds good for all the Neritidæ that I have studied.

Lenssen gives a rather summary—but, on the whole, an accurate—description of the male accessory organs of *N. fluviatilis*. It is open to criticism in matters of detail, but these are not of sufficient importance to justify a discussion of them in this place. There is very little difference between the male organs of the different species of *Neritidæ*. Of *Nerita* I have examined *lineata* and *melanotraga*; of *Paranerita*, *gagates*, *variegata*, and *longispina*; and I have verified Lenssen's description of *Neritina fluviatilis*. Fig. 50 is a drawing, founded upon sections and dissections, of the male organs of *Paranerita gagates*, and those of *variegata*, *longispina*, and of the unknown species from Fiji are indistinguishable. The sperm-duct is seen passing forward and upward with a slightly sinuous course close to the external body-wall on the right side. Just behind the posterior end of the right columellar muscle it comes into close relations with the gonadial extension of the cœlom and forms a few coils close against its wall. At this point the sperm-duct turns abruptly to the left and is immediately thrown into most complicated convolutions which are closely applied to one another and form a large ovoid mass—the epididymis. This, as has been explained above, is enclosed in a fine membranous bag, and is so large that it projects backwards into the cœlomic cavity and extends across to the left side of the body. Its relations are clearly seen in fig. 44. It can be seen that the sperm-duct narrows somewhat on entering the epididymis, forms a great number of very fine convolutions on its left side, and passing to its hinder end increases appreciably in diameter. The ultimate coils lie on the right side, are greatly swollen and filled with spermatozoa. The last coil finally emerges from the epididymis-sac close to where the sperm-duct entered it, and immediately contracts to form a rather thick-walled tube, which I shall call the middle tube. The sperm-duct before it enters the epididymis is lined by small cubical ciliated cells. On entering the epididymis the epithelium changes its character. The cilia are lost; the cells become relatively large—in the narrower coils three or four suffice to surround the lumen of the duct,—their cytoplasm becomes dark and granular and their nuclei clear with a sparse chromatic reticulum. In the thick terminal convolutions (fig. 55) the epithelial cells are very large and their cytoplasm is full of deeply-staining granules. So far as I am able to judge, the spermatozoa mature during their passage through the coils of the epididymis. In the follicles of the testis and in the initial part of the sperm-duct they have globular or ovoid heads, which do not stain deeply, and short filiform tails. In the large terminal coils of the epididymis the heads are elongate, stain intensely with hæmatoxylin, and the tails are longer and apparently thicker. They are, however, so matted together that it is impossible to make out details. But it is clear that the chromatin has increased in quantity and that the spermatozoon, as a whole, has increased in bulk. The characters of the epithelial cells are suggestive of the function of elaborating material for the nutrition of the spermatozoa. In the middle tube the epithelium again becomes cubical and richly ciliated. The middle tube passes into the genital complex, runs some way forward in its wall, makes an abrupt turn backwards, and at once enters a small thick-walled chamber which I shall call the thalamus, as it evidently corresponds to the chamber into which the oviduct opens in the female.

There is very little pigment on the course of the sperm-duct in the species of *Paranerita* that I have studied: if any is present it is on the walls of the middle duct, but I have only observed this in *P. gagates*.

The thalamus is a narrow and elongated chamber situated in front of the posterior third and near the inner or left side of the genital complex (figs. 44 & 48, *th.*). It is lined by a very long ciliated columnar epithelium sharply marked off from the ciliated lining of the middle tube of the sperm-duct. This abrupt passage from one kind of epithelium to the other indicates, I believe, the boundary between the mesodermic and ectodermic structures. Anteriorly and posteriorly the thalamus receives the ducts of a compact acinous gland which I shall call the prostate (figs. 48 & 49, *prs.*). It is clearly formed by evaginations from the wall of the thalamus and has a distinct lumen. Its epithelial lining is shown in fig. 54. It is interesting as exhibiting in its simplest form a mixed epithelium consisting of ciliated and glandular cells. The latter are very large with basal nuclei surrounded by dense granular protoplasm, the outer ends of the cells containing eosinophilous granules in a protoplasmic reticulum. The ciliated cells are very small and wedged in between the glandular cells in a very regular manner. The prostate corresponds to what Lenssen calls the "glande annexe" in *N. fluviatilis*, in which species it is relatively of enormous size. Lenssen did not observe that the epithelium is mixed, as just described, but though it is not so easy to distinguish its characters in the former, there is no difference between *N. fluviatilis* and *Paranerita* in this respect.

The thalamus, then, is a split-like cavity extending some distance in front of and behind the entrance of the sperm-duct. Below and at the sides it communicates widely with the vast cavity which I shall call the terminal chamber. Lenssen has called it the "poche semilunaire" from its appearance in section. This is in reality a large pyriform sac, of which the outer wall remains thin and but slightly glandular, while the inner wall is greatly thickened by glandular differentiation of its epithelium and projects like a demi-column into the cavity of the sac, reducing its lumen to a crescentic slit (figs. 44, 48, & 50). This projecting glandular column is attached along a slightly spiral line, is much thicker posteriorly than anteriorly, and its hinder end loses its attachment to the inner wall and projects backwards into the cavity of the sac. Hence sections through this end show not a semi-lunar but a circular cavity surrounding a central pillar (fig. 49). The thalamus opens into the recess where the column becomes free from the inner wall. Anteriorly the terminal chamber diminishes in diameter; its walls become less glandular and more muscular, but the glandular thickening on the inner side is continued for some distance forward and eventually ends in a free projecting process, not far from the external aperture.

Posteriorly a gland of some size (figs. 48 & 50, *b.gl.*) opens into the terminal chamber. This like the prostate has a distinct lumen, and is a saccular outgrowth of the hinder part of the terminal chamber with much-folded walls. Its epithelium is wholly glandular, without any admixture of ciliated cells, and the elements composing it are loaded with globules which stain deeply in hæmatoxylin and are therefore probably mucinogenous. Each globule contains a minute spot, staining brightly in carmine, and the whole epithelium has a very characteristic appearance, which I have represented in fig. 56.

That the terminal chamber corresponds to the ootype of the female there can be no doubt. The structure of the glandular walls is identical. The outer wall is only feebly glandular compared with the inner, but its structure, shown in fig. 52, is interesting as illustrating the steps by which a mixed ciliated and glandular epithelium, such as that of fig. 54, has become modified into the complex glandular organ depicted in fig. 53. The illustrations explain themselves and need no comment.

Comparing the above with Lenssen's account of the male organs in *N. fluviatilis*, it must be observed that in the latter species there is no posterior gland; the prostate is relatively of great size; the thalamus (not described by Lenssen, but distinctly represented) is relatively small and unimportant; the epididymis is small, deeply pigmented, and does not project into the cœlom, but remains compacted against the base of the terminal chamber, and like it slung up to the roof of the mantle-cavity.

The male organs of *Nerita lineata* are depicted in fig. 51. The epididymis has been partly unravelled to show that it consists of a long greatly convoluted narrow tube, deeply pigmented throughout its extent, and a comparatively short, less deeply pigmented, wide tube. In its natural position the epididymis is packed closely against the hind end of the terminal sac and lies in the mantle-roof without projecting into the cœlom. In other respects the male organs of this species (and of *N. melanotraga* and *plicata*, which are indistinguishable) closely resemble those of *Paranerita*. It will be observed that *Nerita* resembles *N. fluviatilis* in the size, pigmentation, and position of the epididymis, but differs from it in possessing a posterior gland and in the relatively small size of the prostate.

Thus there is a close resemblance between the male organs of the Neritidæ. They are monaulic; there is no gonaduco-cœlomic funnel; and *Nerita* stands midway between *Paranerita* and *Neritina*.

The same relations as regards the different sections are shown in the female organs. A diagram of the female organs of *Paranerita gagates* is given in fig. 60 and sections in figs. 61, 62, & 63. Their structure is very similar in *P. longispina* and *variegata*. The essential features are the same as in *Septaria*. The ducts are triaulic. The ovipository aperture lies close alongside of the anus and leads into a large ootype whose cavity and glandular walls are so closely similar to those of *Septaria* that they need no further description. At a short distance from its aperture the ootype gives off dorsally and rather to the right a diverticulum, which soon enlarges to form a thin-walled sac of some considerable size filled with spherical calcareous concretions; this is, of course, the crystal sac. The hinder end or fundus of the ootype divides into two passages whose course is somewhat simpler than in *Septaria*. That on the right, the egg-duct, after passing through a "clear gland," a mucous gland, and a "rose-coloured gland," leads into the thalamus (*th.*), which is surrounded by a well-developed vitelline gland. The thalamus receives the oviduct, and there is a distinct oviduco-cœlomic funnel (fig. 41, *od.c.f.*) opening into the gonadial cœlom a short distance behind the posterior end of the right columellar muscle. The left-hand passage leads, as in *Septaria*, into a bilobed sperm-sac, and this receives the muscular duct of the receptaculum seminis (fig. 63, *R.s.*). The left horn of the sperm-sac is produced into the ductus enigmaticus, of which the minute opening into the mantle-cavity is shown in fig. 61, *ap.de.* Thus far the identity with *Septaria* is nearly complete, but there are differences in the remaining structures. The right horn of the sperm-sac is continued into the vaginal canal, which is very long and thrown into a number of convolutions occupying a considerable part of the middle third of the genital complex (fig. 62, *vag.c.*). The walls of the vaginal canal are very thick and muscular; their thickness increases at the anterior end, where the canal makes an abrupt turn backward and opens into the vagina. The form and relations of the last-named are clearly shown in fig. 60, this part of the drawing being a careful drawing from a dissection. The vagina is a thick-walled muscular tube, opening anteriorly into the mantle-cavity by a slit-shaped aperture rather behind and to the right side of the ovipository aperture in *P. gagates* (fig. 61, *vag.ap.*). Posteriorly the vagina increases gradually in diameter, its walls gradually become thinner and less muscular, and its hinder end expands suddenly to form the thin-walled spermatophore-sac, which projects into the cœlomic cavity and bears the same relations to it and the adjacent organs as does the epididymis-sac in the male. There are some minor differences in the shape of these organs in the different species of *Paranerita.* In *P. longispina*, for instance, the vagina projects some way beyond the ovipository and anal apertures and its free extremity is coiled in the shape of **S** (fig. 64.). In the same species the vagina is much longer than in *P. gagates*, is of the same diameter throughout, and its posterior end makes a half-turn round the spermatophore-sac before opening into it.

In *P. gagates* and *variegata* the walls of the vagina and vaginal canal are longitudinally ridged internally. The vaginal canal is lined by a columnar, ciliated, and non-glandular epithelium. The vaginal epithelium is made up of larger cells, still ciliated but more glandular in appearance and filled with chromophilous granules. The epithelium lining the spermatophore-sac consists of elongated columnar cells filled with chromophilous granules, but not, as far as I could determine, ciliated. I cannot, however, be certain on this point, for the epithelium and contents of the spermatophore-sac were macerated in all my specimens. The spermatophore-sac always contains a number of fusiform spermatophores embedded in an abundant coagulum. Their structure will be described later.

The female organs of *Nerita* differ to a considerable extent from those of *Paranerita* and *Septaria.* They have been concisely described in *N. pica* by Thiele (**39**). Working with sections he has correctly observed the main features and his drawings of sections are perfectly accurate. But it would take a much larger number of drawings than he was able to give to present a clear idea of the complicated ducts and cavities present, and his diagram gives a very poor idea of the actual structure. I must therefore repeat and add to his observations, but take the opportunity of remarking that he shares with Gilson and Lenssen the credit of having first elucidated the structure of these remarkable organs in the Neritidæ.

I have studied the female organs of *Nerita plicata*, *melanotraga*, *lineata*, and *plexa*. They are all very similar to one another and to *N. pica*, as described by Thiele. The following account founded on *N. plicata* may therefore be regarded as applicable to the subgenus. As shown in the diagram fig. 65, there is a great similarity as regards the ootype, crystal sac, the various glands surrounding the egg-duct, and in the thalamus between *Nerita* and *Paranerita* and *Septaria*. I have already given so sufficient an account of these structures that I need not recapitulate in this place, but will confine myself to the differences.

The oviduct takes the usual course close to the right side of the pedicle of the visceral sac, and opens in the usual place into the cœlomic cavity by an oviduco-cœlomic funnel, particularly large and distinct in *N. melanotraga*. Turning into the base of the genital complex the oviduct passes in front of the receptaculum seminis and opens into a relatively large thalamus. The position of the thalamus is indicated in figs. 65, 67, 68, *th*. Its cavity is relatively rather large, and the epithelium lining it has the characters described for *Septaria*, but is unusually long, and between the ciliated epithelial cells open the ducts of the unicellular vitelline glands. The oviduct enters about the middle of the thalamus and its characteristic ciliated, cubical, non-glandular epithelium is continued downwards and forms the lining of the inner—that is the left-hand—side of a duct, or rather a fissure, for although very narrow in transverse section it is of considerable vertical depth, leading from the thalamus towards the base of the uterus. This fissure is the equivalent of the egg-duct. Its right-hand wall is formed by the elongated epithelium bordering a large glandular mass, which corresponds to the mucous gland in *Septaria*. As in *Nerita* it stains intensely blue with hæmatoxylin, I have no doubt that it is a mucous gland. The lowest edge of this gland is shown in fig. 68, *m.gl.* At the lower level represented in fig. 67 the mucous gland is replaced by another which corresponds to the "rose-coloured gland" of *Septaria*, but the left side of the egg-duct is still lined by the simple, cubical, ciliated epithelium. Beyond the rose-coloured gland, at a higher level than that shown in fig. 67, the egg-duct receives through a distinct duct the secretion of the mucous gland of the opposite side; a portion only of this is shown in the figure at *m.gl.*[1]. At this point the egg-duct enlarges, bends very sharply round, and becomes continuous with the lower portion or fundus of the ootype cavity (*Oo.t*). The simple ciliated epithelium dies out at the bend and is no longer seen in this region. Passing upwards again, we find the ootype extending far forward alongside of the rectum, and in the middle of it on either side the two lobes of the "clear gland," as indicated in outline in fig. 68. The clear gland soon disappears and the two sides of the ootype are formed by a thick mass of the characteristic glandular tissue, but the two ends of its fissure-like cavity remain very thin.

To return again to the lower level depicted in fig. 67. Somewhat further down than this the right-hand portion of the wall of the ootype disappears, and the bottom of its cavity ends in a large thin-walled sac, which is really the lowest portion of the sac shown on the right-hand of figs. 65, 67, & 68. This is clearly comparable to the sperm-sac of *Paranerita* and *Septaria*, but it is not bilobed and its structure and further relations in *Nerita* are different, and can best be explained by reference to the diagram fig. 65. The sac turns upwards and is closely applied to the left face of the rectum. Its outer or abrectal wall is deeply pigmented, rendering it a very conspicuous object in dissections, and is thrown into a number of folds running on the whole longitudinally. The pigment is deposited in the bodies of the very distinct band of columnar ciliated cells which forms the outer wall of the sac, and may be described as a plicated ciliated band rather than a groove. This band of ciliated cells, at a lower level than is shown in fig. 67, passes round the left and lower side of the sac and is continued into the ciliated epithelium of the egg-duct, which again, as described above, is continuous with the ciliated epithelium of the oviduct. The rest of the walls of this pigmented sac are extremely thin and non-ciliated. It is a remarkable feature that the adrectal part of the cavity of the sac and also its lower part adjoining the base of the uterine gland is broken up by a number of trabeculæ, which in arrangement greatly resemble those of the glandular part of the kidney, but they are not in this case glandular. Some of these trabeculæ are shown in fig. 67. They are much more developed in *N. melanotraga* than in *N. plicata*, and they have been noted by Thiele in *N. pica*. At the top of the pigmented sac the abrectal ciliated band becomes a distinct groove, and this separates off as a duct, at first thin-walled, and lined by the same pigmented ciliated epithelium as the groove. The duct soon diminishes notably in diameter; its pigmented ciliated epithelium gives place to a non-pigmented epithelium composed of much smaller cells but still ciliated, and at the same time it acquires a thick external muscular coat. This duct (fig. 65, *vag.c.*) pursues a very slightly sinuous course posteriorly (it is somewhat longer and more convoluted in *N. melanotraga*), and while its lumen continues to diminish, its muscular coat increases greatly in thickness (fig. 68, *vag.c.*). It is evidently, I think, the homologue of the vaginal canal of *Paranerita* and *Septaria*. It opens into a dilatation, with less thick but muscular walls, lined by an epithelium which is continuous throughout all the structures I have yet to describe and whose characters I will specify presently. From the lower end of the dilatation a diverticulum is given off, sometimes, as shown in the diagram fig. 65, in the form of a narrow stalk with a bulbous termination, sometimes a simple blind tube of subequal diameter throughout. It contains spermatozoa and is evidently the receptaculum seminis. Anteriorly the dilatation narrows and is continued forward alongside and to the left of the rectum as the vagina, which opens by a slit-shaped aperture into the mantle-cavity on the posterior and inner side of the swelling formed by the terminal portions of the ootype and rectum. At about two-thirds of its length from its anterior end the vagina gives off from its posterior side a diverticulum, which at once expands to form a capacious spermatophore-sac containing several spermatophores. This does not, as in *Paranerita*, project into the cœlom, but remains closely attached to the dorsal body-wall, projecting, indeed, very little backwards beyond the receptaculum seminis. In *N. plicata*, in which the kidney (as also in *Septaria*) extends far over to the right side of the body, the posterior end of the spermatophore-sac is partly imbedded in this organ.

The inner walls of vagina, receptaculum seminis, and spermatophore-sac are thrown into longitudinal folds and clothed by a similar epithelium which has been accurately described by Thiele. The cells are all of one kind, non-ciliated, with basal nuclei and clear vacuolated outer ends. They appear to be glandular, but do not contain the chromophilous granules characterizing the epithelial cells lining the similar structures in *Paranerita*. In any case they differ from the ciliated cells of the vaginal canal.

It will be observed that there is no ductus enigmaticus, and the female organs of *Nerita* are therefore diaulic, agreeing in this respect with *Neritina fluviatilis*, but differing from *Paranerita* and *Septaria*.

Lenssen has given so sufficient an account of the female organs of *Neritina fluviatilis* that I need do no more than say that I have carefully verified his statements and find them correct. It is perhaps necessary to repeat that the large thin-walled sac at the base of the ootype, which he calls the "poche de confluence," is the equivalent of the sperm-sac of other forms; that what he calls the "connecting canal" is the vaginal canal; and that what he calls the "bursa copulatrix" is the equivalent of the spermatophore-sac. I may further point out that the position of the receptaculum seminis on the course of the vaginal canal is another feature in which *N. fluviatilis* more nearly resembles *Nerita* than *Paranerita* and *Septaria*.

There is apparently no oviduco-cœlomic funnel in *N. fluviatilis.* I have carefully examined several series of sections in the expectation of finding it, but have failed to discover a trace. The oviduct as it passes from the ovary to the thalamus runs in the wall of the gonadial cœlom, but makes no communication with this cavity, and I have made use of sufficiently high powers of the microscope to be able to say that I have not overlooked this structure because of its minute size. I am satisfied that it does not exist.

It is not, perhaps, very profitable to discuss the homologies of such complicated organs as the genital ducts of the Neritidæ in the absence of any exact knowledge of their development, and I am not yet in a position to supply this defect in our knowledge of the group. But as Thiele has homologized the spermatophore-sac and vagina with the right kidney of other Aspidobranchs, a criticism of his conclusions will not be out of place.

In considering this question, we must start from the fact established by von Erlanger (**14**) and Miss Drummond (**13**) that in *Paludina* the post-torsional right kidney makes its appearance in the course of embryonic development, but is eventually arrested and becomes the gonaduct. Miss Drummond has given a very instructive figure (*loc. cit.* pl. vii. fig. 6) showing the reno-pericardial opening of the right kidney still open, after the latter has acquired a connection with the gonad. This is the permanent condition in female Neritidæ (except *Neritina fluviatilis*), and it cannot be doubted that in this family the gonaduct is, as in *Paludina*, the representative of the right kidney. This being the case, the gonopore—that is to say, the opening of the gonad into the kidney—must be looked for on the course of the oviduct, somewhere behind the reno-pericardial (oviduco-cœlomic) opening. All that lies in front of the last-named may be kidney, or part of it may be derived from the mantle-epithelium, either by invagination or by the closing in of a primitively open groove.

The facts do not warrant our expecting that the kidney and the gonaduct should have acquired separate openings into the mantle-cavity as Thiele supposes. Such an expectation, indeed, would be nonsensical, for the kidney and gonaduct are one and the same thing. But it is possible—and this, I think, is what Thiele means—that of the two mantle-openings in the diaulic *Nerita* one is the primitive aperture of the right kidney, the other secondarily acquired, whether by invagination of the mantle-epithelium or by a secondary outgrowth from the kidney. Basing his opinion on the histological characters of the epithelium, which in *Nerita* has, but in *Paranerita* and *Septaria* has not, a resemblance to the epithelium of the left functional kidney, Thiele decides that the vagina is the true renal aperture and the spermatophore-sac the representative of the right kidney. He does not push this homology to its logical conclusion and assert, what must be true if his view were correct, that the vaginal canal, sperm-sac, receptaculum seminis, fundus of the ootype, egg-duct, and thalamus as well as the oviduct itself, are all representative of the right kidney. He further supposes that in the monaulic male the right kidney has disappeared. But the sperm-duct no less than oviduct must be formed from the arrested post-torsional right (pretorsional left) kidney; and as the male pore obviously corresponds to the ovipository aperture of the female it would appear more probable that the latter, and not the vaginal aperture, is the representative of the primitive uropore. And this, I believe, is the more correct view of the case.

I have pointed out that the true generative opening into the kidney must be situated behind the oviduco-cœlomic funnel in the Neritidæ. If, now, we make a comparison with the more primitive Aspidobranchia, with *Pleurotomaria*, *Haliotis*, *Trochus*, *Cemoria*, we find that the gonaduct enters the kidney at no great distance from its external aperture, and close to the reno-pericardial canal, when this structure is present. The glandular part of the kidney lies behind the entrance of the gonaduct. It would be contrary to what we see in all other forms if we were to find, as we should if Thiele's view were correct, the glandular part of the kidney situated in front of the opening of the gonad and the reno-pericardial canal, between these and the renal pore. The presence of an anterior lobe of the right kidney in *Pleurotomaria* and *Haliotis* does not invalidate this reasoning, as may readily be seen on consideration of its relation to the ureter or non-glandular part of the kidney. But, it may be asked, if the complex of glandular tissue and ducts lying in front of the oviduco-cœlomic funnel in the Neritidæ do not represent the glandular part of the kidney, what do they represent? I have no doubt that they are, in large part, analogous to the modified glandular terminal part of the ureter described by M. F. Woodward (**41**) in *Pleurotomaria*, or, to seek a nearer homology, to the glandular sac forming the ureter in the left functional kidney of the Neritidæ themselves. I have already instituted a comparison between this glandular ureter and the various glands found on the course of the ootype and egg-duct, and have given reasons for believing that both are derived from an invagination of the mantle-epithelium. If these comparisons are correct, the conclusion follows that the ovipository aperture in the female and the single pore of the male are the representatives of the ureter of the right side. The vaginal aperture of the female has therefore nothing to do with the primitive right renal opening. As to how it has been established I will not, in the absence of embryological evidence, hazard an opinion. I will merely point out that the formation of accessory sexual ducts is a common phenomenon. The ductus enigmaticus of *Septaria* and *Paranerita* is an example. So also are the vaginal ducts of the triaulic Dorididæ and Elysiidæ. In the Platyhelmia multiplication of the female orifices, *e. g.* in *Trigonoporus*, is common; and I do not think it altogether fanciful to say that there is some analogy between the Laurer-Stieda canal of Trematodes and the ductus enigmaticus of the Neritidæ.

The spermatophores of *Nerita* and *Paranerita* require some description. They are very similar in general appearance in all species I have studied. As shown in fig. 69, a spermatophore consists of a cylindrical body, rounded at one end and produced at the other end into a long hollow filament. In several cases I have seen this filament engaged in the aperture of the vaginal canal, as represented in fig. 64, and extending for a long distance into its lumen. It is therefore evident that the contents of the spermatophore—the spermatozoa—are voided through the filament into the lower end of the vaginal canal, possibly into the receptaculum seminis, and do not pass into the lumen either of the vagina or of the upper part of the vaginal canal. Usually there are half a dozen or more spermatophores in the sac, but sometimes only one. In no case have I found an empty spermatophore-sac. Though I have tried in many different ways, I have not been able to make any preparations giving a satisfactory demonstration of the structure of the spermatophores. They are brittle, and are always contracted and distorted by the action of reagents; probably the study of fresh specimens is necessary for the elucidation of their mechanism. As shown in figs. 66 and 69, the cylindrical body contains a central cavity filled by a mass of spermatozoa. The wall of this cavity is formed of a thin layer of a hard brittle substance which must be of the nature of chitin. Around it is a protoplasmic layer (fig. 66, III.), from which a number of fine filaments radiate to an external wall composed of an elastic homogeneous substance. The radiating fibres pass from the inner to the outer walls at regular intervals, so that the body of the spermatophore appears in a side view to be made up of a number of segments. The layer of protoplasm surrounding the central capsule is filled with chromophilous granules, but there is no trace of nuclei. Both the inner capsule and the outer wall are continued into the filament, which is therefore a double tube. There is some evidence that the filament is coiled up within the capsule and afterwards shot out much as is the filament of a nematocyst, but of this I cannot be certain. It is a curious thing, of which I can offer no explanation, that neither I nor any of my predecessors have seen any trace of a spermatophore in the male organs. It seems certain that they must be formed in the terminal sac, but there is no positive evidence as to their origin.

It is interesting to note that in the freshwater forms, *Septaria* and *Neritina*, there are no spermatophores. Gilson has followed out the process of fertilization in *N. fluviatilis*, and it is clear from his account that spermatophores do not exist in this species. Lenssen, it is true, alludes to the probability of their occurrence, but he did not discover them, and my experience is the same as his. I have found in one or two specimens a number of spermatozoa agglutinated together in a mass of coagulum in the vagina, but I could not detect any structure resembling that of the spermatophores of *Nerita* and *Paranerita*. The reduced size of the spermatophore-sac in *Septaria borbonica* and *S. bougainvillei* affords evidence that spermatophores are not formed in these species. Against this must be set the fact that Thiele describes a large spermatophore-sac in *S. parva*, and in fig. 128 gives the outline of a large irregular mass in its interior, but he makes no mention of spermatophores.

In fig. 57, *a*, *b*, *c*, *d*, *e*, I have given drawings of the different forms of concretions found in the crystal sac of *Nerita melanotraga*. They dissolve readily in dilute acids with evolution of bubbles, leaving an organic residue in which I could not find any trace of a nucleus. They are composed of a number of crystalline prisms radiating from the centre of the concretion and projecting on the surface as shown in *a* and *b*. Sometimes the crystals are arranged in several concentric layers as in *d*, and in other cases, as in *c*, a concretion is made up of an aggregate of several smaller concretions. As the crystal sac is always full of these concretions in *Nerita* and *Paranerita* they must be of some importance, and I think that they are connected with the formation of an external calcareous layer of the egg-shell. The egg-cases of *Nerita* and *Paranerita* are not known, but those of *Septaria bougainvillei* have an external calcareous envelope which is readily dissolved in dilute acids leaving a horny layer beneath. The crystal sac is very small in *Septaria*, and this may account for the calcareous layer being very thin. If this surmise be correct, the "crystal sac" is a calcigenous gland, as hinted in a footnote by Thiele, though for some unexplained reason he prefers to call it the uterus.

Before bringing this part of my work on the Neritacea to a close, I may conveniently discuss the various questions arising out of the facts enumerated. In the first place, there is the question of the inter-relationship of the existing members of the Neritidæ. Leaving *Scutellina* out of the question, because I have not been able to obtain specimens of this genus, I have to justify my subdivision of the members of the family into the groups *Nerita*, *Paranerita*, *Septaria*, and *Neritina*. The fact that the female *Neritina* (*sensu restricto*) is diaulic and *Paranerita* triaulic is in my opinion sufficient to separate these forms from one another. Further than this *Neritina* resembles *Nerita* more closely than *Paranerita*, not only in being diaulic, but also in the characters of the epididymis, in having the epididymis and spermatophore-sac restricted to the mantle-region instead of projecting backwards into the cœlom, and in the position of the receptaculum seminis on the vaginal canal. *Neritina*, again, is more specialized than any other of the Neritidæ in that it has lost the supra-intestinal nerve and the oviduco-cœlomic funnel. The evidence of comparative anatomy therefore points to its having been evolved independently of *Paranerita* from a marine *Nerita* stock, and this conclusion is strengthened by a consideration of the evidence afforded by distribution in space and time. Assuming, as we are amply justified in doing, that all estuarine and freshwater forms are descended from marine Neritidæ, the various species of *Neritina* inhabiting rivers debouching into the Mediterranean, Caspian, and Northern European seas must have been derived from a marine form inhabiting those seas. At the present time no member of the genus *Nerita* (*s. stricto*) is found in any of them. *Neritina viridis*, it is true, is found in the Mediterranean, but this is probably a fluviatile form which has found its way back to the sea, for even *N. fluviatilis* occurs in brackish and sometimes in salt water. The ancestral marine forms must therefore be looked for in geological strata, and it is significant that, whereas *Neritina* is common in Tertiary deposits and extends back as far as the Lias, the most recent fossils recognized as members of the genus *Nerita* occur in the Upper Cretaceous—the subgenus *Otostoma*, for instance, in the Upper Cretaceous of Europe, Algeria, and Asia Minor. Making due allowance for the fact that the distinction between *Nerita* and *Neritina* is not very obvious, especially in fossil shells, it is clear that the numerous examples of the latter genus found in freshwater tertiary deposits must have been derived from marine forms that have long since disappeared from European seas, and the existence of *Neritina* in European secondary strata pushes back its origin to a remote period. It is probable on the palæontological evidence that the European species form a distinct geographical group, and the coincidence of anatomical evidence makes the probability well nigh a certainty.

That *Septaria* is derived from *Paranerita*—the females of both are triaulic—and that the latter is descended from the marine *Nerita* still abundant in tropical seas, is beyond all doubt. But the geographical distribution of these forms presents problems which become more difficult the more one reflects upon them. The species of *Paranerita* that I have studied come from localities as far apart as Fiji and Mauritius, but belong to the Indo-Pacific region, the marine life of which is tolerably uniform in character. The anatomy of these species is so similar that they are practically indistinguishable from one another, though I have noted small differences between them. *Paranerita*, however, is only exceptionally a marine form. Most of the species are fluviatile, some (e. g. *P. cornea* from the Philippines) are amphibious or almost terrestrial in habit, and it is a singular thing that, although largely continental, they abound in oceanic islands. Similarly *Septaria*, an exclusively freshwater genus, is characteristically insular, and species scarcely distinguishable from one another are found in the Mascarene Islands, in Fiji, and other Pacific islands. How have these freshwater forms reached their present habitats? Surely not by the ordinary means of dispersal, for the animals, adapted as they are to existence in fresh water, cannot have migrated over the whole Polynesian area, across great extents of deep ocean. Nor could the egg-cases of *Septaria*, which are attached to the shell of the parent, have been wafted uninjured by any conceivable agency across the Indian Ocean. If we fall back on the stereotyped explanation that the species now isolated are representatives of a genus which is still widely distributed and has been throughout long periods of geological time, it is still insufficient, for it assumes what will not readily be granted, the existence of former land-connections between distant oceanic islands, between the Mauritius Islands, Samoa, and Fiji. It is a tempting supposition that, as the marine *Nerita* is universally distributed in tropical seas and as *Paranerita* is abundant in rivers running into seas where *Nerita* is abundant, and as the anatomical characters of the two forms are singularly alike, and as the conchological characters separating *Paranerita* from *Nerita* are just those which are characteristic of freshwater shells—viz. relative lightness and smoothness of shell and operculum due to the greater proportion of organic over calcareous material, and might therefore be attributed to the direct influence of external conditions,—then, wherever circumstances were favourable, marine forms ascended rivers and as a result of changed conditions of life assumed the characters which in our artificial systems of classification are attributed to *Paranerita* (the tropical *Neritina* of previous authors). I can see no *à priori* objection to this supposition, for if evolution is still going on within a group of animals as it has gone on in past times, marine Neritids must still be passing into estuaries, and from estuaries into rivers, and as they change their conditions of life so they must react to their surroundings and undergo modifications of structure. And as the organization of marine Neritids is extremely similar in all parts of the world, and as the conditions obtaining in rivers are also very similar, a similar environment acting upon a similar organization must produce similar results. Let no one object that the environment does not have a direct influence on the organism. It can be proved that it has in certain Mollusca. Take a sample of oysters that have been reared for two years, say, in the Schelde and another sample reared for a similar period, say, in the Bay of Arcachon. Their shells will have such distinct and easily recognizable characters that an experienced eye will have no difficulty in identifying them. Take both samples and lay them down, say, at Whitstable, and leave them there for another two years. At the end of that time the two samples will still be distinguishable because of the characters of the first two years' growth. But in the last two years' growth they will exactly resemble each other, and this new growth will have neither Schelde characteristics nor Arcachon characteristics, but Whitstable characteristics differing from both the former. These facts are well known to oyster-merchants, and I have personally verified them. They are proof of the direct action of the environment on the growing shell, and if only conchological evidence were forthcoming, I should be inclined to accept the supposition put forward above. Indeed, before I made a detailed study of the genital organs, I thought that it was the best explanation of the problem, but when I found that the females of *Nerita* were diaulic, and those of *Paranerita* triaulic, and that there were parallel differences in the male organs, the explanation no longer satisfied me. It is inconceivable that such a structure as the ductus enigmaticus could have been independently evolved several times over. At the same time I think it probable that many of the fluviatile Neritidæ have been independently derived from marine Neritidæ, and I have entered upon this discussion in the hope that others will make an anatomical examination of species from different localities and determine how far they differ from one another. An anatomical study of freshwater Neritidæ from the Atlantic seaboard is very much to be desired.

As to the larger questions of the relationship of the Neritidæ to other groups of the Rhipidoglossa, and whether they can be regarded as representatives of the stock from which the Pectinibranchia were derived, I think that some evidence can be offered from the foregoing pages. The Neritidæ are commonly held to be a highly specialized and at the same time an annectant group leading to the Architænioglossa. Such a view, though it may contain an element of truth, cannot, in my opinion, be held without considerable modification.

To deal first with the position of the Neritidæ among the Rhipidoglossa. Thiele admits that he cannot assign them a satisfactory position. He is inclined to derive them from the Trochidæ, but also detects resemblances to the Acmæidæ; as he rightly observes, they cannot be derived from the latter family, for it is docoglossate.

If we compare the Neritidæ with the rest of the Rhipidoglossa we see that they possess a number of primitive characters common to the whole group. Such are, the short snout, without pre-tentacular or post-tentacular elongation; in the nervous system, the presence of a labial commissure, of elongated buccal ganglia, of a long cerebral commissure, of elongate pedal nerve-cords sheathed in ganglion-cells. The pharyngeal bulb is large, situated far forward in the head and embraced by the cerebral commissure. The ventricle of the heart is traversed by the rectum, and although that of the right side is much reduced there are two auricles. The ctenidium is typically bipectinate and is less modified than in the Trochidæ, for the lower gill-lamellæ are equal in size to the upper.

The characters indicating a higher degree of specialization than in other Rhipidoglossa are as follows:—The eyes are closed, the supra-intestinal nerve is reduced or even absent, and the left symmetrical pallial nerve takes a principal share in the innervation of the ctenidium. The subintestinal ganglion is closely approximated to the right pleural and is united by a very short zygoneurous branch with the latter. A direct commissural connection is established between the right and left pleural ganglia. Only a single functional kidney—the left post-torsional—is present, its fellow of the right side having been converted into the gonaduct. The accessory genital ducts are extremely complicated and in the female are diaulic or triaulic. The visceral spire is reduced and the animal has acquired a secondary symmetry emphasized by the presence of a left as well as a right columellar muscle. In possessing a single (left) ctenidium the Neritidæ stand on the same level of organization as the Trochidæ or Turbonidæ.

It might be concluded from all this that the Neritidæ are nothing more than Rhipidoglossa which have been specialized in certain directions while retaining many of the primitive features characteristic of all the Aspidobranchia, and that they so far resemble the monobranchiate forms (Trochidæ and Turbonidæ) that they have probably descended from them. But this conclusion cannot be sustained. In some important respects the Neritidæ are more primitive than any of the Rhipidoglossa. The cœlom, in particular, extending as it does across the whole width of the body, retains features which may be called embryonic when we compare it with von Erlanger's and Miss Drummond's account of the development of *Paludina*, but must surely be regarded as primitive when we consider the probable phylogeny of the Gastropoda. No such extensive cœlomic space has been described in any other gastropod, and to find a parallel to it we must refer, as Thiele has done, to the Cephalopoda. When a feature is shared by representatives of two orders now widely separate, and is also shown by embryological evidence and by *à priori* reasoning to be primitive, there are very good grounds for regarding it as ancestral. In other Rhipidoglossa the cœlom is reduced to a pericardial sac surrounding the heart. This pericardial sac, as embryology teaches us, is the reduced representative of a primitively much more extensive space. This more extensive space is preserved in the Neritidæ, and the conclusion is that they have inherited it from ancestors more generalized in this respect than the remainder of the existing Rhipidoglossa. This ancestor must have been older even than *Pleurotomaria*, for the cœlom is reduced to a pericardial sac in this genus.

The same conclusion is reached by a consideration of the excretory organs. In Pleurotomariidæ, Haliotidæ, Trochidæ, Turbonidæ, and Fissurellidæ the post-torsional left kidney is reduced to a small sac, and in the first four families this "papillary sac," as it is called, has undergone modification. It no longer serves for the elimination of waste matters from the blood, but is phagocytic. In the Neritidæ the left post-torsional kidney is large and persists as the functional excretory organ; it is the right kidney that has changed its function and undergone reduction. It cannot be doubted that the ancestral Gastropod possessed paired functional kidneys as do the Chitonidæ and among the Fissurellidæ *Cemoria* (*fide* Haller). The obvious inference is that the families in which the left kidney is modified to form a papillary sac are to that extent modified, and that the Neritidæ are descended from an ancestor in which this modification had not yet taken place. The persistence of the left kidney in Neritidæ, therefore, is to be regarded as an ancestral rather than as a specialized character, and as evidence that this family cannot have been descended from Trochidæ or Turbonidæ, in which specialization has taken a different direction.

These arguments indicate that the Neritidæ are descendants of a very primitive stock (a conclusion sufficiently supported by Palæontology), from which the remainder of the Rhipidoglossa and probably other groups of Gastropoda were also derived.

If these conclusions are accepted, the question of the relationship of the Neritidæ to the Tænioglossa is simplified. In this case we have to consider whether the special characters of the

Neritidæ appear, and if so, to what extent, in the more primitive Tænioglossa. If they do not reappear, it cannot be maintained that the latter group is descended from the former. Secondly, whether such resemblances as there may be between the two groups may be attributed to inheritance from a common ancestor or to convergence, or whether possibly both these factors have taken a share in producing these resemblances, and, if so, what share.

Taken by itself, the persistence of the left post-torsional kidney as the functional excretory organ in the Neritidæ and Pectinibranchia would be strong evidence of their relationship, but relationship does not imply that one group is descended from the other. It may be remote and may only indicate that both groups are descended from a common ancestor, and this is clearly the true conclusion in the matter. Among the special characters of the Neritidæ those of the nervous system are the most important. If the Pectinibranchs were descended from a Neritid stock, we should expect to find in the more primitive members of the suborder traces of the special features of the Neritid nervous system. But we find nothing of the sort. The generalized Pectinibranchs such as *Paludina*, *Cyclophorus*, *Littorina*, or *Cyclostoma* are typically dialyneurous. In none of them is the subintestinal ganglion approximated to the left pleural. There is not a zygoneurous connection between the right pleural and the subintestinal ganglia. There is no trace of a direct commissural connection between the right and left pleural ganglia. The supra-intestinal nerve shows no sign of reduction or disappearance. *Paludina*, as Bouvier has shown, is quite rhipidoglossan in respect of its nervous system. The evidence is clear that the archaic Tænioglossa cannot have descended from the Neritidæ.

On the other hand, the persistence of the left kidney as the functional excretory organ, and the fact that the permanent relations of the reduced right kidney (gonaduct) of female Neritidæ to the cœlom almost exactly represent an embryonic phase in *Paludina*, are coincidences which must almost certainly be attributed to inheritance from a common ancestor. At some remote age the Prorhipidoglossan stem must have divided into two branches. In one the left kidney underwent reduction, and this branch gave rise to the Pleurotomariidæ, Haliotidæ, Trochidæ, Fissurellidæ, and probably also to the Docoglossa. In the other branch the left kidney retained its size, and with the reduction of the right kidney became the only excretory organ. From this branch all the Gastropoda which retain the left kidney only —the Neritidæ, the Pectinibranchia, and the Euthyneura—are descended. The last two must have branched off at a very early period, while the ancestral form still retained all the primitive characters of the nervous system, as these are preserved in *Paludina* and in *Actæon*. The Neritacea remain as the much modified representatives of the primitive stock. Their special characters are peculiar to themselves and are not to be explained by reference to any other existing group. Thus the resemblance of the shell of some members of the group to the Naticidæ is due to convergence. So also the possession of a single functional ctenidium on the left side, a character shared by the Trochidæ and Pectinibranchs, does not indicate that the Neritidæ stand midway between these forms, but only that the right ctenidium has been suppressed independently in each. I have brought forward evidence showing that the loss of the right ctenidium is comparatively recent in the Neritidæ, probably as a consequence of the great development of the accessory genital organs which occupy all the space on the right side of the spacious mantle-cavity.

A consideration of the Helicinidæ, the most specialized of the Neritaceæ, must be postponed to the second part of this memoir.

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## EXPLANATION OF THE PLATES.

### Plates XLVI.–LXVI.

*Lettering in all the figures, except figs.* 36–39.

*af.br.* Afferent branchial vessel.
*An.* Anus.
*ap.de.* Aperture of the ductus enigmaticus.
*ax.* Axial plate of ctenidium.
*b.gl.* Basal gland of the male genital organs.
*bp.n.* Branchio-pallial nerve.
*br.n.* Branchial nerve.
*b.si.* Blood-sinuses of kidney.
*c.ap.* Aperture between pericardial and gonadial cœlom.
*cil.c.* Ciliated cells.
*cil.ep.* Ciliated epithelium.
*cil.p.* Ciliated passage into ureter.
*cil.tr.* Ciliated tract of gill-lamellæ.
*cl.gl.* Clear gland.
*cm.l.* Left columellar muscle.
*cm.r.* Right columellar muscle.
*Cp.* Cephalic penis.
*Cry.s.* Crystal-sac.
*Ct.* Ctenidium.
*D.en.* Ductus enigmaticus.
*E.* Eye.
*Ed.* Egg-duct.
*ef.br.* Efferent branchial vessel.
*Epd.* Epididymis.
*fr.cil.* Frontal cilia.
*g.co.* Gonadial cœlom.
*Gd.* Genital complex.
*gl.c.* Gland-cells.
*Hy.g.* Hypobranchial gland.
*Hy.g.a.* Aperture of hypobranchial gland.
*Int.* Intestine.
*int.c.* Interstitial cells.
*K.* Glandular portion of the kidney.
*K′.* Bladder or non-glandular portion of the kidney.
*L.au.* Left auricle.
*Li.* Liver.
*Li.d.* Hepatic ducts.
*l.msc.* Longitudinal muscles of gill.
*M.* Mantle.
*M.c.* Mantle-cavity.
*M.ep.* Mantle-epithelium.
*m.f.* Muscle-fibres.
*m.gl.* Mucous gland.
*m.t.* Middle tube of gonaduct.
*O.* Otocyst.
*od.* Oviduct.
*od.c.f.* Oviduco-cœlomic funnel.
*Oe.* Œsophagus.
*Oot.* Ootype.
*Oot.ep.* Epithelium of ootype.
*Op.* Opercular lobe.
*Os.g.* Osphradial ganglion.
*Ov.* Ovary.
*Ov.ap.* Ovipository aperture.
*P.* Pedal nerve-centres.
*pc.co.* Pericardial cœlom.
*Ph.* Pharyngeal bulb.
*prs.* Prostate.
*R.* Rectum.
*R.au.* Right auricle.
*R.ct.* Right ctenidium.
*rc.gl.* Rose-coloured gland.
*Rd.* Radula.
*R.p.c.* Reno-pericardial canal.
*R.s.* Receptaculum seminis.
*R.s.d.* Duct of receptaculum seminis.
*S.g.* Salivary gland.
*Sp.* Spermatophores.
*sp.d.* Sperm-duct.
*sp.ep.* Epithelium of sperm-duct.
*Sp.s.* Sperm-sac.
*Spz.* Spermatozoa.
*St.* Œsophageal division of stomach.
*St′.* Pyloric division of stomach.
*T.* Tentacle.
*tch.* Terminal chamber.
*th.* Thalamus
*Ts.* Testis.
*Ur.* Ureter.
*Ur.p.* Uropore.
*V.* Ventricle of heart.
*Vag.* Vagina.
*Vag.ap.* Vaginal aperture.
*Vag.c.* Vaginal canal.
*vis.gn.* Visceral ganglion.
*vis.n.* Visceral nerve.
*vt.g.* Vitelline gland.

## Plate XLVI.

Fig. 1. Dorsal view of *Septaria borbonica*, ♀. The mantle has been cut through and partly removed to show the organs of the pallial complex (× 5).

2. A semi-diagrammatic drawing to show the course of the gut in *Septaria*.

3. A diagram of the female genital organs of *Septaria*.

## Plate XLVII.

Fig. 4. A transverse section through the anterior part of the viscera mass of *Septaria bougainvillei*, showing the connection between the pericardial and gonadial divisions of the cœlom and the oviduco-cœlomic funnel, *od.c.f.*

5. The oviduct and oviduco-cœlomic funnel as shown in the last figure, but magnified 300. This figure is reversed.

## Plates XLVIII.–L.

Figs. 6–16. Transverse sections taken at different levels through the genital complex of *Septaria bougainvillei*, ♀. For full description of these figures, see text, pp. 839–841.

Fig. 17. *Septaria bougainvillei*, section through the osphradium and osphradial ganglion. × 300.

## Plate LI.

Fig. 18. Portion of a horizontal section through *Septaria depressa*, showing the uropore (*Ur.p.*), the opening of the reno-pericardial canal (*Rp.c.*) into the glandular part of the kidney (*K.*), the pericardium (*pc.co.*), &c.

19. A section more ventral than that shown in fig. 18, showing the opening of the reno-pericardial canal into the pericardium, and the large extent of the non-glandular part of the kidney.

## Plate LII.

Fig. 20. An oblique section through the left or efferent edge of the ctenidium of *Septaria bougainvillei*.

21. The more median part of the same section, showing the ciliated junctions of the gill-lamellæ.

22. A section through the right or afferent edge of the same ctenidium.

23. A surface view of a single gill-lamella of *Septaria borbonica*, showing the relative extent of the ciliated and non-ciliated tracts.

24. The ciliated epithelia of the terminal portions of the ovipository and vaginal ducts of *S. bougainvillei*. Highly magnified.

25. The ootype epithelium somewhat further down the duct, showing gland-cells containing eosinophilous granules pushing through the basement-membrane into the subjacent connective tissue.

## Plate LIII.

Fig. 26. A portion of the ootype gland and ootype epithelium of *S. bougainvillei*. × about 200.

27. A portion of the "clear gland" from the genital ducts of *S. bougainvillei*, ♀, showing the elongated ciliated epithelial cells lining the lumen of the duct, and the bunches of clear secretory cells the long ducts of which pass between the epithelial cells. Magnified about 750.

28. A portion of the epithelial lining of the thalamus and the vitelline gland of *S. bougainvillei*, ♀, showing the bunches of granular secretory cells and their ducts filled with granules. Magnified about 500.

## Plate LIV.

Fig. 29. Left side view of *N.* (*Paranerita*) *gagates*, removed from its shell. × 5. The pericardium has been opened to show the relative positions of heart, ctenidium, rectum, and kidney.

30. The right tentacle and cephalic penis of *Neritina fluviatilis*. × 10.

31. The right tentacle and cephalic penis of *Nerita melanotraga*. × 5.

32. The right tentacle and cephalic penis of *N.* (*Paranerita*) *gagates*. × 5.

33. A horizontal section through the cephalic penis of *N.* (*Paranerita*) *variegata*.

34. A portion of the opercular gland of *Nerita melanotraga*, showing the gland-cells in different phases of activity and the interstitial or covering cells (*int.c.*).

## Plate LV.

Fig. 35. View of the pharyngeal bulb and alimentary tract of *N.* (*Paranerita*) *longispina* unravelled.

36. A dorsal view of the pleuro-pedal nerve-centres and principal nerves issuing from them in *N.* (*Paranerita*) *gagates*. The lettering in this and the succeeding figures is the same as that adopted by Bouvier (**9**). *Cd.* Right pleural ganglion. *Cg.* Left pleural ganglion. *O.* Otocyst. *P.* Pedal centres. $b^1$. Left symmetrical branchial nerve. $d^1$, $d^2$. Anterior pallial (parietal) nerves of the right side. $e^1$, $e^2$. Anterior pallial (parietal) nerves of the left side. *h.* Supra-intestinal nerve. $h^1$. Subintestinal nerve. $k^1$. Cerebro-pedal connective. $k^2$. Cerebro-pleural connective. *ld.* Right columellar nerve. *lg.* Left columellar nerve. *m.* Pallial branch of the left branchio-pallial nerve. $m^1$. Right pallial nerve. *op.* Opercular nerves, issuing from the upper surface of the pedal centres. *s.* Branches of the cerebro-pleural connectives passing to the walls of the head. *Sb.* Subintestinal ganglion.

37. A section taken somewhat obliquely through the pleural and pedal centres. 2. Origin of the lower of the two direct commissural connections between the pleural ganglia. *Z.* Zygoneurous connection between the right pleural ganglion and the subintestinal nerve. Other lettering as in fig. 36.

## Plate LVI.

Fig. 38. A section through the pleural centres posterior to that shown in the preceding figure. 1 & 2. Upper and lower direct commissural connections between the pleural ganglia.

39. A still more posterior section through the pleural centres.

40. A transverse section through the proximal end of the subintestinal nerve, showing two bundles of nerve-fibres.

41. Part of a longitudinal section through *N.* (*Paranerita*) *gagates*, ♀, showing the relation of the spermatophore-sac (*Sp.s.*) to the gonadial division of the cœlom (*g.co.*) and the opening of the oviduco-cœlomic funnel (*od.c.f.*) into the latter.

## Plate LVII.

Fig. 42. A horizontal section through *N.* (*Paranerita*) *gagates*, ♂, showing the two divisions of the stomach, the extent of the lower part of the pericardial cœlom, and the relations of the right auricle.

43. A similar section taken at a somewhat higher level, showing the extension of the pericardial cœlom towards the right side and the opening of the reno-pericardial funnel into it.

## Plate LVIII.

Fig. 44. A similar section, more dorsal than fig. 43, showing the relations of the epididymis to the viscera.

45. A section through the uropore, more highly magnified, showing the relations of the visceral ganglion and reno-pericardial canal.

46. A section showing the opening of the reno-pericardial canal into the pericardial division of the cœlom in *N.* (*Paranerita*) *variegata* and the extension of the ciliated epithelium of the ureter (*ci.ep.*) into the bladder.

## Plate LIX.

Fig. 47. A section through the ureter and adjacent part of the kidney in *N.* (*Paranerita*) *variegata*, showing the opening of the reno-pericardial canal into the glandular part of the kidney and the ciliated passage (*cil.p.*) leading directly from the latter into the ureter.

48. A longitudinal section through the genital complex of *N.* (*Paranerita*) *gagates*, ♂.

49. Part of a horizontal section through *N.* (*Paranerita*) *variegata*, showing the opening of the hypobranchial gland (*Hy.g.a.*) into the mantle-cavity.

## Plate LX.

Fig. 50. The male organs of *N.* (*Paranerita*) *gagates*, semi-diagrammatic.

51. A similar representation of the male organs of *Nerita lineata*.

52. Part of a section through the outer wall of the terminal chamber of the male ducts of *N.* (*Paranerita*) *variegata*, illustrating the formation of bunches of unicellular glands in the connective tissue underlying the epithelium of the chamber. × about 1000.

## Plate LXI.

Fig. 53. Part of a section through the inner wall of the terminal chamber of the same species, showing a bunch of unicellular glands the ducts of which pass between the ciliated epithelial cells lining the chamber. × about 1000.

54. Part of a section through the prostate of the same species, showing the gland-cells and ciliated interstitial cells (*cil.c.*). × about 1000.

55. Part of a section through the terminal coils of the epididymis of the same species, showing the tube filled with spermatozoa and the granular non-ciliated cells (*ep.*) lining the tube.

## Plate LXII.

Fig. 56. Part of a section through the basal gland of the male organs of the same species, showing groups of gland-cells containing vesicular bodies, each with a brightly staining spot.

57. *a*, *b*, *c*, *d*, *e*. Different forms of concretions from the crystal sac of *Nerita melanotraga*.

58. A diagram illustrating extent and relations of the cœlom in *Paranerita*.

59. Reticular connective tissue and metabolic cells from *Neritina fluviatilis*, × about 1000. *ret.* Protoplasmic reticulum with nuclei. *met.* Metabolic cells with granules.

## Plate LXIII.

Fig. 60. The female organs of *N.* (*Paranerita*) *gagates*, semi-diagrammatic. This figure, as also figures 64 and 65, represent the organs as they appear when dissected from the ventral surface. The ootype and rectum, which in their natural position lie dorsad of and partly to the left of the vagina, are thrown over to the right side of the figure.

61. A longitudinal section through the anterior part of the genital complex of *N.* (*Paranerita*) *variegata*, showing the vaginal aperture and the aperture of the ductus enigmaticus.

## Plate LXIV.

Fig. 62. A section from the same series through the middle of the genital complex.

63. A section from the same series through the lower part of the genital complex.

64. A drawing of the vagina and spermatophore-sac of *N.* (*Paranerita*) *longispina*: the spermatophore-sac has been laid open.

## Plate LXV.

Fig. 65. A semi-diagrammatic representation of the female organs of *Nerita plicata*.

66. A section of a spermatophore of *Nerita plicata*. I. Central capsule filled with spermatozoa. II. Chitinous wall of the central capsule. III. Layer of protoplasm with chromophilous granules. IV. Radiating fibres. V. External wall.

67. A transverse section passing through the bottom of the fundus of the ootype of *Nerita plicata*, illustrating the relations and structure of the sperm-sac. For further description see pp. 870 & 871.

## Plate LXVI.

Fig. 68. A section from the same series as fig. 67, taken at a higher level and showing the connection of the thalamus with the fundus of the ootype.

69. A spermatophore of *Nerita plicata*.

## 2. An unknown Lemur from the Lushai Hills, Assam.

By N. ANNANDALE, D.Sc., C.M.Z.S., Superintendent, Indian Museum.

[Received November 3, 1908.]

(Text-figure 173.)

Mr. T. D. La Touche, of the Geological Survey of India, has recently shown me a remarkable photograph taken by himself during the Lushai Expedition of 1889–90. It represents two individuals of a small mammal evidently allied to the Slow Lemurs (*Nycticebus*), but differing from all known Asiatic species of the order in possessing a thick, bushy tail. The photograph is not clear as regards the tail, but Mr. La Touche assures me that it was present.

Text-fig. 173.

An unknown Lemur from Assam.

The new Lemur is white in colour, with a narrow black mid-dorsal stripe extending from the occiput to the base of the tail, a dark triangular patch round each eye, and the anterior surface of the ears dark. The tail is apparently very thick and cylindrical, shorter than the head and body, and without definite markings. The limbs are comparatively short and stout. The head is large and round, the face flat, the muzzle small, the ears short and rounded; the eyes are perhaps a little smaller than those of *Nycticebus tardigradus*, but are separated by less than their own diameter. The fur is apparently close and woolly.

*Hab.* "Caught near Fort Lungleh, Dec. 1889" (*La Touche*). Evidently an inhabitant of dense jungle on the outer ranges of the Lushai Hills, Assam.

Mr. La Touche tells me that the individuals he photographed were caught in the jungle and escaped from captivity after a short confinement. They were habitually so slow in their movements that no precautions were taken to prevent their escape; but when once they had got out of their cage they vanished rapidly. They were fond of hanging upside down, as the upper animal of the photograph (text-fig. 173) is doing. It will be noticed that in this position the tail does not hang down but is supported against the side of the box. Possibly it is prehensile, but this is not clear. The lower animal in the photograph is evidently asleep. It sits with its head tucked in under its chest, much as *Nycticebus* does; the tail is also tucked in under the body.

Possibly on examination the skull of this interesting Lemur would show further differences from the known Indian genera, *Nycticebus* and *Loris*. *Nycticebus* and *Loris* have a rudimentary tail or no tail at all; *Tarsius*, the only other Asiatic genus, which is the type of a separate family and only occurs in the Malay Archipelago, has a long, thin tail with a tuft at the end. The closest extra-Asiatic allies of *Nycticebus* and *Loris* are the Pottos (*Perodicticus*) from W. Africa, which have short or rudimentary tails. Even the type of coloration of La Touche's Lemur, however, so closely resembles that of the Indian forms that it is impossible that the new genus is widely separated from them. Among the Madagascar genera, moreover, *Indris*—like *Tarsius*, the type of a separate family—has a rudimentary tail; and even in the genus *Perodicticus*, as it is now defined, there is a considerable difference in the length of this organ in different species.

[Since the above was written I learn from Col. E. W. Loch that the tailed Lemur of the Lushai Hills is well known to him. I defer the publication of a technical description and the naming of the genus until it has been possible to examine specimens.—January 5, 1909.]

December 15, 1908.

Dr. Henry Woodward, F.R.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions made to the Society's Menagerie during the month of November 1908:—

The number of registered additions to the Society's Menagerie during the month of November was 91. Of these 50 were acquired by presentation, 18 by purchase, 12 were received on deposit, 10 by exchange, and one was born in the Gardens.

The number of departures during the same period, by death and removals, was 190.

Amongst the additions special attention may be directed to:—

Two Walruses (*Odobœnus rosmarus*) from Franz Josef Land; purchased on Nov. 23rd.

One Sumatran Civet (*Viverra tangalunga*) from Sumatra; presented by A. R. Heath, Esq., on Nov. 24th.

Two Pardine Genets (*Genetta pardina*) from Warri, Southern Nigeria; presented by E. G. Stevens, Esq., on Dec. 13th.

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Mr. Frederick Gillett, V.P.Z.S., gave an account of his recent Hunting Trip to the Thian Shan, illustrated by lantern-slides.

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Mr. R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Society's Gardens, exhibited photographs of a Sumatran Tiger, recently purchased by the Society, and made remarks upon this animal and upon the other Tigers at present living in the Gardens. He said:—"This Tiger, a male, was one of a litter obtained by Mr. Pinckney at Deli in Sumatra. Its ground-colour is noticeably darker and duller in hue than in the Indian and Siberian Tigers in the adjoining cages. The stripes are numerous, closely placed, and broad, nearly all of those on the sides of the body, behind the shoulders, and on the hind-quarters, being looped or reduplicated. The shoulder is scantily striped, and the outside of the fore leg nearly unstriped, except for one or two narrow stripes across the wrist and a few abbreviated stripes along the back of the leg below the elbow, which are continuous with those on the inner side of this limb. The inner sides of both fore and hind limbs are fully striped to the feet. The pale areas over the eyes, on the cheeks, chest, belly, and inside of the limbs are only dirty white and not sharply defined from the yellow-brown hue of the rest of the body. The yellow-brown hue of the muzzle extends over the whisker-area down to the black patch round the corner of the mouth and separates the white patch on the front of the upper lip from the white of the cheek.

Except for the multiplication and duplication of the stripes, this specimen seems to agree with other Sumatran Tigers that have been described. In his Monograph of the Felidæ, for example, Elliot remarks that Sumatran Tigers are smaller than Indian examples and do not exhibit any white about the face and throat, those parts being buff, while the general colour is dark red, but with the stripes distributed in the typical style.

Text-fig. 174.

Sumatran Tiger (from a specimen now living in the Society's Gardens).

Our Sumatran Tiger is also small. His age is uncertain, however, and he may be no more than about three years old. His weight is probably only about half that of our large Indian Tiger. He stands about 29 inches at the shoulders.

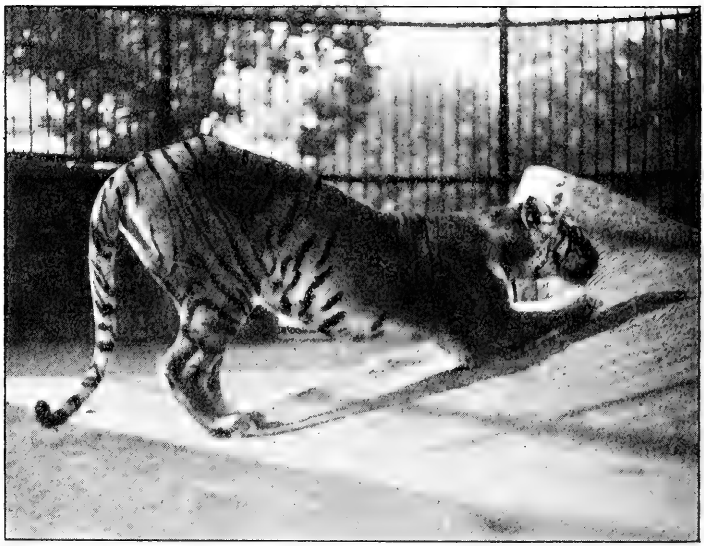
The Sumatran Tiger was originally named *Felis tigris nigra* by Lesson (Nouv. Tabl. R. Anim., Mamm. p. 50, 1842.) But since no description was subjoined, *nigra* must be regarded as a *nomen nudum*. Fitzinger subsequently described it as *Tigris sondaica* (SB. kais. Akad. Wien, lviii. pt. i. p. 454, 1868), and this name has been universally and correctly adopted.

Our Sumatran specimen resembles in the nature of its stripes the Persian Tiger described and figured by Dr. Heck (Lebende

Bilder etc. p. 157), but may be at once distinguished by the indistinctness and small extent of the white areas of the head and body, by the absence of the fringe of hair on the belly, and the shorter hair of the cheeks and throat. The Persian race has been named *F. tigris virgata* by Matschie, in allusion to the completeness of the pattern of stripes.

Of Indian Tigers the Society possesses at the present time three examples: one large male from Mysore, presented by A. Forbes, Esq., C.S.I., and two females from Nepal, presented by H.R.H. the Prince of Wales. The latter are remarkable for the reduction both in number and length of their stripes, of which scarcely any

Text-fig. 175.



Nepalese Tiger (from a specimen now living in the Society's Gardens).

show a sign of looping. The greater part of the shoulder, the outside of the fore leg, and a large portion of the costal area of the thorax are without stripes; while on the inner side of the fore leg the only stripe that persists is the brachial stripe, a constant feature in many species of *Felis*. On the hinder part of the body and on the hind-quarters the stripes show a strong tendency to abbreviation, in addition to being comparatively thin and widely separated. From their general appearance I am convinced that these two specimens came from the same litter, a conclusion which lessens the systematic value one might be inclined to attach to the features they have in common. Be it noted, moreover, that another Tigress which came at the same time from the same country was as fully striped as our other Indian Tiger, though much less so than the individual from Sumatra; and that a thick-coated Siberian specimen in the British Museum is as poorly striped as the two Nepal specimens here described. These Nepal Tigers do not develop a thick winter coat, although they are kept in the open all through the cold weather. Indian Tigers are regarded systematically as typical representatives of *Felis tigris*.

Of Mantchurian Tigers the Society has a fine pair presented by the Duke of Bedford. From their facial similarity I should say that they undoubtedly came from the same litter. Beyond the fact that they were shipped from Vladivostock, their exact locality is unknown. They seem to be typical members of the Mantchurian race, and differ from our Indian Tigers in having a considerably greater extent of white and a correspondingly lesser extent of yellow on the body, head, and limbs. They also develop a thick coat in the winter. The male stands about 38 inches at the shoulder.

The race to which these Tigers belong was named *F. tigris mongolica* by Lesson (Nouv. Tabl. R. Anim., Mamm. p. 50, 1842); but since the name was unaccompanied by a diagnosis, it cannot stand, although it has been adopted by Matschie, Trouessart, and Lydekker, who at the same time reject the name *nigra* given by Lesson to the Sumatran race. I adopt, therefore, the name *longipilis* proposed by Fitzinger (SB. kais. Akad. Wien, lviii. pt. i. p. 455, 1868).

The four described races of Tigers may be briefly characterized and contrasted as follows:—

*a*. Pale areas of the head, body, and limbs dirty to buff white and small in extent; size small or medium ............ *sondaica*.

*a'*. Pale areas of the head, body, and limbs clean white, sharply defined and greater in extent.

- *b*. A copious mane on the cheeks and throat and along the belly; size medium ................................ *virgata*.
- *b'*. Mane on cheeks shorter; practically none on throat and belly.
  - *c*. White on belly, face, and inside of legs considerably more extensive; winter coat thick and woolly ... *longipilis*.
  - *c'*. White on belly, face, and inside of legs much less extensive; winter coat short and not markedly longer and thicker than that of the summer ....................... *tigris*.

The following papers were read:—

## 1. Some Notes on the Muscular and Visceral Anatomy of the Batrachian Genus *Hemisus*, with Notes on the Lymph-Hearts of this and other Genera. By FRANK E. BEDDARD, M.A., F.R.S., F.Z.S.

[Received October 23, 1908.]

(Text-figures 176–190.)

The existing knowledge of this genus of Frogs is limited, so far as I am aware, to the external characters *, the osteology, and certain points in the anatomy of the tadpole †. I therefore take the opportunity afforded by the death of the only example of a species of *Hemisus* (*H. guttatum*) ever possessed by the Society to lay before the Meeting a few notes upon the structure of the "soft parts" of the adult, as a further ‡ contribution to the anatomy of the Engystomatidæ.

As I have had only one individual for examination, my account of the anatomy of *Hemisus* cannot aim at being comprehensive. I have, however, been able to get together a considerable number of facts upon the anatomy of many organs and systems of organs in this Frog, which I treat of in the following order:—



### § *Muscles of the Dorsal Surface.*

Contrary to what is found in *Breviceps* and *Rhinoderma*, the *depressor mandibulæ* of *Hemisus* is quite large and well developed. It arises in the ordinary way from the fascia dorsalis overlying the latissimus dorsi and crosses the scapula on its way to its insertion on to the lower jaw. Of this muscle the outer margin is thicker than the rest, though there is no abrupt break dividing the muscle into two sections.

* Boulenger's Cat. Batr. Sal. B. M. 1882, and literature therein cited; Gadow, in Cambridge Natural History. vol. viii. 1901, relating to Reptiles and Amphibians.
† Bles, "Notes on Anuran Development, &c.," Budgett Mem. Vol., Cambridge.
‡ "On the Anatomy of *Breviceps*," P. Z. S. 1908, p. 11. "On the Anatomy of *Rhinoderma*," P. Z. S. 1908, p. 678.

The *latissimus dorsi* is a large muscle, the origin of which commences some way behind the scapula and extends forward to a point about on a level with its posterior border. It arises from the middle line of the back and underlies the fascia dorsalis which is closely adherent to it. It should be mentioned in considering this muscle that the humerus is not free from the body. It is closely connected with the fascia covering the body and a strongish band connects the fascia dorsalis with the very elbow. This state of affairs must necessarily, one would suppose, have influenced the adjacent musculature. In any case, the latissimus dorsi blends early with the infraspinatus, and indeed it is difficult to distinguish between the two muscles anywhere. The conjoined muscles narrow rapidly to form a thick muscle a little way from the insertion on to the humerus.

The *cucullaris* is a very massive muscle and is attached up to the very tip of the suprascapula, along its anterior border.

When the latissimus dorsi is cut and reflected I can find no muscle comparable exactly to the transversely running rhomboideus (or retrahens scapulæ) of *Rhinoderma*. The position of that muscle is occupied by fascia binding the suprascapula to the middle line of the back, in which no muscular fibres can be detected on dissection. The cutting and reflection of the latissimus dorsi, and the fact that the suprascapula thus exposed is a narrow plate of cartilage with a concave posterior boundary-line, brings into view certain muscles connecting the transverse processes of the third and fourth vertebræ with the scapula and suprascapula, which have received various names in *Rana*.

Inasmuch as these muscles have not been described in the large female *Rana guppyi*, where they are naturally peculiarly clear, and in which Frog they appear to differ slightly from the corresponding set of muscles in *Rana esculenta*, it will not be useless to describe these muscles before proceeding to deal with those of *Hemisus*.

In *Rana guppyi* the muscles in question, which obviously resemble, as has been pointed out, the serratus group of muscles of higher animals, can be divided into two groups :—those which are inserted on to the under surface of the suprascapula and those which are inserted on to the under surface of the scapula. The direction of the two sets of muscles is totally different, and their course indeed lies nearly at right angles. The broad cartilaginous edges of the suprascapula nearly completely cover this system of muscles. The group which are inserted on to the suprascapula consist of four muscles, of which one, the *rhomboideus*, has been already described by myself in this species *.

The second is a large flat muscle arising from the free end of the transverse process of the fourth vertebra, which I take to be the *retrahens scapulæ* of Ecker (with which therefore I was wrong in identifying the rhomboideus in my description of *Pipa* quoted

* *Cf.* memoir on *Pipa*, P. Z. S. 1895, p. 835.

below) and which is perfectly distinct from the rhomboideus of *Rana guppyi* to which I have just referred. The muscle is inserted on to a considerable area of the suprascapula and is in contact in front with the insertion of the rhomboideus, which is in its turn in contact with the insertion of the cucullaris. At its origin the muscle is connected with the tendinous intersection of the longissimus dorsi as well as with the transverse process of the fourth vertebra. Between this muscle and the next to be mentioned lies the anterior lymph heart which is described on another page *. This next muscle arises from the end of the transverse process of the third vertebra and is distinctly composed of two parts. Each of these is a flat sheet of muscular fibres.

The two sheets are perfectly distinct at their origin. For the outer of the two does not extend so far along the surface of the cartilage posteriorly as does the inner muscle. At their insertion, however, close to that of the retrahens scapulæ, there is no distinction between the several layers of this muscle, which must therefore be regarded as simply double-headed. It differs therefore from the *transverso-scapularis tertius* or *serratus* (Ecker) of *Rana esculenta*, with which I believe it to be homologous. The insertion of this muscle is in contact with that of the retrahens scapulæ. The fourth muscle is not a flat muscle like the last two, but is narrow and more or less oval in transverse section. It arises independently of the last muscle from the anterior edge of the free end of the transverse process of the third vertebra, and is inserted quite away from the serratus near the anterior border of the suprascapula outside of the insertion of the levator anguli scapulæ. This muscle is not mentioned by Ecker, unless, indeed, it is this which is the transverso-scapularis tertius.

The remaining muscle of the "serratus" series is obviously the homologue of the *transverso-scapularis major* (Ecker) of *Rana esculenta*, and is the only muscle of the series which is inserted upon the scapula. As in *R. esculenta*, it arises by two heads, one from each transverse process of vert. 3 & 4. That arising from the transverse process of the fourth vertebra is very much the larger and both heads are entirely fleshy. The insertion of this muscle on to the scapula lies between the insertions of the sterno-cleidomastoid and the protrahens scapulæ, which are the two head muscles of the scapula corresponding to the single head muscle of the suprascapula referred to above †.

When in *Hemisus* the latissimus dorsi has been cut through and reflected, two muscles belonging to the serratus series are exposed throughout their entire length and a third very nearly so. The two which are fully exposed belong to the suprascapula, and the third is very obviously the equivalent of the transverso-scapularis major which is inserted on to the scapula.

* *Vide* p. 930.

† The sternocleidomastoideus of *R. guppyi* really consists of two parts, a much larger part and a smaller which is inserted separately by a longish tendon.

The two muscles belonging to the suprascapular series of the serratus group arise respectively from the transverse processes of the third and fourth vertebræ. That arising from the fourth vertebra, and which therefore represents the *retrahens scapulæ* of *Rana*, is much the more slender of the two. It is a flat strap-shaped muscle of much the same diameter throughout. It is inserted on to the end of the suprascapula by a flat tendon. The shorter and wider muscle arises from the transverse process of the third vertebra and is inserted on to the suprascapula along a wider line of insertion than that of the last-described muscle, but in contact with it at its extremity. It corresponds, as I imagine, to that double-layered muscle in *Rana guppyi* which I have identified provisionally with the *transverso-scapularis tertius* of *Rana esculenta*. The chief reason which leads me to this inference is that the anterior lymph-heart lies between it and the retrahens scapulæ just described. Moreover, the muscle is distinctly composed of two layers, or rather it may be better to speak of the lower layer as a distinct muscle, since it is more oval in section than the superjacent layer. In this case the deeper layer may be really the equivalent of the third "serratus" muscle described above in *Rana guppyi*. The two muscles (or three) which have been just described run in a direction which is not far from parallel to the longitudinal axis of the body, being directed obliquely inwards from behind forwards to that axis, and they constitute those muscles belonging to the serratus system which are inserted upon the suprascapula. There is also besides the cucullaris, which has been already referred to, another head muscle, the *levator anguli scapulæ*, which is also attached to and beneath the suprascapula.

There now remain certain muscles of the serratus complex which are inserted upon the scapula. Of these there is first of all the obvious homologue of the *transverso-scapularis major* of *Rana*. This consists, as in *Rana*, of two heads arising respectively from the transverse processes of the third and fourth vertebræ. The two heads are entirely fleshy and more equal in size than in *Rana*; they combine to form a single muscle which is inserted low down on the scapula. The direction of this muscle is quite at right angles to that of the suprascapular series of the serratus complex. A second large muscle lies in front of that which has just been described, and its fibres run about parallel with those of the transverso-scapularis major, and are inserted on to the junction of the scapula and the suprascapula if the junction is fixed by the change of direction of the bony scapula from the chiefly osseous, partly cartilaginous supra-scapula; indeed, perhaps the bulk of the fibres are really attached to the suprascapula. This muscle arises well in front of the third vertebra, but its origin is not covered by the suprascapula. I suppose that it may be compared with the transverso-scapularis minor (Ecker) of *Rana esculenta*; but the origin is different and the muscle actually and relatively much larger.

When the abdominal viscera are removed or pushed aside, the internal surface of the ilia and their muscles are exposed, as I have recently figured * in the genera *Megalophrys*, *Rana*, *Pelobates*, and *Ceratophrys*. The conditions observable in *Hemisus* when a dissection of this kind is made are more like those of *Ceratophrys* than those of any of the other genera to which I have just referred. The ilium is exposed for the greater part of its length and devoid of muscular covering, for the *ilio-coccygeal* origin does not extend at all over the ventral surface of the bone.

The *ilio-lumbaris* arises towards the anterior end of the ilium, exactly in the way in which I have figured it in *Ceratophrys*. It is, however, a rather more solid muscle and passes up to the origin of the œsophageal muscle † without a break except for tendinous intersections which correspond to the transverse processes of the successive vertebræ. Moreover, it abuts closely upon the centra of the vertebræ, at any rate anteriorly. There is no long lateral slip of this muscle as in the Pelobatidæ ‡.

### § *Ventral Musculature.*

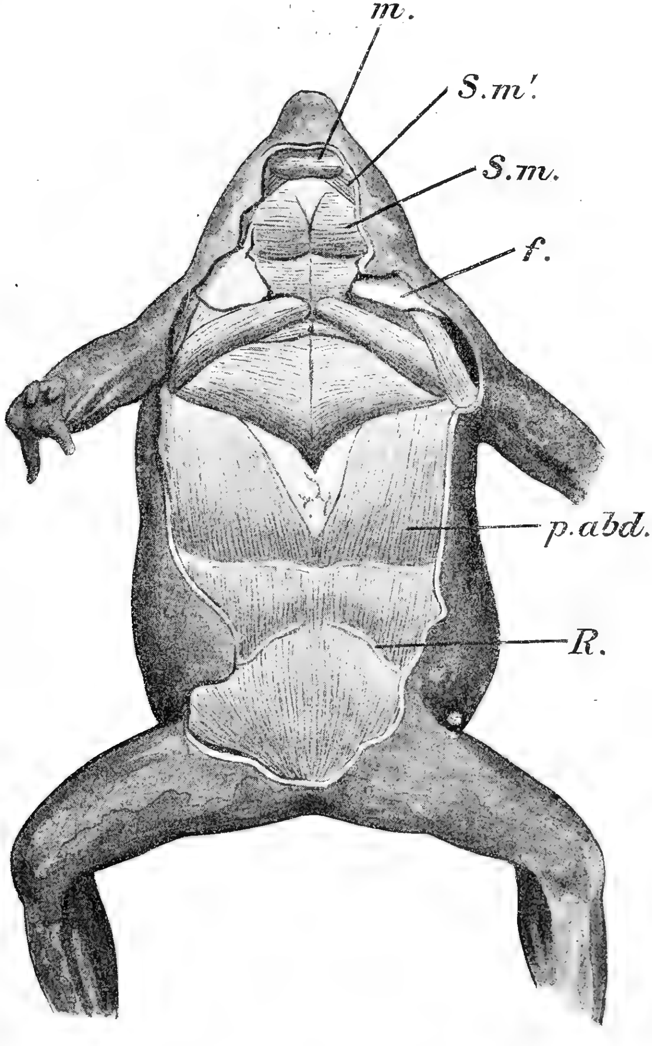
The two *pectorales abdominis* differ from those of many Frogs in that they meet in the middle line ventrally. The rectus abdominis absolutely ceases to be visible with their origin, and is, in fact, anteriorly to this line covered by them, a peculiarly strong inscriptio tendinea forming the boundary line between the two muscles. Another peculiarity of this inscriptio tendinea besides its strength and toughness, which is doubtless in relation to the importance of the pectoralis attached to it, is the fact that this tendinous seam is firmly attached to the skin. So firm and so direct (*i. e.* not through a special septum such as those which divide the other subcutaneous lymph-spaces) is this connection that some fibres of the muscles concerned have the appearance of arising from the skin. The two pectorales abdominis are not only continuous at their origin from this tendinous seam and septum, their fibres are nearly in contact for some little space in front of this; for there is a prolongation forwards of the seam at right angles to the rest, from which the innermost fibres of each pectoralis abdominis arise. This is not, however, continued far towards the sternal region. A triangular or, indeed, almost V-shaped space is left between these two pectorales abdominis and the pars sternalis anteriorly, as is shown in the figure (text-fig. 176), which is uncovered by any muscular layer and where the posterior region of the pectoralis sternalis is exposed.

In the middle ventral line of the body the septum between the pectoralis abdominis and the rectus abdominis is pretty well at right angles to the longitudinal axis of the body. Laterally the line of origin of the pectoralis curves more and more anteriorly, so that at the sides of the body the origin of the

* P. Z. S. 1907, p. 332, text-fig. 93, p. 333, text-fig. 94, &c.
† For which see p. 915.
‡ P. Z. S. 1907, p. 905.

pectoralis abdominis is not far from the armpit. Furthermore, in this region the fibres of the muscle very distinctly arise from

Text-fig. 176.




Ventral musculature of *Hemisus guttatum*; the skin has been largely removed, but no muscles have been cut and reflected.

*f.* "Thymus gland." *m.* Submentalis muscle. *R.* Rectus abdominis muscle; the letter points to the first inscriptio tendinea. *p.abd.* Pectoralis abdominis *S.m.* & *S.m.'* Two portions of submaxillaris muscle.

the skin itself and entirely from the skin, not merely by a few fibres here and there as may be the case towards the middle line of the body.

The *pectoralis cutaneus* is completely absent. The septum which divides the thoracic from the ventral lymph-sac runs across the pectoralis sternalis at about its middle; but I observed no trace of the muscles in or about this septum which are so obvious in *Rana*. These muscles would appear to be not unfrequently unrepresented among the Batrachians. In the present species they can hardly be represented by the cutaneous fibres of the outer part of each pectoralis abdominis described above.

The *sterno-radialis*, as in *Rana*, arises from the omosternum, and its origin is limited to the omosternum. Instead of being overlapped by, it overlaps the anterior part of the pectoralis sternalis. It is a broadish strap-shaped muscle, but not relatively so large as in *Rana*.

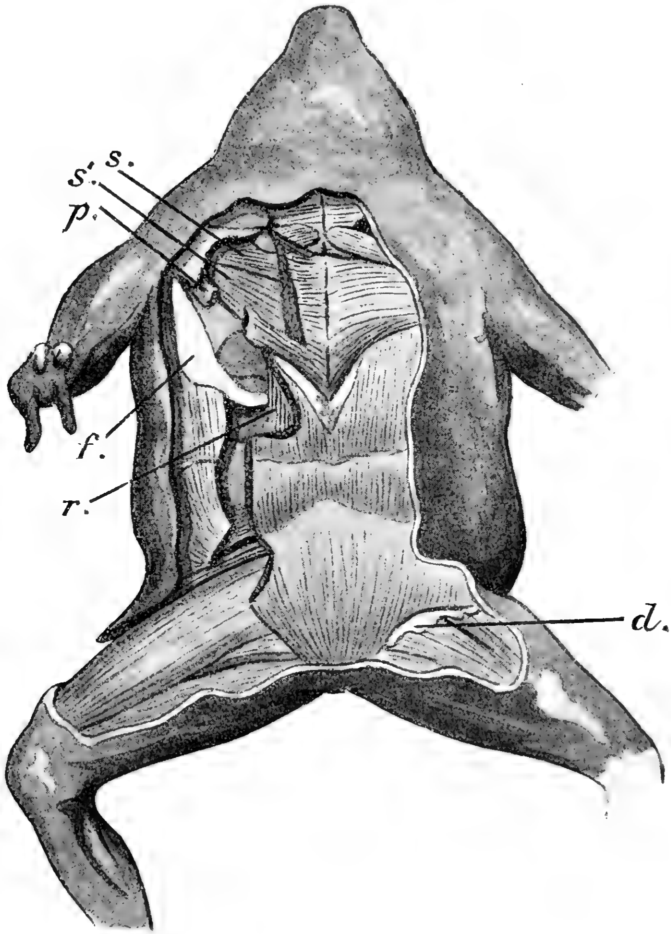
The *pectoralis sternalis* is divided, as in *Rana*, into a *portio anterior* and a *portio posterior*. The first of these two halves of the muscle is not visible superficially for the whole of its extent. Only a small part appears before any dissection is made, as may be seen in the text-figure accompanying this description (text-fig. 176, p. 899). The origin of most of it underlies the origin of the sterno-radialis, and some underlies the origin of the pectoralis posterior. The latter is a very large and deep fleshy muscle, much larger than the portio anterior. It is triangular in form and overlaps, as already stated, a part of the portio anterior. There is a tendinous seam running along it for about half of its course before reaching the humerus, on to which a part of the pectoralis abdominis is inserted. The muscles of the two sides of the body meet at a tendinous seam from which they chiefly arise, but they take origin also from the very obliquely set coracoids.

*Coraco-humeralis* and *pectoralis minor*.—There are in *Hemisus* three strong and fleshy muscles which correspond, as I presume, to the two muscles thus named in *Rana* (*R. guppyi* *) to their origin from the coracoid; they lie one behind the other. The most posterior of the series (text-fig. 177, *p.*) is quite visible superficially before any dissection of the ventral musculature is made. It is in contact with, but obviously separate from, the pectoralis sternalis posterior. In section the muscle is at first crescent-shaped, since it partly underlies, as well as being parallel to, the part of the pectoralis already referred to. Further on the muscle becomes flatter, and is inserted upon the humerus by a flat strap-shaped short tendon immediately ventral of the insertion of the pectoralis abdominis. It may be that this muscle is really referable to the pectoralis sternalis rather than to the coraco-humeralis; but in any case it is perfectly distinct from the pectoralis from origin to insertion.

* See Beddard, "Anatomy of *Pipa*," P. Z. S. 1895, p. 837.

Immediately underlying the last-described muscle (when the animal is viewed in the ordinary position of dissection) is a much broader muscle which I take to represent that muscle which I

Text-fig. 177.




Ventral musculature of *Hemisus guttatum*, with the skin removed and some of the superficial muscles cut and partly removed.

*f*. Fat-mass, lying within a lymph-sac covered by pectoralis abdominis and floored by a delicate layer of muscle (*r*) partly belonging to the rectus abdominis and partly to the obliquus internus. *d*. Fibrous wall of femoral lymph-sac cut irregularly near to its origin from the reflected border of the rectus abdominis. *p*. Muscle (cut across) which is perhaps part of the coraco-humeralis. *s*. Coraco-humeralis. *s'*. Pectoralis minor.

have just referred to in *Rana guppyi* and *Pipa** as the *pectoralis minor*. It arises (text-fig. 177, *s.'*, p. 901) from the more internal part of the coracoid not only below the pectoralis sternalis, but from the opposite (*i. e.* the dorsal) side of the coracoid bone. It arises by several partly separate strands, is fan-shaped, and rapidly narrows to a cylindrical muscle, which is inserted on to the opposite side of the humerus to the pectoralis, and is doubtless a muscle of antagonistic action.

In front of this lies the third muscle of the series which I am now considering (text-fig. 177, *s.*). It is a short rather broad muscle arising from the humeral half of the coracoid. It is attached to the humerus just below the insertion of the first-described of the three muscles belonging to the present series. I think that there can be little doubt that it really corresponds to the coraco-humeralis of *Rana*.

The *obliquus* is quite extensive on the dorsal surface of the body, the fibres having precisely the same direction as those of the obliquus externus in *Rana*, *i. e.* obliquely from before backwards and outwards. When the animal is pinned in a dissecting-dish with the ventral side downwards, the whole of the flanks are seen to be occupied by this muscle up to the large vacuity posteriorly occupied by the saccus iliacus. Dorsally the fibres originate laterally of the ilia and expanded sacral transverse processes from the tough aponeurosis which covers the dorsal musculature loosely, and is attached by a downward band to the ilia and sacral transverse processes before it becomes confluent with the obliquus externus. Posteriorly the muscle appears to end in a slightly thickened concave margin at the saccus iliacus. This ending, however, is only apparent; there is a folding over exactly such as will be described in the case of the rectus in the pubic and femoral region, but less in extent, and caused in exactly the same way, or, at any rate, correlated with an anatomical fact of the same nature. For in the muscle now being described there is a firm insertion along the bend of the muscle-layer of the dorsal wall of the iliac lymph-sac. The fold in this dorsal region of the obliquus is by no means so deep, however, as is that of the rectus abdominis ventrally. It is plain all the same from following them out that the fold in question is perfectly continuous from the ventral region to the dorsal, and it follows therefore that there is no strict demarcation between the rectus abdominis and the obliquus externus in this Frog. That is to say, there is no line of demarcation between the deeper flap of the rectus and the obliquus externus. The superficial flap of the rectus, as already said, ends upon the skin. The two parts of the muscle are thus nearly at right angles here, and the posterior sheet runs almost dorso-ventrally, forming the anterior boundary of the iliac lymph-sac and exposed by cutting open one of the septa

* A redissection of the muscles in question in *Rana guppyi* shows the presence of the "*pectoralis minor*" in that Frog, as I have asserted.

of the lymph-sac. When the dorsal part of the muscle now under description is cut through by an incision running parallel with the long axis of the body, it can be plainly seen to be a single though fairly thick layer of muscle. There is no layer underneath it. There is, in fact, in this region, that is along the entire back, but one obliquus muscle. There is, however, a strong fascia covering the muscle dorsally. This latter may really represent the obliquus externus as well as a portion of the rectus abdominis already described as being inserted upon the skin. For the muscle which I am now describing has, in spite of the direction of its fibres, more in common with an obliquus internus. When the fibres are traced ventralwards they are seen to end in a digitate fashion on the sides of the body in a delicate membrane. Anteriorly the muscle extends to within a very short distance of the scapula, but not in the least touching it. It is bounded, in fact, anteriorly by the origin of the depressor mandibulæ. It is interesting to notice how thoroughly this Frog *Hemisus* differs from its ally *Breviceps* in the oblique muscles. In the latter they are both well developed and fleshy throughout. In *Hemisus* the muscles are largely defective as muscular tissue; and on the ventral side there is only the delicate membranous continuation of the obliquus.

This sheet of the body-wall is partly muscular and partly forms a delicate membrane of connective tissue, in which no muscular but only wavy connective-tissue fibres can be detected by the microscope. As to the latter tract, I shall presently mention it in describing the rectus abdominis muscle. When the rectus is cut across, reflected in the middle region of the body, a delicate membrane comes into view which underlies the rectus and is the membranous part of the obliquus internus referred to. It is even suggestive of an omentum, such is its freedom from the rectus. It is not, however, attached to the viscera which it covers, save here and there by an emergent blood-vessel. It extends all over the body-cavity right back to the neighbourhood of the bladder—in fact, to the posterior boundary of the abdominal cavity. It is quite thin and transparent. It appears to me that this membrane must be referred to the obliquus internus, since it is absolutely continuous with a sheet of muscle laterally which can be nothing else than the obliquus internus, as well as the muscular sheet anteriorly which bounds the thoraco-abdominal cavity.

The *rectus abdominis* in this Frog is much more like that of *Breviceps* than of *Rhinoderma*. For it has only one inscriptio tendinea between its origin at the pubes and the inscriptio tendinea to which the pectoralis abdominalis is attached. The fibres too are arranged in a fan-shaped way like those of *Breviceps*, and do not run only in an anterior direction parallel with the long axis of the body as in *Rhinoderma* and many Frogs. In the middle line of the body the fibres run postero-anteriorly; laterally they are quite oblique in direction. Furthermore, it will be noticed from the drawings (text-figs. 176 & 177, pp. 899, 901) that, as in *Breviceps* *, the boundary-line between the thigh ventrally and the trunk ventrally is entirely occupied by these muscles, a separate obliquus externus not being visible on this view of the animal. Whereas in *Rana*, when the skin is reflected from the abdomen and thigh, the obliquus externus as well as the rectus are seen to form the boundary-line between limb and trunk. There is another important difference which this muscle shows and in which it resembles *Breviceps*. The rectus abdominis overlaps a considerable portion of the thigh, to the extent indeed of 6 mm. or so. Under the free edge of the muscle laterally a seeker can be pushed. There is, however, a plain distinction laterally between the rectus abdominis and the obliquus muscle (for the moment I leave it undecided whether it is to be regarded as externus or internus), which is not merely the lateral and dorsal extension of the rectus. It will be noticed that the one inscriptio tendinea (see text-fig. 177) which exists behind the origin of the pectoralis abdominis, and along the course therefore of the rectus abdominis, does not reach the edge of the muscle which overlaps the thigh musculature and towards which it tends. In this region then it is impossible to discriminate between rectus and obliquus, on the assumption, that is, that we have here reached the border-line of the two. I am disposed, however, to think that this lateral extension of the rectus is wholly rectus; for a careful dissection shows that it ends by being inserted upon the skin and its fibres are not continuous with those of what is obviously the obliquus muscle described above as originating from the dorsal aponeurosis.

When the pectoralis abdominis is cut through and reflected the anterior portion of the rectus abdominis is brought into view. This lies at a much lower plane than the posterior region of the muscle. For there is a deep cavity between it and the covering pectoralis abdominis. This cavity is not merely a lymph-space. It contains an elongated body which I describe later in connection with the thymus †. This cavity then is floored (examined in the ordinary position of these muscles when dissected from the ventral surface) by a delicate layer of muscles (text-fig. 177, *r.*) which is by far thinner than the rectus abdominis of which it is the forward continuation from the anterior inscriptio tendinea. The muscular fibres, however, do not extend over the whole of the cavity thus exposed. Towards the middle line the muscular fibres form an area which is not only thicker in its muscular tissue than more laterally, but definitely arises from the inscriptio tendinea. Laterally there is no such origin from the inscriptio tendinea where the rectus abdominis and the pectoralis abdominis meet, and this sheet has been described as a part of the obliquus internus.

The lateral portion of the *rectus abdominis*, under which, when it covers the thigh, a probe can be passed, as already mentioned, demands a more detailed consideration. It is to be noted, in the

* P. Z. S. 1908, p. 16, text-fig. 3. † See p. 915.

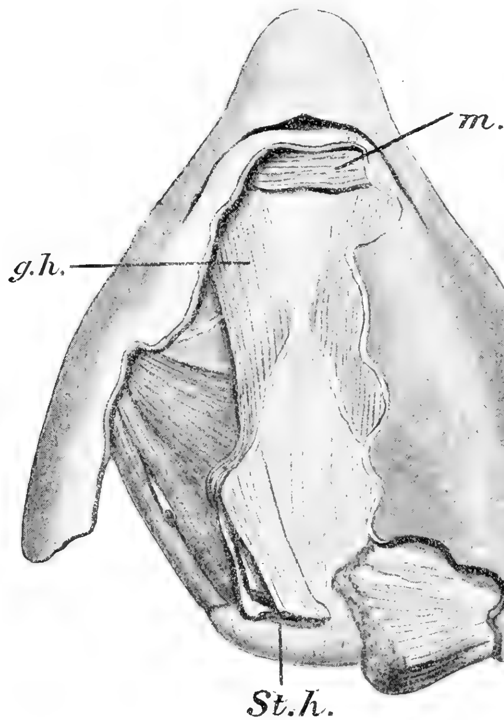
first place, that there is here not simply the matter of a muscle extending loosely over the proximal region of the thigh during its relaxed condition. The edge of the rectus which lies upon the thigh is bound down to the skin of the leg by a septum of connective tissue (text-fig. 177, *d.*) which forms the wall of a lymph-sac belonging to the system of femoral lymph-sacs. When this septum and the flap of muscle is cut through transversely by a pair of scissors, the section is seen to be V-shaped, the edge of the V being, of course, the line along which the wall of the lymph-space already referred to is inscribed. The ventralmost flap of the V is naturally the muscle exposed on a dissection from the ventral surface, and is what has been described as the rectus abdominis. The more dorsal flap is folded under this up to the very line (the mid-ventral line of the body) where the muscles of the two sides of the body meet, and is inserted on to the edge of the pubis. Although here the fibres of the superficial flap of muscle are accurately antero-posterior in direction, while those of the subjacent flap are exactly at right angles to them—running, that is to say, in a lateral direction—the directions of the fibres become coincident at the apex of the V which the two flaps of muscle form. It should now be mentioned that the deep-lying flap of muscle of which the fibres are consistently lateral in direction throughout is not a continuation of the obliquus internus. The membranous sheet which represents the latter muscle in this region of the body underlies and is free from the layers of muscle which have just been described. The lower flap of the muscle of one side of the body is quite distinct from that of the other, since they are divided by the line of the pubis from each edge of which they arise. The superficial flaps are, however, quite united in the middle line, and posteriorly, at any rate, no linea alba is to be seen.

The *submentalis* (text-figs. 176, 178, *m.*, pp. 899, 906) has a shape which is evidently influenced by the shape of the jaw and is also a considerably larger muscle than in *Rana*. The anterior extremity of the lower jaw, instead of forming a uniform curve as in *Rana*, has a perfectly straight or square region anteriorly, which is shown in the accompanying text-figure (text-fig. 178). The breadth of the jaw here is fully 5 mm., and the length of the submentalis is therefore only a little less and it has not in so marked a degree as in other Frogs a lenticular shape. It has the form of a cylinder tapering to both extremities. Its fibres can be seen to run straight across from one side of the jaw to the other in the middle region of the muscle. At both ends they curve upwards and are inserted into the angle of each mandibular ramus where the straight anterior portion of each, which is at right angles to the longitudinal axis of the body, passes into the side of each ramus. I have described in *Rhinoderma darwini** a pair of triangular muscles lying behind the submentalis which I compared to the *genioglossus*. It might perhaps—though at

* P. Z. S. 1908, p. 686, text-fig. 146 *a*.

present any suggestion as to the homology of the muscles lacks a firm base upon comparative anatomy—be more reasonable to regard the muscles in question as a part of the submentalis. In any case, I do not find the least trace of this muscle in *Hemisus*.

Text-fig. 178.




Ventral musculature of neck-region in *Hemisus guttatum*.

*m.* Submentalis muscle. *g.h.* Geniohyoid; the white lines dividing the two lateral parts of the muscles from the median practically unpaired portion represent the hypoglossal nerve. *St.h.* Sternohyoid muscles; the three separate muscles are shown. To the left of these are seen the petrohyoidei.

*Submaxillaris.*—Although *Hemisus* differs from *Rhinoderma* in the matter just referred to, the two agree in the specialization of the submaxillaris proper (not including the subhyoideus, which was formerly regarded as being a part of this muscle) into two regions. The conditions observable in *Hemisus* are shown in the figure referred to above (text-fig. 176, p. 899). The main mass of the muscle, which is all that exists in *Rana* and many other Batrachians, is indistinguishable posteriorly from the subhyoideus. Each muscle is divided from its fellow in the middle line of the throat by a considerable tendinous interval anteriorly. This non-muscular interval diminishes in breadth posteriorly until it practically disappears in the region of the subhyoideus. In addition to this the *submaxillaris* consists of an anterior layer of fibres on each side which are comparable to an almost similarly placed layer of fibres in *Rhinoderma.* A thin layer of fibres runs on each side from the fascia covering the submentalis to the ramus of the jaw in an oblique direction, and overlies almost at right angles the section of the submaxillaris which is contiguous. This is clearly shown in text-figure 176, *s.m.'*, and needs no more elaborate description.

The *subhyoideus* is of about the same proportions as in *Rana*, and passes behind the ramus of the lower jaw on its way to the cornua of the hyoid. That it is attached to the cornua of the hyoid and not to the wall of the skull is quite apparent. An examination of text-figure 176 would seem to show an additional muscle belonging to the series which form the floor of the mouth, and arising on either side from the anterior extremity of the sternum. I am unable, however, to give any further details about this muscle than are displayed in that figure. It may of course be merely an anterior slip of the pectoral series (including the sterno-radialis).

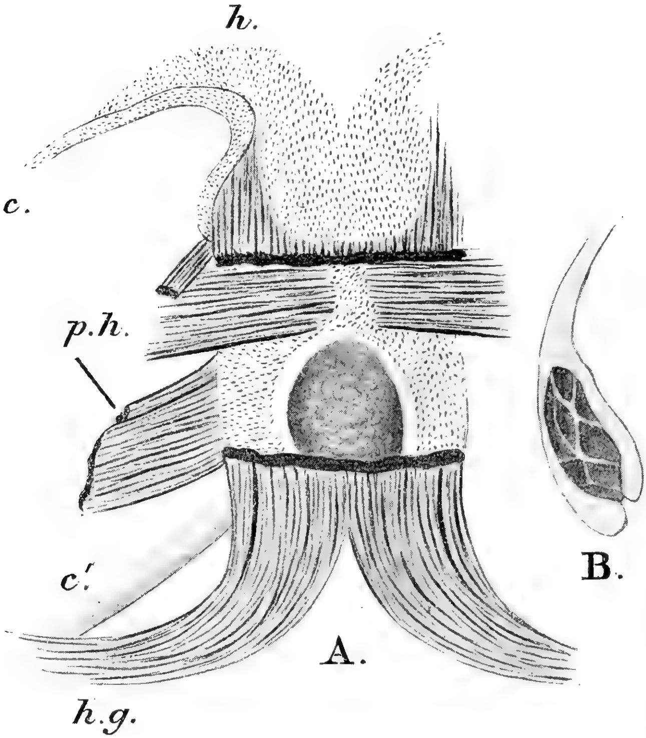
### § *Hyoid and its Musculature.*

The hyoid cartilages of *Hemisus* are peculiar in several respects. The main features of this part of the skeleton can be understood by a reference to the accompanying text-figures (text-figs. 179, 180, pp. 908, 909). The body of the hyoid is rather long and narrow. The anterior hyoid processes of the body of the hyoid join the anterior cornua much in the way that is to be seen in the hyoid of *Breviceps* *. Furthermore, the two anterior cornua or ceratohyals themselves join ventrally of the median body of the hyoid and project in the shape of a rather broad plate for some way backwards over the latter. The hyoglossus muscle therefore passes through an actual foramen in the hyoid, which it completely fills. It is evident, however, that this hyoglossal foramen is not absolutely homologous with that of *Xenopus* †, but is more comparable to the nearly complete foramen seen anteriorly in the hyoid of *Pelodytes* ‡. For the foramen in *Xenopus* is an actual perforation of the body of the hyoid, whereas in *Hemisus* the foramen is produced beyond the end of the body of the hyoid and by the approximation of the origins of the anterior cornua of the hyoid. Were there a complete foramen in the hyoid of *Pelodytes punctatus* it would be more comparable to that of *Hemisus* in that the anterior cornua enter into its formation. It would not, however, be strictly homologous; for in *Pelodytes* and *Pelobates* there are a pair of

* P. Z. S. 1908, p. 12, text-fig. 2.
† See Ridewood, Journ. Linn. Soc., Zool. vol. xxvi. pl. 8. fig. 1, *h*.
‡ Ridewood, P. Z. S. 1897, pl. xxxv. fig. 10.

lateral foramina as well as the median notch nearly converted into a foramen in these genera (and, it may be added, in *Megalophrys* *). I take it that in *Hemisus* the single median foramen embraces

Text-fig. 179.




A. Ventral surface of hyoid of *Hemisus guttatum* partly cleared of muscle (the geniohyoids are removed and the hyoglossus cut through twice and the middle part removed).

*c*. The anterior cornu of one side. *c'*. The posterior cornu in which the absence of dotting indicates bone. *h*. Thin portion of anterior cornua, which meet in the middle line to form a ventral and backwardly projecting sheet of cartilage, with a rounded posterior margin which partly covers the hyoglossus (divided just behind the edge of this cartilage). *h.g.* Posterior region of hyoglossus. *p.h.* Sternohyoideus posterior; the anterior petrohyoideus is seen anteriorly to be inserted on to the body of the hyoid, where it nearly meets its fellow in the middle line; above this is seen the insertion of the anterior of the sterno-hyoids.

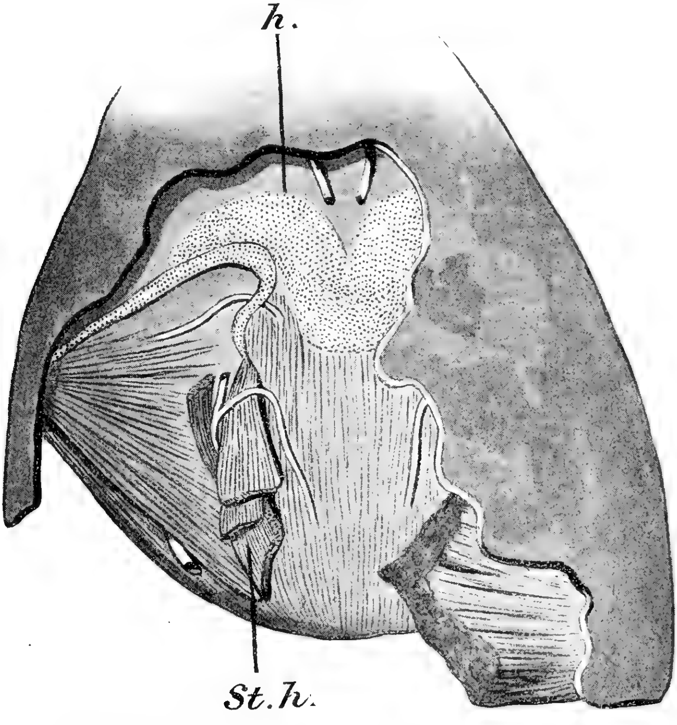
B. Section through body of hyoid in a longitudinal direction.

these lateral foramina as well as the median notch, since it is bounded laterally, not only by the roots of the anterior cornua,

* Beddard, "On Pelobatidæ," P. Z. S. 1907, p. 895, text-fig. 237.

but also by the anterior lateral processes of the body of the hyoid. It is perhaps possible to compare the lateral foramina in the hyoid of *Breviceps* with the lateral foramina of *Pelodytes* and *Pelobates*.

Text-fig. 180.




Hyoid of *Hemisus guttatum* and its musculature. Ventral aspect.

*h.* Anterior border of hyoid: the letter points to the plate formed by the union of the thinner portion of the anterior cornua which underlie the hyoglossus muscle, which muscle passes above them through the foramen thus formed. *St.h.* Sternohyoid muscles (3), over which the hypoglossal nerve is seen to pass and to supply, by one branch, the hyoglossus muscle. To the left of the figure are seen the petrohyoidei.

The anterior cornua near to the wall of the skull are bars of translucent cartilage of approximately equal diameter throughout. Towards its attachment to the body of the hyoid each bar gets much wider, as is shown in text-figure 179. The wider region of each cornu is due to the existence there of a semilunar tract of cartilage reinforcing the outer edge of the bar and becoming excessively thin along its anterior convex border. This cartilage is perfectly continuous with each cornu, but has the appearance of an extrinsic addition to it, because of its lack of translucency. This part of the hyoid cartilages is, in fact, whiter and more opaque than the bluish translucent cornu. This is not so evident where it is so very thin (*i. e.* at and near to its free edge) as it is where the two tracts of cartilage fuse to form the hood which has already been spoken of.

The body of the hyoid is, as already stated, long and rather narrow; it is also slightly oval in contour, is very thick, opaquely white coloured, and has a swollen appearance with a convex surface. It is obviously very thick without further proof by section with a scalpel (text-fig. 179, B., p. 908). It therefore contrasts greatly with this cartilage in, at any rate, many other Frogs, where it is thin and flat and even translucent. When the body of the hyoid of *Hemisus* is divided up by a longitudinal incision it is seen to present a rather complicated structure which accounts for its external appearance when uninjured. Anteriorly the cartilage is not particularly thick; it underlies and is closely adpressed to but is not continuous with a plate of bone which immediately underlies the wall of the pharynx. This is not, it will be observed, precisely the same thing as the ossifications which sometimes occur in the body of the hyoid among Batrachians *, nor obviously can it be compared to the splint of bone found underlying the body of the hyoid in *Pelodytes* and figured by Ridewood †. We have in *Hemisus* a plate of bone overlying the cartilaginous body of the hyoid, from which it is completely separate and non-adherent.

This plate of bone in its turn is closely connected with the ventral wall of the pharynx. The cartilaginous plate which underlies this bone when divided longitudinally presents a remarkable appearance, which is also shown in text-figure 179, B. Anteriorly the cartilaginous plate is relatively thin and flat. It is behind the insertion upon it of the petrohyoid that the cartilage has the convex outline and swollen appearance already commented upon. This turgid region is seen to be formed by a division into two plates of the cartilaginous hyoid which do not absolutely meet but come into the closest contact possible short of fusion posteriorly. Imbedded in the space between the two layers of the dichotomously divided sheet of cartilage is a lenticular mass of a softish consistency and a spongy appearance. I am unable to suggest what this is, unless it is developing bone. Though the above description is incomplete in this, it is obvious from the facts which I have been able to ascertain definitely that the hyoid complex in *Hemisus* is very remarkable.

There are other Frogs than the Engystomatid in which the hyoid apparatus is in certain respects like that of *Hemisus*. I have already directed attention to the likenesses shown in the hyoid of *Breviceps*. The thin layer of rather different-looking

* E. g., *Rappia* sp., *Cyclorhamphus marmoratus*, &c., Parker, Phil. Trans. 1881.
† *Loc. cit.* pl. xxxv. fig. 10.

cartilage fixed on to the ceratohyals and extending backwards in *Hemisus* to form a ventral hood over the hyoglossal muscle is represented in other Engystomatid Frogs though to a less degree; for I identify this cartilage with that termed "extra-hyal" by the late Prof. W. K. Parker*. This anatomist has figured a small piece of cartilage so named in *Engystoma carolinense* where it caps the forward convexity of the ceratohyal. The same structure is depicted in the same place exactly in *Tomopterna breviceps* (? = *Rana breviceps*). In another Frog, *Pyxicephalus rufescens* (= *Rana rufescens*), the extra-hyal cartilage is shown to be much larger, extending for a long way down the ceratohyal; but there is nothing like the hood of *Hemisus*. In *Callula*, however, nothing of the sort is figured. But the Engystomatid *Diplopelma ornatum* differs from its congener *D. berdmorei* and agrees with *Engystoma* in possessing this cartilaginous cap. *Phryniscus* also seems to want this structure.

The *hyoglossus* is a very thick muscle, as is usual; it forms a single muscle for the most part where it traverses the lower surface of the body of the hyoid. But a distinct slip on either side is quite distinguishable from the main body of the muscle, from the very origin of the muscle from the posterior cornua of the hyoid. The fibres of origin of the hyoglossus can be stripped away from the shaft of the posterior cornu, with which bone they have no relation except at the very tip, where they arise contiguous with the insertion of the petrohyoideus posterior (see text-fig. 178, p. 906). The hyoglossus, in fact, merely covers ventrally the shaft of the posterior cornu; it is not at all wrapped round it.

The *petrohyoideus* is shown in text-figs. 178, 179, & 180. The most remarkable feature about this series of hyoid muscles is the insertion of the anterior part of the muscle upon the ventral surface near the middle line of the basihyoid. This muscle divides, as will be seen, the insertion of the first from those of the second and third portions of the sternohyoid (see text-fig. 179). The last petrohyoid is attached to the tip of the thyrohyal and does not extend beyond it on to the larynx.

The origin of the *sternohyoideus* I am unable to describe fully. But the greater part at least seems to be derived from the under surface of the conjoined coracoids. Whether any of it is formed as a direct continuation of the rectus abdominis I do not know. In any case the muscle is divisible from at least very near to its origin into three distinct slips, which run forwards in close contact and as one muscle. Whether these three separate slips correspond or not to the three muscles in *Breviceps*, of which I have referred two to the sternohyoid and one to a derivative of the obliquus which I have termed in that Frog "hyoabdominal"†, I am uncertain; but their insertion one after the other in both Frogs is in favour of this comparison. Moreover, the origin of the hyoabdominal in *Breviceps*, a little way behind and to the outside

* Phil. Trans. 1881.

† P. Z. S. 1908, p. 12, text-fig. 2, *Hy.abd.*, and p. 23, text-fig. 5, *hy.abd.*

of the sternum, may be covered over in *Hemisus* by the greatly modified coracoids, and thus cut off from its relations with the obliquus. The insertions of the sternohyoid are shown in text-fig. 179, p. 908. They lie one behind the other to the outside of the hyoglossus. It is clear that in the disposition of this muscle *Hemisus* is nearer to *Breviceps* than to *Rana*.

The *geniohyoideus* (see text-fig. 178) has the two usual insertions posteriorly which exist in other Batrachia Salientia. They are divided from each other for a long way up the muscle (towards the mouth) by the main anteriorly running branch of the hypoglossal nerve. The lateral insertion on to the body of the hyoid of the geniohyoideus is preceded by a gathering together of the fibres of the muscle into a thick strap-shaped band which curves round the insertion of the sternohyoid (the most anteriorly inserted slip of that muscle) and is inserted below it—out of sight in the ordinary position of dissection from below. The inner portion of the muscle is a very delicate layer of fibres which with its fellow of the opposite side completely covers the hyoglossus and extends to the very end of the hyoid apparatus. In this the muscle resembles that of *Breviceps*, but, as pointed out in my description of the latter genus *, the peculiarity is not important. The *omohyoid* appears to be completely absent, as in *Breviceps*. I could discover no trace of that muscle in *Hemisus*.

## § *Musculature of the Thigh.*

When the skin is removed from the inside of the thigh the following muscles are brought into view, which are named in order from the anterior border of the thigh, viz., the vastus internus, adductor longus, sartorius, adductor magnus, rectus internus major, and rectus internus minor.

There is therefore nothing particularly striking so far about these muscles, which resemble those of *Breviceps* and even *Rana*. It is to be noted, however, that the *adductor longus* is hardly at all exposed and is almost completely covered by the *sartorius*. In this feature *Hemisus* differs from *Breviceps* † and is nearer to *Rhinoderma* ‡ and *Rana*.

In describing the anatomy of *Breviceps* § I have directed special attention to the partial origin of the *rectus internus minor* from the skin. The same characteristic feature occurring also in *Rhinoderma* is a bond of union between these two, in some other respects, not very closely allied genera. This peculiar attachment of the muscle in question to the inner surface of the skin of the leg is also noticeable in *Hemisus*, but not nearly to so marked an extent as in *Breviceps*. The insertion upon, or origin from, the skin of the thigh of a few fibres of the muscle was, however, plain enough.

The *semitendinosus* is formed by the union of two fleshy heads.

* P. Z. S. 1908, p. 14.
† P. Z. S. 1908, p. 25, text-fig. 6.
‡ P. Z. S. 1908, p. 691.
§ P. Z. S. 1908, p. 26.

When the thigh-muscles are viewed from the outside more muscles are visible without dissection than in the corresponding view of *Rana*. Several of these are shown in text-fig. 183, p. 919. The *rectus anticus femoris* is a thin and slender muscle as in *Rhinoderma* *, and broadening out it ends on the surface of the vastus internus, the head of origin of which is also visible on the present view. On the same side of the glutæus the *ilio-psoas* is also visible without any further dissection. The *vastus externus* is not at all of unusual size as it is in *Breviceps* †; and the *biceps*, which comes next, is perhaps rather large. The *pyriformis*, distinctly broad, is as usual inserted dipping down between this muscle and the last of those belonging to the dorsal series, which is, of course, the *semimembranosus*.

§ *Abdominal Viscera.*

The *liver* consists of three lobes and is rather different from that of *Breviceps*. In the first place, it does not in the very least conceal the heart. Secondly, it does not only possess three lobes as in *Rana*, but the right half of the liver is much smaller than the two lobes which together constitute the left half of the gland. These two lobes are not completely separated. The *gall-bladder* is large and spherical and almost hidden by the right lobe.

The gastro-hepatic ligament shows an interesting structural feature which may or may not be common to other Frogs. The ligament in question is, of course, part of the ventral mesentery of the alimentary canal. The ligament does not extend far forward along the stomach; it is limited to about the last one-third of an inch of the stomach before it bends abruptly to join the duodenum. In this course four gastrohepatic vessels, which later join to form two, and which are separated by a nearly if not quite anangious section of the membrane from that close to the duodenum which carries the main portal vein.

The *stomach* (text-fig. 181, *st.*, p. 914) when cut open is seen to be marked internally by thick rugæ, of which I counted eleven near to the end of that organ. It is noteworthy that in this region at any rate five or six of these rugæ are to some extent connected by transversely running folds, a coarse network being thus formed. The remaining plicæ of the internal surface of the stomach are completely detached folds without any connecting folds. These simple separate folds occupy the ventral surface of the organ; the others are dorsal, and the internal surface of the stomach is fairly evenly divided between them. As in *Rhinoderma*, the stomach does not end where it bends sharply to the right and narrows. It is thus V-shaped and its lining ends very abruptly where the duodenum begins.

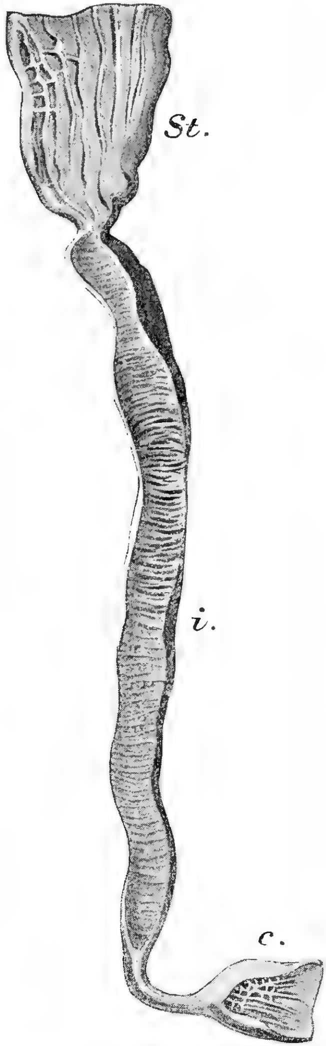
The *duodenum* (text-fig. 181, *i.*) is marked by very fine and transverse delicate folds or valvulæ conniventes. There is no

* P. Z. S. 1908, p. 691.

† P. Z. S. 1908, p. 26.

intermediate region between these and the strong longitudinal folds of the stomach. Moreover, the thickness of the walls of

Text-fig. 181.




Alimentary tract of *Hemisus guttatum* opened to show the varying characters of the lining membrane in different regions.

*c.* Colorectum. *i.* Small intestine. *St.* Stomach.

the stomach is at once diminished at the commencement of the duodenum. Thus the pyloric region almost projects in a valve-like fashion into the duodenum. The small intestine measures when stretched out 55 mm. Throughout its whole course the small intestine is occupied by rather closely set valvulæ conniventes, and nowhere can I detect any distinct reticulate arrangement of the folds such as I have figured in *Rhinoderma*. Here and there faint indications of such are present, but nothing that can be seriously compared to the reticulations found in *Rhinoderma* or at the commencement of the duodenum as figured in *Rana esculenta*. The *colorectum* (text-fig. 181, *c.*), into which the ileum opens, suddenly projecting indeed into its interior, is marked by longitudinally running folds. There is a remarkable resemblance to the stomach in that on one side of the gut the folds are simple, while on the other side there are transverse folds connecting them, and thus a network is formed.

The *kidneys* are of considerable length; the right kidney measures 19 mm., which may be compared with the total body-length of 60 mm.

The *oviducts* are thick and very much coiled. The straight piece which intervenes between the funnel and the coiled region is very short. The oviducal funnel lies behind the root of the lung. It is unusually long, and that of the right side at any rate measured 7 mm. It is an open groove and is attached all along to the cervical aponeurosis, the layer of the obliquus internus which closes the abdominal cavity anteriorly.

The *lungs* hang quite freely into the abdominal cavity; they are only attached to the liver quite at the root as in *Rana guppyi* *.

The *diaphragm* or *œsophageal muscle* is not an extensive muscle in *Hemisus*. In this it agrees with its allies. It appeared to me also that, as in *Breviceps* †, the muscle is entirely inserted upon the œsophagus.

§ *The Thymus Glands.*

In describing the anatomy of *Breviceps* I have pointed out the large size, compared to those of *Rana*, of the thymus glands. In the Batrachian with which I deal in the present communication, a pair of bodies which I take to be the thymus glands are much larger still, proportionately as well as actually. In *Rana esculenta* they are described and figured as being about 3 mm. in length. In the specimen of *Hemisus* upon the dissection of which the present paper is based, and which measured 60 mm. ($2\frac{1}{3}$ inches about), each thymus consisted of two discrete portions; the larger on each side was quite 7 mm. across at its greatest diameter. The position and size of the organs are shown in text-figure 176, *f.*, p. 899. They lie on each side behind the subhyoideus muscle and in front of the sterno-radialis and upon the deltoid, to which especially they are attached by flat bands of connective tissue. Each gland is flat and plate-shaped, of rounded contour; from the middle of the ventral surface a

* P. Z. S. 1907, p. 349, text-fig. 99, *m.*

† P. Z. S. 1903, p. 27.

process arises which runs forward as far as the angle of the lower jaw, which has almost the appearance of a duct, but which is, of course, no such thing. The glands are white and appear to be chiefly composed of fat.

In addition to these structures there is on each side of the body another "gland" of the same general appearance, but smaller, which I refer to the same category. These are flat circular bodies 2·5–3 mm. in diameter. These lie on either side well behind the head and just behind the scapula, covered over by the fascia which is continued into the depressor mandibulæ, and have a special relation to the thickened lateral edge of that muscle, as is described elsewhere *. Their position is considerably more posterior than the thymus glands of *Rana* and than the additional glands of *Hemisus* already described. It is well known † that among the Amphibia there are in the adult various remains of bodies derived from cells belonging to the branchial system of the tadpole, which have been termed "postbranchial bodies," "Epithelkörperchen," &c. I take it that in *Hemisus* these various structures which have just been described are also to be referred to the same category. They are, however, unquestionably much larger relatively as well as actually than in at least some other Amphibia Salientia.

### § *Posterior Lymph-Hearts and Associated Sacs.*

The enormous size, actual as well as relative, of the posterior lymph-hearts of *Breviceps* ‡ is at present an unique fact in the anatomy of the Batrachia Salientia. On grounds of affinity the existence of equally or nearly as large posterior lymph-hearts might have been expected in *Rhinoderma darwini*; but a careful search convinced me that *Rhinoderma* § was unlike *Breviceps* in this important and remarkable peculiarity. In *Hemisus*, however, I find an equivalent of this structure, which is very different in its character, though retaining certain features which lead to the inference that we have in this genus a modified and degenerate homologue of the enormous posterior lymph-heart of *Breviceps verrucosus*.

As is the case with *Breviceps*, though not to so great an extent as in that Frog, the thigh of *Hemisus* is fairly enclosed within the contour of the body. The body does not, however, extend beyond the tip of the coccyx as it does in *Breviceps*.

There is thus in *Hemisus*, as in *Breviceps*, a space left dorsally on each side of the posterior region of the vertebral column, behind the oblique muscles, which is floored by the muscles of the proximal region of the thigh. This space is cut off from the lymph-spaces covering the rest of the thigh by a transverse and

* *Cf.* p. 894.

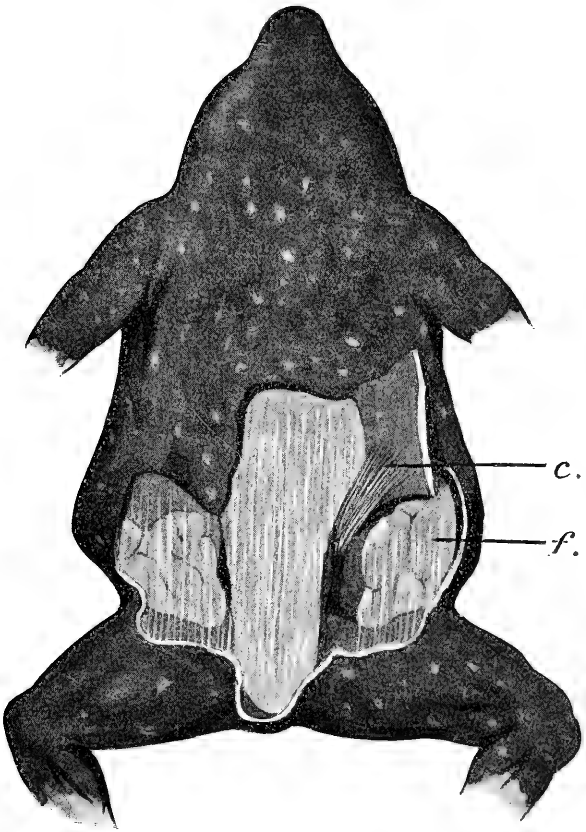
† Maurer, "Schildrüse, Thymus und Kiemenreste der Amphibien," Morph. Jahrb. xiii. 1888, p. 298.

‡ Beddard, "Anatomy of *Breviceps*," P. Z. S. 1908, p. 33.

§ *Id.*, "On *Rhinoderma*," P. Z. S. *t. c.* p. 678.

oblique septum starting in the neighbourhood of the coccyx. The length of this space is some 11 mm., the total length of the body being, from snout to tip of coccyx, 58 mm. It is therefore proportionately smaller than the corresponding space in *Breviceps*, which contains the lymph-heart; the greater size in *Breviceps* is, however, effected by the extension of the body behind the tip of

Text-fig. 182.




Dorsal view of *Hemisus guttatum*, with the skin of the back partly removed.

*f.* Fat-body lying in saccus iliacus and covered by a membranous wall.
*c.* Cutaneous muscle.

the coccyx. This cavity is exposed by the removal of the skin, which is particularly thick and glandular on the dorsal surface of the body generally in this Frog. To the wall of the greater part of the cavity the skin is not adherent and can be, therefore, removed without tearing the structures which it covers. When this has been done (see text-fig. 182, *f.*, p. 917), a transparent and toughish membrane is revealed, which completely covers the cavity and is continuous with the septum bounding it on the side of the leg, to which reference has been already made. Anteriorly and laterally, however, the membrane described is adherent to the skin. Below this membrane, and of course perfectly visible through it, is a large fat-body quite similar in appearance to the structure which I have termed the thymus gland and to the abdominal fat-bodies at the anterior end of the gonads. These fat-bodies are lobulated and extend some little way down the side of the body in the direction of the abdomen. The transverse diameter is thus the greatest and they measure in this direction about 15 mm. In the opposite direction the diameter is 8 mm., showing that these bodies nearly fully occupy the suprafemoral cavity, which is now under discussion. These fat-masses are also of considerable thickness, and lobulated upon the lower surface as well as the upper. They are by no means to be confused with the mass of apparently coagulated lymph which I have described in a corresponding position in *Breviceps verrucosus*. The general aspect of this region of the body will be understood after a reference to text-figure 182.

So far there is nothing exactly corresponding to the lymph-hearts of *Breviceps*. There is merely a correspondence in the existence of a space lying above the thigh and to the side of the coccygeal region of the vertebral column in the two Frogs. There is, moreover, the important difference that in *Hemisus* this space is largely occupied by the bulky fat-body already described. Anteriorly to the fat-body on each side, as is shown in the accompanying drawing (text-fig. 182, *c.*), a broad strap-shaped muscle is to be seen; this is not to be confused with the obliquus externus which lies in front of it, and, indeed, until a dissection is made, almost, if not quite, in contact with it. Whether this muscle is morphologically a portion of the obliquus which has become detached from the rest of that muscle and diverted to a separate function is another matter; it is not in any case in anatomical continuity with it. This muscle arises from the ileum below, passing upwards to the dorsal surface of the body and at the same time outwards. Its oblique course ends chiefly upon the skin, but also upon the membrane, uniting the fat-body to the skin in this region.

When the membrane covering the fat-body, and connecting it with the mass of bone and muscle constituting the caudal and pelvic regions of the body, is cut and the fat-body pushed aside towards the side of the body (away from the middle line) it is seen (text-fig. 183) to fill but loosely the space in which it lies and from which it is, indeed, partly cut off by membranes which cover it below. This membrane is largely fenestrated, so that the space which contains the fat-body is not shut off completely from the space lying below it. It is also attached by flat strands of membrane to another membrane lying beneath and rather in front of the fat-body and partly covered over by the strap-shaped cutaneous muscle already in part described.

Text-fig. 183.

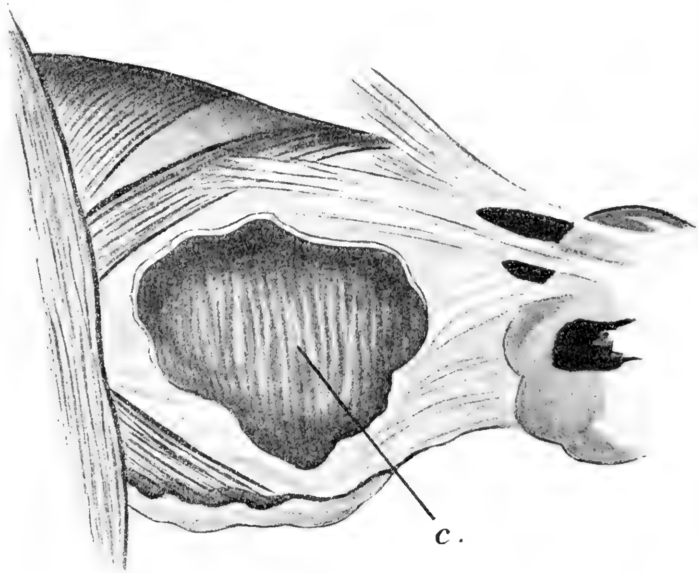

Saccus iliacus of *Hemisus guttatum*.

The fat-body (*f*) has been pushed over to the left; strands of connective tissue uniting it with the walls of the sac are shown.

*s.* Anterior septum of lymph-sac.

This membrane bounds the cavity below, and when it is cut through (as is shown in text-fig. 184, *c*, p. 920) the obliquus muscle is exposed; but as the membrane is quite free of the muscle it would seem to be really the dorsal wall of a subsidiary sac lying on the obliquus. It seems to me to be clear that this large sac, almost filled up by the fat-body already described, and in which also lies—as will be described presently—the lymph-heart, corresponds to the saccus iliacus of the Frog, *Rana esculenta*. Furthermore, the muscular slip which I have referred to as traversing the sac in *Hemisus* near to its anterior wall appears to me to be probably the musculus cutaneus iliacus of *Rana*. This sac and the muscle is figured in the edition of Ecker's 'Frog' which has been translated by Dr. Haslam*. There is a fuller account of the lymph-sacs of the Common Frog in the more recent edition of Gaupp. I figure here (text-fig. 185) for purposes of comparison with *Hemisus* the saccus iliacus in the large female of *Rana guppyi.* It is a much more elongated sac in proportion to its breadth than is the case with that of *R. esculenta,* as displayed in the figure cited from Dr. Haslam. Its walls also are

Text-fig. 184.




Saccus iliacus of *Hemisus guttatum.*

The fat-body is pushed to the right; the strands of connective tissue connecting it with the walls of the sac are shown.

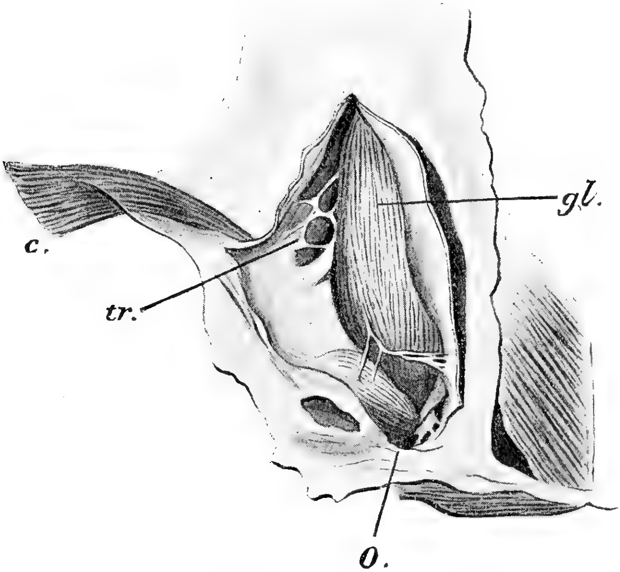
*c.* Obliquus muscle revealed by cutting open the floor of the sac.

attached by branched threads of stout connective tissue, which present the exact appearance, as will be seen in the figure, of the chordæ tendineæ of the valves of the mammalian heart. There are two of these branched stays between the dorsal and ventral walls of the sac. Gaupp mentions these structures as occurring in the lymph-sacs of *Rana,* but does not particularize their existence in the saccus iliacus. They are not represented in the figure, to which I have referred, of the sac in *Rana esculenta.* This sac communicates by a wide orifice

* Fig. 173, p. 259.

with the abdominal cavity at a point corresponding to that of the ostium in *Rana esculenta*, and also at its posterior extremity where it dips underneath the sac lodging the posterior lymph-heart. A seeker pushed through each ostium eventually appears at the same place in the abdominal cavity. In Haslam's edition of Ecker's 'Frog' it is mentioned that the hinder portion of the posterior lymph-heart lies in the saccus iliacus; but in Gaupp's edition it is stated that the lymph-heart lies in a special sac of its own.

Text-fig. 185.




Saccus iliacus of *Rana guppyi* opened.

*c.* Cutaneous muscle. *gl.* Glutæus. *O.* Ostium, leading into abdominal cavity. *tr.* Trabeculæ connecting walls of the lymph-sac.

The latter statement is clearly correct for *Rana guppyi*, where the lymph-heart lies just in front of the pyriformis muscle in a special sac, which is at least not in open communication with the saccus iliacus, and which indeed overlies it. There is thus an obvious difference between *Hemisus* and *Rana* in that the posterior lymph-heart of the latter lies in a special sac of its own, whereas that of *Hemisus* is contained in the saccus iliacus, as is plainly shown in text-fig. 186 (p. 923), where the posterior boundary of that sac touches the posterior wall of the heart. There is a further difference in that the interior of this lymph-sac is largely divided by trabeculæ, in the interstices of which is lodged the large lobate fat-body already described and figured (text-figs. 182, 183, pp. 917, 919). At the same time it will be noted that the "chordæ tendineæ" of the lymph-sac of *Rana* would seem to foreshadow (or to be the remains of) this trabecular system. The mass of trabeculæ and contained fat-mass is carried to an extreme in the opposite direction in the case of *Xenopus*, where (see p. 924) a tough mass of connective-tissue fibres and interspersed fat surrounds the lymph-hearts.

It is said, and in a sense correctly, that there are no lymphatic glands in the Frog. The absolute truth of this generalization (which of course applies to other lower Vertebrates as well as the Frog) depends upon what is meant by the term "lymphatic gland." For if we regard a lymphatic gland as an enlargement on the course of a lymphatic vessel the lumen of which is subdivided by trabeculæ, then the structures described here in *Hemisus* are at least not very unlike lymph-glands. One cannot but think, in view of the masses of fatty tissue with which they are partly plugged, that they must play some important part in the function of the lymphatic system; and the existence of fatty masses in *Xenopus*, described below *, strengthens this supposition in that it shows that the structure is not unique.

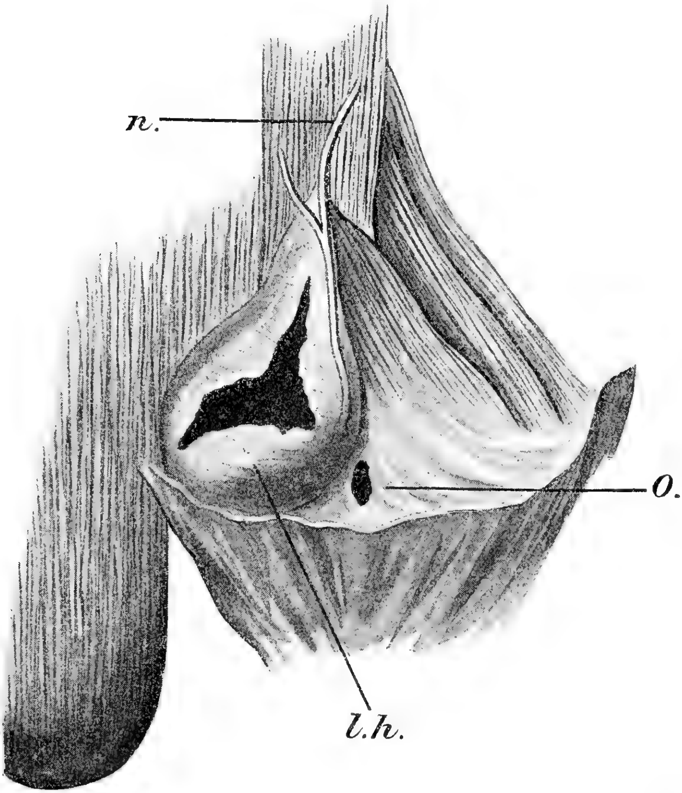
The lymph-heart itself is of considerable size, though not so colossal as in *Breviceps*. It measures fully 4 mm. in length and is rather elongate in form. It is displayed in text-fig. 186, *l.h.*, from which it will be seen that the heart occupies quite a normal position. It lies, however, quite definitely within the large saccus iliacus which has just been described. In *Rana esculenta* the lymph-heart of the same pair is said by Gaupp † to lie in a special sac of its own. This is certainly not the case with *Hemisus*. The posterior lymph-heart lies at the inner angle of the saccus iliacus. The heart is in contact with the vastus externus, upon which it lies ventrally; with the ilio-coccygeal muscle to the inside. On the opposite side its wall lies freely within the lymph-sac already mentioned and described at length. It is in front of the pyriformis muscle. It is not very closely related to the glutæus muscle. The septum bounding the saccus iliacus posteriorly is attached along the vastus externus and ends on the wall of the heart, or at least is firmly attached to the posterior wall of the heart at this point. Just in the angle where the septum in question and the heart meet is a smallish circular ostium (text-fig. 186, *O.*), which I take to be a communication between the saccus iliacus and the heart. A small blood-vessel, as is shown in the figure (*n*), runs along the outer side of the heart forwards, dipping down to the glutæal muscle; it is possible that this is the vein into which the heart opens. The heart is rather pear-shaped and lies with its long axis parallel to the long axis of the body. The narrow end is anterior. The heart is easily to be distinguished from the posterior septum of the saccus iliacus

* See p. 924.

† See his edition of Ecker's 'Frog.'

which is attached to it, and from such septa generally, by its yellowish colour, due of course to the fact that its walls are muscular and not formed of connective tissue. The outer wall of the heart is quite smooth and has a bronzy appearance, due to its muscular walls; the internal surface is sculptured into raised

Text-fig. 186.




Lymph-heart (posterior) of *Hemisus guttatum* and associated structures.

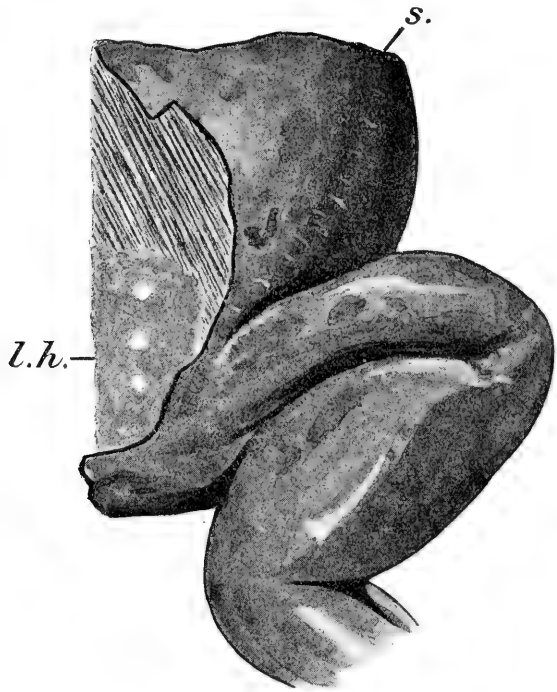
*l.h.* Lymph-heart cut open to show its interior. *n.* Vein referred to in the text. *O.* Ostium referred to in the text.

muscle-masses here and there with, of course, depressions between. The fibres in the outer wall of the heart run largely, as I have convinced myself by a microscopic examination, across its long diameter.

### § *The Posterior Lymph-Hearts of* Xenopus.

The posterior lymph-hearts of this genus are not, so far as I am aware, known. As I have dissected them in two individuals of this African Frog, and as they present certain remarkable differences from those of other Frogs, I think it worth while to append to my account of these structures in *Hemisus* some notes upon the lymph-hearts of *Xenopus*. When the animal is dissected, a mass of yellow fat is seen to lie upon the thighs and to spread

Text-fig. 187.



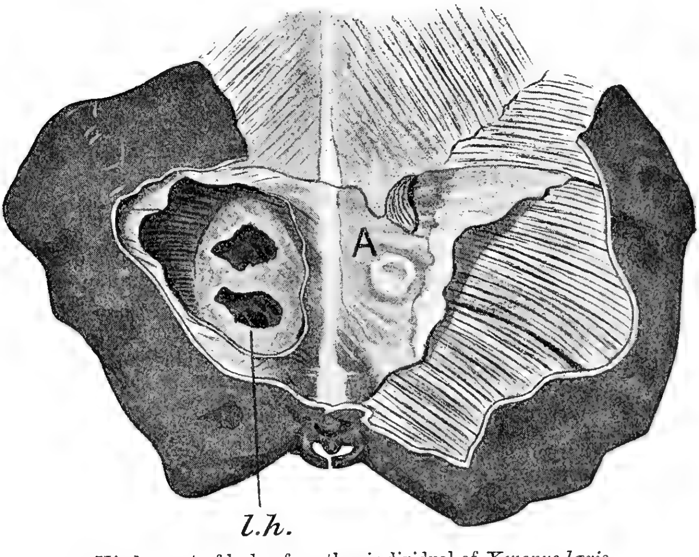

Hinder part of body of one side of *Xenopus lævis*.

*l.h.* Mass of fat in which lie lymph-hearts—distinguished as light circles. *s.* Sense-organs of lateral line.

upwards for some way on to the back. The mass of fat upon the proximal region of each thigh is, as is to be seen in the annexed figures (text-figs. 187, *l.h.*, & 188, *l.h.*), of roughly circular outline. It is seen on excavation by the scalpel to be of some depth, and I regard the space in which it lies as representing the saccus iliacus of the lymph-system of *Hemisus* and other Frogs. There is, however, no empty sac here. The fat entirely fills the cavity. The actual fat itself is contained in a very close meshwork of fibres of connective tissue. When this is cut into and pressed the actual fat readily escapes and floats up to the surface of the water in the dissecting-dish.

The figure to which reference has been made (text-fig. 188) shows the saccus iliacus and adjacent structures intact on the right side save for the removal of the skin. The thin membrane covering the saccus iliacus is left intact. The cut edge of the membrane lying further to the right and continuous with this is the inner lateral wall of the femoral lymph-sac. On the left side the wall of the saccus iliacus is not shown, having been removed by tearing it away, and thus exposing the spongy fat-laden interior

Text-fig. 188.




Hinder part of body of another individual of *Xenopus lævis*.

A. Single lymph-heart seen through delicate membrane which covers iliac fat-body

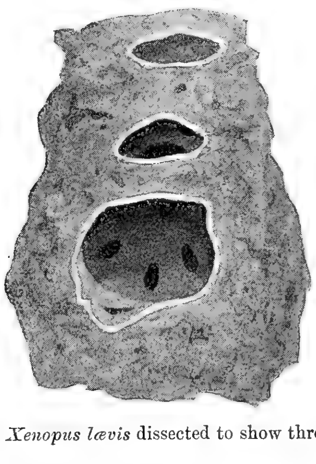
*l.h.* Two lymph-hearts lying in fat-body and cut open.

of the lymph-sac in question. This wall does not fit loosely, but is intimately connected with the fat-holding reticulum below, so that it has to be removed in fragments. The border-line between the two sacs is shown by a depression running along the membrane; it is along this line that the boundary between the sacci iliacus and femoralis is fixed. At the inner upper corner of the saccus iliacus, where it abuts upon the middle line of the body, a triangular flap of the covering of the saccus iliacus is cut and reflected. This shows a portion of a muscle which is presumably to be regarded as the cutaneus iliacus, and which has already been described in *Hemisus* and *Rana guppyi*.

It will be noted that, as in *Hemisus*, this muscle lies within the saccus iliacus, and that it is entirely attached to the wall of that sac at its insertion, and does not reach the skin at all. In *Hemisus* some of the fibres of the corresponding muscle are thus intercepted, but the rest reach the skin. In *Rana* all of the fibres of the muscle reach the skin. It is noteworthy that the wall of the saccus iliacus, as is clearly shown in the figure, is distinct from the overlying skin and not fused with it as are the dorsal walls of other lymph-spaces such as the adjoining femoral to the lateral septa, to which reference has already been made. On the left side the attachments of the septa bounding the femoral lymph-sac are shown in their attachments to the skin. On the right side a circular elevation is visible (text-fig. 188, A, p. 925), lying pretty well in the centre of the area occupied by what I here compare to the saccus iliacus. This, when cut open, proved to be the single lymph-heart of that side of the body; it contained a large orange-coloured clot (presumably of lymph), the darker colour of which, as compared with the surrounding tissues, was obvious before cutting into the lymph-heart. The clot was roughly spherical in outline, slightly flattened from above downwards. Its greatest diameter was 4 mm. Thus the heart itself may be considered to be a little larger. On the opposite side of the body there was no single lymph-heart corresponding to that of the right side. There were most distinctly visible, when the surrounding spongy tissue was carefully cut away, *two perfectly detached and separate posterior lymph-hearts*. Between them was some of the spongy tissue which fills up the lymph-sac, and there was no open communication between the two hearts, whatever may be the facts with regard to a communication by means of finer tubes. These two lymph-hearts lay one behind the other in a perfectly straight line, parallel with the longitudinal axis of the body. A careful comparison of the relative positions of the two lymph-hearts of the left side of the body with the single lymph-heart of the right side of the body, showed very clearly that the latter occupied a place midway between the anterior wall of the anterior and the posterior wall of the posterior left lymph-hearts. It would thus appear to correspond to the two of them—that is, the single right lymph-heart has been produced from a concrescence of two originally separate lymph-hearts, or it has given rise by division to two lymph-hearts on the left side. Of these two lymph-hearts of the left side the anterior was distinctly the larger, which is not very well shown in the figure referred to (text-fig. 188). This larger left lymph-heart, moreover, contained a blood-clot which was not to be seen in the interior of the hinder and smaller lymph-heart of the left side. This suggests, of course, that the systole and diastole of the two consecutive hearts are not synchronous, but that one is in systole, while the other is in diastole. The remains of the lateral line which are so prominent in *Xenopus* as stitch-like along the sides of the body did not appear to me to have any exact relation to the series of lymph-hearts of the left side, that is, they did not accurately overlie them. The hearts lay to the inside of the lateral line, as is also shown in the figure.

The soft and yet toughish and even sticky tissues which form the fat-holding plug which nearly, or quite, fills the saccus iliacus, and in which the hearts are imbedded, are not altogether easy of dissection, and the exposure of the lymph-hearts with much neatness is very difficult. It is possible that in the specimen which has just been described I have overlooked a lymph-heart; for in two others which I have dissected *there were undoubtedly three pairs of posterior lymph-hearts.* In one of these, which happened to be rather a small individual, the hearts, at any rate of one side of the body, were distinctly visible directly the skin was removed and the fatty mass exposed (see text-fig. 187, p. 924). This latter was, as usual, very yellow. Conspicuous—this time by their paler and browner colour—were the three lymph-hearts, of which the most anterior was not only the most conspicuous but the largest. The other two lying in a row behind it were, however, quite evident, though probably they would escape the attention of anyone not aware of their existence.

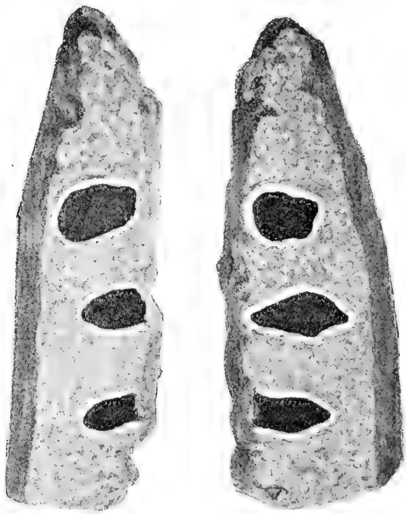
Text-fig. 189.



Iliac fat-body of *Xenopus lævis* dissected to show three lymph-hearts.

Indeed, it was after the discovery by dissection of three lymph-hearts on each side of the body of a third specimen, that I noted the external appearance of these lymph-hearts in the small specimen to which reference has just been made. In this latter specimen the three lymph-hearts of the right side are represented, as seen by dissection, in text-figure 189, the upper wall of each heart having been removed in order to display the interior. It happened that this particular specimen was especially favourable for displaying the structures in question. The preservative alcohol had hardened the hearts and the surrounding tissue in such a way as to render them very tough and had decolorized the hearts, while rather deepening the yellow of the fat-mass. It was thus found convenient to cut through with a pair of scissors the fat-mass of the left side of the body along a line presumed to pass through the hearts. Text-figure 190 shows that this was successfully accomplished, and represents the two sides of the cut whereby the mass of fat and the contained lymph-hearts were divided longitudinally.

Text-fig. 190.



Iliac fat-body of *Xenopus lævis* cut longitudinally into two halves to show cavities of lymph-hearts.

This longitudinal section passed, I believe, very nearly through the middle of each lymph-heart. It will be seen that they are not all of them of exactly the same size, though the differences between them are not very great. In the dissection (text-fig. 189, p. 927) of the hearts on the right side of the same Frog it will be noted that the last of the three hearts is considerably the largest of the three, perhaps twice as large as either of the others. This did not appear to be the case on the left side of the body. What is particularly striking about these hearts when seen evenly divided, and in section, is the great thickness of their walls. This is not exaggerated in the drawing to which reference has been made. The dissection of the corresponding hearts on the opposite side of the body (text-fig. 189) of this specimen shows the apertures in the walls of the hearts which presumably admit lymph into their interior. The thickness of the walls is also shown in this drawing. It is doubtless partly owing to the strong contraction of the hearts at the moment of death.

I am not aware that the posterior hearts of *Xenopus* have been described. The pectoral lymph-hearts, however, of this Frog are described and figured by Dr. Bles in his beautiful memoir * upon the larval development of *Xenopus*. There is but a single pair, and each is enveloped in a lymph-sac of its own. Dr. Bles remarks that the early development of these structures in *Xenopus* is remarkable, since in *Rana temporaria* and *Bufo calamita* the author found that the pelvic lymph-hearts do not appear until after the metamorphosis. This, however, does not argue that these structures are new formations and not comparable with the lymph-hearts in Urodeles. It is hardly likely that the anterior and posterior lymph-hearts are not parts of the same series, and therefore the early development of the pectoral hearts in *Xenopus* is to be set off against the late appearance of the pelvic hearts in certain Frogs, including, as it is to be supposed, *Xenopus* itself.

Inasmuch as the lymph-hearts of *Rana* are connected with veins supplying the fore and hind limbs respectively, a suggestion may be made as to the retention (or, if my opinion be not accepted, the multiplication of these hearts) of three pairs of posterior lymph-hearts in *Xenopus*. While in most Frogs, indeed in all, the hind limbs are the powerful swimming-organs of the animal, and exceed in size the relatively feeble fore limbs, the disproportion reaches its maximum in *Xenopus*. Of this Frog Dr. Bles justly writes:—"The size of the arm is altogether out of proportion to the size of the leg, which is an extremely powerful swimming-organ. The limbs of *Xenopus* as a Frog are paralleled by the limbs of *Macropus* as a Marsupial" †. The excessive size of the hind limbs in *Xenopus* bears some relation to the triple lymph-hearts. It is true that I have not succeeded in finding the veins into which the hearts open. But it can hardly be doubted, from the position which they occupy, that their orifices are into veins connected with the legs.

Attention may be drawn to the variability of these posterior lymph-hearts in *Xenopus*. This fact, as it appears to me, is of itself evidence, though naturally not of a positive character, that the structures in question are not a new formation, but are derivatives of the chain of lymph-hearts in certain Urodeles. The variability affects, as I think, the number of the hearts, which does not only differ in individuals, but from side to side of the same individual. But even if I am mistaken in this and have simply failed to find the supposed missing hearts in those specimens where only one or two appear to exist, there still remains the variability in point of size. There is, I hope, no

* "The Life-history of *Xenopus lævis* Daud.," Trans. Roy. Soc. Edinb. vol. xli. pt. iii. 1905, p. 789.

† Trans. Roy. Soc. Edinb. *tom. cit.* p. 819.

doubt whatever about this. An inspection of my figures, which were drawn quite independently of any directions from myself, will settle this matter. It is well known that variation is apt to affect organs or series of organs undergoing reduction. And, therefore, I dwell upon this fact as bearing upon the view upheld here, that in this Frog we have a persistent multiplicity of lymph-hearts, such as that which characterizes certain Urodeles, but which is considerably reduced.

The interest attaching to these facts concerning the posterior lymph-hearts of *Xenopus* is not only that they are—so far as I am aware—a contribution to the anatomy of that Frog. Their chief interest centres in the possibility of comparing them with the multiple lymph-hearts of certain Urodeles. With regard to this matter Dr. Wiedersheim sums up as follows in his 'Vergleichende Anatomie der Wirbelthiere'*:—"Bei *Salamandra maculosa* und *Siredon pisciformis* sitzen zahlreiche Lympherzen längs des *Sulcus lateralis* unter der Haut und zwar entfallen bei dem erstgenannten Thier auf dem Schwanz (beide Seiten zusammengerechnet) 10–12, auf den Rumpf mindestens ebensoviel. Bei *Siredon pisciformis* finden sich jederseits 8 rhythmisch pulsirende Lympherzen die wie bei *Salamandra maculosa* aus ovalen, von quergestreifter Muskulatur umwickelten Bläschen bestehen." These facts were first discovered by Weliky †.

## § *The Lymph-Hearts of* Rana guppyi.

Although it is usually stated in books and memoirs dealing with the anatomy of *Rana* that the posterior lymph-heart is a single structure on each side, this is not the universal view. Hoyer ‡ has given an account, with figures in the text, of the lymph-heart of *Rana esculenta*. A longitudinal section of one of the hearts given by him shows three distinct cavities, of which the hindermost is the larger. It is to be noted, however, that this figure is hardly convincing of itself as to the existence of three separate hearts, such as we have seen exist in *Xenopus*. For the muscular wall shown in Hoyer's figure extends without a break over the three cavities; there is no such complete separation as is indicated in text-figure 189 (p. 927) of the present communication. And so far, therefore, Dr. Hoyer's figure bears out the statement of Oehl (which is quoted by him), viz. "Das Herz gelappt ist," and that of Ranvier (also quoted by him), who observed that each apparently single posterior lymph-heart was divided by partitions into several divisions. Weliky, however, according to Hoyer, found that each heart "aus 3 gesonderten Abtheilungen besteht: dass also 3 hintere Lympherzen jederseits vorhanden sind." This, of course, agrees precisely with the facts which I have detailed in the present paper with regard to *Xenopus*. At the same time it cannot be disputed that the conditions obtaining

* Zweite Auflage, Jena, 1886. † Zool. Anz. 1884.
‡ Bull. Acad. Cracovie, 1904, p. 228.

in *Xenopus* are more primitive than those found by the above writers to occur in *Rana*. The hearts are larger and, extending as they do over a larger area of the body, are more widely separated, and thus more completely distinct than can be the case with *Rana*, when so small a cleft contains the three hearts—or the trifid heart,—which are not indeed difficult to overlook altogether. Whatever may be the case with *Rana esculenta*, I found in a specimen of *Rana guppyi* a single lymph-heart on each side posteriorly, and measuring about 6 mm. in length; it lay in quite the usual position in front of the pyriformis muscle, but well behind the glutæus, separated from it, in fact, by the posterior end of the ilium.

The direction of the heart is rather obliquely outwards, very nearly parallel to the pyriformis muscle. Although each heart may be accurately described as a single heart, the cavity is completely divided across its major length (*i. e.* transversely to the long axis of the pyriformis muscle) by a septum of the same appearance and texture as the general parietes of this lymph-heart into two quite separate chambers. This division, however, is merely a septum; there is no question of any separation of the obviously single heart into two hearts. Nor is there any external constriction of a marked character which could fairly justify a statement that there were two consecutive lymph-hearts present on each side. I may say that the lymph-hearts on both sides of the body of this Frog were identical. This, it may be observed, is a very different condition of the posterior lymph-heart to that which has just been described in *Xenopus*. In the latter genus, I repeat, there are three distinct lymph-hearts on each side, in *Rana guppyi* only a single heart the cavity of which is divided *.

I may take this opportunity of calling attention to the anterior lymph-heart in *Rana guppyi*, where it is very conspicuous on account of its large size. It is quite 9 mm. long (when slightly stretched perhaps) and lies in a lymph-sac completely covered by the suprascapula, which has to be lifted up in order to display it. The sac and the contained heart are bounded by the longissimus dorsi and the retrahens scapulæ on the inside, and by the transverso-scapularis tertius on the outside †. The greater part of the lymph-heart consists of a single chamber, in which there is no trace of any septa. At the inner side, however, an incomplete septum partly separates off a very small chamber, which is about 1·5 mm. in breadth. This contains, I believe, the orifice into the vein. It would be better perhaps to describe the incomplete septum as a valvular flap which regulates the flow of blood and lymph. In any case, there is no complete division of this anterior lymph-heart into two chambers, such as has been described in the posterior lymph-hearts of the same Frog.

* Mr. Burne kindly allows me to quote a letter in which he informs me that the posterior lymph-hearts in a specimen of this Frog in the College of Surgeons Museum are quite similar.

† For these muscles, *v. supra*.

## § *Résumé of principal Muscular and other Characters of* Hemisus.

The principal characteristics of the genus *Hemisus* which I have been able to elucidate in the foregoing pages, are as follows:—

(1) The rectus abdominis has but one inscriptio tendinea. It cannot be distinguished laterally from the obliquus externus and is folded over itself at edge of the abdomen, where it joins the thigh, in a remarkable way.

(2) The obliquus internus consists of a thick layer of muscles, arising mainly from the dorsal aponeurosis to the outside of the ilia, which end upon a thin membrane which represents the ventral portion of this muscle. It is uncovered for the greater part by the obliquus externus.

(3) The sternohyoid consists of three distinct muscles inserted separately and behind each other on to the hyoid body.

(4) There is no omohyoid.

(5) The submaxillaris appears to be specialized into three tracts on each side, of which the fibres run at different angles to each other.

(6) The dorsal portion of the depressor mandibulæ is present.

(7) The latissimus dorsi has an origin extending considerably beyond (behind) the scapula and joins early with the infraspinatus.

(8) There is no rhomboideus muscle.

(9) There are altogether four "serratus" muscles on each side of the body; 1 and 2 arise respectively from the transverse processes of vertebræ 3 and 4; 3 arises from the transverse processes of both those vertebræ; 4 arises from the neck laterally in front of the third vertebra.

(10) In the thigh the rectus internus minor partly arises from the skin.

(11) There are two pairs of large fat-masses lying in lymph spaces and another pair corresponding in position to the thymus lying beneath the skin.

(12) The stomach is elongate, with a narrower portion bent to form a U with the major portion.

(13) The small intestine is traversed throughout by closely set transverse folds.

(14) The fat-bodies are very large.

(15) The oviducts are much coiled and with a long drawn out gutter-like funnel.

(16) The lymph-sacs are not particularly large and in the usual position.

(17) The hyoid has large extra-hyals anteriorly which fuse ventrally below the hyoglossus muscle, and the body of the hyoid is very thick, with a bony plate distinct from and overlying the convex and swollen cartilaginous layer.

The above 17 characters appear to me to be the chief anatomical distinguishing features of *Hemisus*, besides certain osteological and external peculiarities which I do not deal with here. Of the former there are more that are peculiar to *Hemisus* than of those which ally it to its allies. *Hemisus* is peculiar, so far as is at present known, in Nos. (1), (2), (3), (6), (7), (11), (13), (17)—that is, in nearly one-half of those which I have selected.

*Hemisus* agrees with both of its allies, *Breviceps* and *Rhinoderma*, in (5)—at any rate, as to the fact that there are various additional muscles, not present in *Rana*, upon the floor of the mouth; there is, however, no detailed agreement between the three genera in the disposition of these muscles. In (10), (12) *Hemisus* agrees with *Rhinoderma*, and differs from *Breviceps* in (16). *Hemisus* agrees with *Breviceps* and differs from *Rhinoderma* in (4), (8), (14). I am not quite certain as to the remaining features of the anatomy, which I have made use of as indications of closer or more remote affinity. These facts, and indeed others which will be found in the foregoing pages, do not, as it seems to me, permit of a very decisive placing of *Hemisus* with regard to the two remaining genera of Engystomatid Frogs whose anatomy is known. The particular likenesses which *Hemisus* shows to *Breviceps*, as opposed to *Rhinoderma*, may be increased by the addition of the fact of the partial inclusion of the limbs within the area of the trunk, and by the division of the rectus abdominis muscle by only a single inscriptio tendinea. But *Breviceps* remains, after all, an extremely specialized type in many ways. General reflections upon the arrangement of these Frogs will, in fact, be better deferred until more anatomical facts have been collected.

### § *Résumé of principal new Facts.*

It may be convenient to extract from the foregoing account of *Hemisus*, and of *Xenopus* and *Rana*, the following principal new facts which I have been able to ascertain:—

(1) *Hemisus* is characterized by the existence of three pairs of large-lobed fat-bodies, of which one pair correspond in position to the thymus in other Frogs, the second lie in a cavity (? a lymph-sac) behind the shoulder-girdle, and the third pair are contained in a sac partly overlapping the thigh, which is to be compared with the saccus iliacus of *Rana*. The prerenal fat-bodies are also very large.

(2) *Xenopus* has a similar pair of fat-bodies in the representative of the saccus iliacus, the fatty tissue, however, straying further forward on to the back.

(3) The saccus iliacus in *Hemisus* and *Xenopus* is divided by trabeculæ in the interstices of which lies the fat-body; the commencement of such a division of the saccus iliacus is seen in *Rana guppyi*. It is possible to compare these structures with lymph-glands.

(4) *Hemisus* has a single pear-shaped posterior lymph-heart, which, unlike that of *Rana*, lies in the saccus iliacus.
(5) *Xenopus* has a chain of three perfectly distinct posterior lymph-hearts on either side of the body, which lie in the saccus iliacus.
(6) In *Rana guppyi* the single posterior lymph-heart of each side is completely divided into two consecutive chambers.
(7) Neither in *Hemisus* nor in *Rana guppyi* is there any division of the anterior lymph-heart.
(8) *Hemisus* possesses a hyoid which is remarkable in several ways and unlike that of other Batrachians. The extrahyals are large and meet in the middle line below and not in contact with the body of the hyoid; the latter consists of a cartilaginous plate continuous with the corona, which is greatly thickened posteriorly by a nucleus of laxer tissue, and above which lies a plate of bone—not imbedded in it, but distinct from it.
(9) A comparison of *Hemisus* with *Breviceps* and *Rhinoderma* allows of the extraction of certain characters apparently distinguishing the Engystomatidæ, *i. e.* specialization of muscles of floor of mouth, division of sternohyoid, connection of rectus internus minor with skin.
(10) *Hemisus*, though a burrowing and ant-eating genus like *Breviceps*, shows comparatively few special structural likenesses to it. The principal resemblances are: partial inclusion of limbs within the trunk; (?) absence of omohyoid and rhomboideus; great strength of muscles attached to the shoulder and fore limb, which, however, are not entirely the same muscles in the two types; the modifications of the muscles of the hyoid and the floor of the mouth, which are to some extent similar in the two types. But the many differences in the abdominal and dorsal musculature obscure and outweigh the special likenesses, which might be referred to similarity in habits and mode of life.

## 2. Description of a new Species of *Lacerta* from Persia. By G. A. Boulenger, F.R.S., V.P.Z.S.

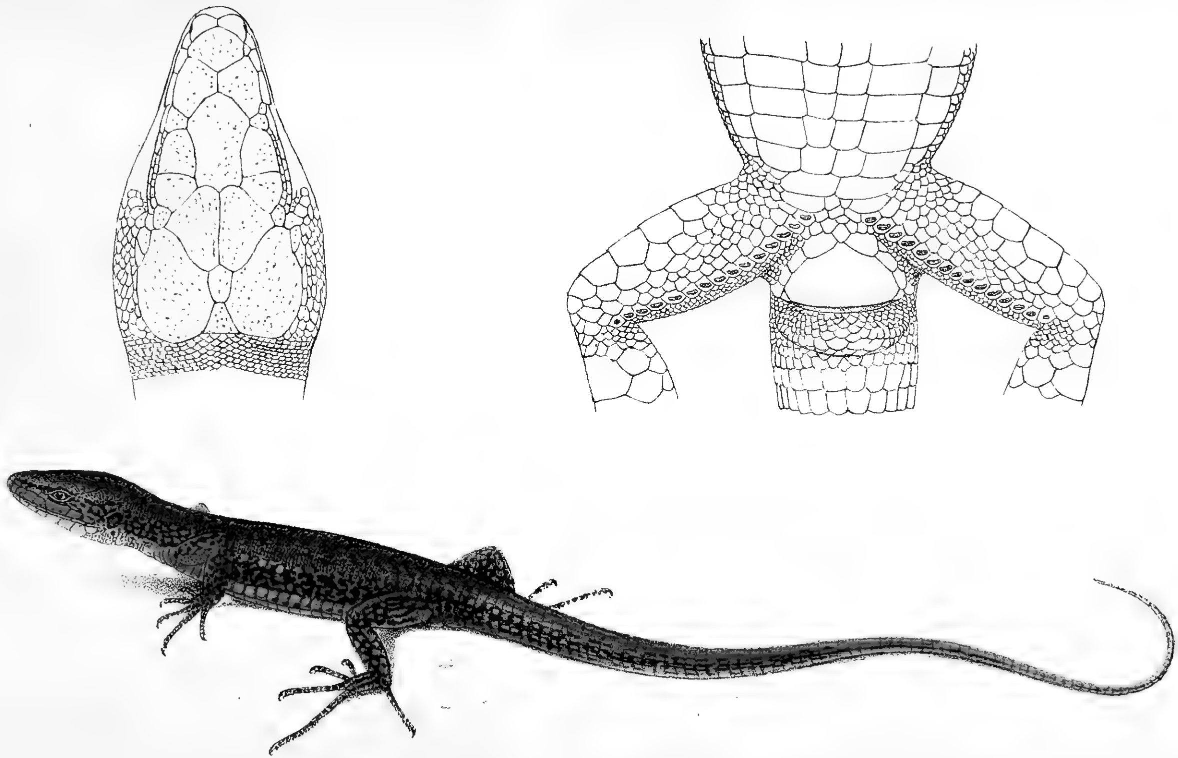
[Received October 13, 1908.]

(Plate LXVII.*)

Lacerta chlorogaster.

Head moderate, once and three-fifths to once and three-fourths as long as broad; snout moderately long, obtuse. Rostral not touching the nostril; one postnasal; a single anterior loreal; four (rarely five) upper labials anterior to the subocular; a complete series of granules between the supraocular and the

* For explanation of the Plate see page 936.



J. Green del. et Chromo lith.

LACERTA CHLOROGASTER.

supraciliaries: occipital usually shorter and broader than the interparietal; temple covered with small smooth scales, with a large masseteric disk and a curved tympanic shield; a large anterior supratemporal, usually in contact with the fourth supra-ocular. A feeble or very indistinct gular fold; 20 to 27 gular scales on a line between the collar and the third pair of chin-shields; collar with feebly serrated edge, composed of 7 to 9 plates. Dorsal scales hexagonal, longer than broad, strongly keeled, juxtaposed or faintly imbricate; lateral scales more feebly keeled, smooth towards the ventrals, a little smaller than dorsals, 3 or 4 corresponding to the length of a ventral plate; 44 to 50 scales across the middle of the body. Ventrals in 6 longitudinal series, the second series on each side from the median line the largest; 25 to 30 transverse series. Præanal plate large, bordered by a single series of scales. The hind limb does not reach beyond the shoulder. 27 to 30 lamellar scales under the fourth toe. Femoral pores 14 to 18. Tail twice, or nearly twice, as long as head and body; upper caudal scales strongly keeled, pointed posteriorly. Head and back greyish-olive in the male, the sides and limbs yellowish-green with a black network, or black with small yellowish-green spots; a few turquoise-blue spots may be present behind the shoulder. Pale golden-brown above in the female, with small blackish spots and a dark brown lateral band with wavy outlines. Lower parts yellowish-green to bright grass-green, the males with a series of turquoise-blue spots on the outer ventral plates and with the throat often blue or bluish-green; anal region and lower surface of hind limbs often lemon-yellow. Iris brownish.

| | ♂. | ♀. |
|---|---|---|
| Total length | 182 mm. | 137 mm. |
| Head | 17 | 13 |
| Width of head | 10 | 8 |
| From end of snout to fore limb | 24 | 18 |
| ,, ,, vent | 61 | 57 |
| Fore limb | 24 | 19 |
| Hind limb | 34 | 29 |
| Tail | 121 | 80* |

This species, which is intermediate between *L. praticola* Eversm. and *L. taurica* Pall., was first discovered in May, 1907, by Mr. R. B. Woosnam at Enzeli, on the south coast of the Caspian Sea. Thanks to the courtesy of Mr. H. N. Rabino, British Consul at Resht, I have since received further specimens from the same locality, some of which reached me alive or recently dead, thus enabling me to describe the natural coloration.

Mr. Woosnam has furnished me with the following note respecting the occurrence of *L. chlorogaster*:—

"These lizards were caught on the narrow dry sandy peninsula between the Caspian Sea and the large salt-lagoon at Enzeli,

* Tail reproduced.

where they were quite common and frequented chiefly the sandy banks and dry reed-fences around the gardens. They are probably to be found all along the south coast of the Caspian, for although none was obtained during the journey along the coast from Resht to Asterabad Bay, this may be accounted for by the fact that it was then early in the year, February and March, and too cold. But I once or twice caught a glimpse of a lizard, among the scrub on the dry sand-dunes near the shore, which I feel sure now must have been this species. None was obtained on the smaller western peninsula, but I should not like to say they are not to be found there, for they probably are, and I expect the species exists all along the south coast of the Caspian Sea where it is dry and sandy."

EXPLANATION OF PLATE LXVII.

*Lacerta chlorogaster*, male, natural size, and enlarged views of upper surface of head and anal region.

## 3. Remarks on some Wart-Hog Skulls in the British Museum. By Dr. Einar Lönnberg, C.M.Z.S. &c.

[Received October 19, 1908.]

When recently describing the mammals collected in German East Africa by Prof. Dr. Y. Sjöstedt * I made some remarks about different races of Wart-Hogs, and, with some hesitation, I expressed the opinion that "for the present at least" five such races must be "discerned and distinguished by names." Since then I have had the opportunity, thanks to the kindness of Mr. Oldfield Thomas, of studying the material of Wart-Hogs in the British Museum (Nat. Hist.), and, thanks to the kindness of Dr. S. F. Harmer, that in the University Museum of Cambridge. It was quite easy to recognize among this material the five races mentioned in the paper quoted above, in such cases where they were represented by skulls of adult specimens, especially boars.

A few remarks about these skulls may be of some value for future study of these animals, as I did not have access to specimens of all five races when writing the first paper.

*Phacochœrus africanus* (Gmelin) appears to be the largest or one of the largest of these races. A skull of an adult boar of this kind in the British Museum from the typical locality, Cape Verde, measures 440 mm. in length, but the extreme tips of the nasals are not complete, so that this measurement should be a little longer. The postorbital portion of this skull is very long, measuring 59 mm., but it is at the same time very broad, viz. 58 mm. across the flat area. By this characteristic *Ph. africanus* is very easily distinguished from *Ph. æliani*, which also has a long but at the same time

* Lönnberg: Mammals, in Wiss. Ergebn. d. schwed. zool. Exp. nach dem Kilimandjaro, dem Meru etc., 1905–1906, unter Leitung von Prof. Dr. Yngve Sjöstedt.

very narrow postorbital portion of the skull. This is proved by the following measurements obtained from specimen No. 69.10.24.47 in the British Museum, ♂ ad. from Zorilla, Abyssinia. The length of this skull from the tip of the nasals to the occipital crest is 388 mm. The postorbital portion has a length of 60 mm., but the breadth of its flat area is only $24\frac{1}{2}$ mm. These differences in the dimensions of the postorbital portion of the skull become still more striking if they are expressed in percentages of the length of the skull. In such a case the length of the postorbital portion of the skull of *Ph. africanus* will be found to be 13·4 °/₀ and the width of its flat area almost the same, or 13·1 °/₀ of the length of the skull. The same percentages for *Ph. æliani* are respectively 15·4 °/₀ and 6·3 °/₀. *Ph. africanus* has a comparatively narrow interorbital space, which corresponds to only 30 °/₀* of the length of the skull. In *Ph. æliani* the interorbital region is a little broader, so that it corresponds to 31·7 °/₀ of the length of the skull. The combined characteristics of the postorbital and interorbital portions of the skulls of these two races give the impression that they are comparatively longer than those of other races. The skulls of these races are therefore at once distinguished from others. *Ph. massaicus* has a comparatively long postorbital region, viz. about 14 °/₀ of the length of the skull, but as it is very broad at the same time, its flat area measuring about 14·5 °/₀, and the interorbital region as well is very broad, being 38·8 °/₀ of the length of the skull, no confusion with other races is possible. *Ph. sundevallii* has a somewhat shorter postorbital region, viz. 13·7 °/₀, and the flat area of the same is considerably narrower, viz. 11 °/₀: at the same time its interorbital region is much narrower than in *Ph. massaicus*, so that the percentage expressing its relation to the length of the skull, 32·3, resembles that of *Ph. æliani*. In such a way these four races may be easily distinguished from each other, if the material is derived from adult males.

Two Wart-Hog skulls in the British Museum from Angoniland (No. 8.2.14,1, ♂ ad., and 8.2.14,2, ♂ jun.) show some affinity to *sundevallii*. Their interorbital width is respectively 33·4 °/₀ and 32·1 °/₀ of the length of the skull (thus rather similar in this respect to *Ph. sundevallii*), but the postorbital portion is smaller than in *Ph. sundevallii*, its length being about 11·7 °/₀ and the width of its flat area 10·1 °/₀ of the length of the skull in the adult. In the younger specimen the last-mentioned dimension is still smaller (8·1 °/₀), as always is the case with the young ones, and cannot be considered. More material is needed before anything can be decided about this Wart-Hog. It may, however, be added that its choanæ are rather wider, 36 mm. in the adult, than in the typical *Ph. sundevallii*, 29 mm.

Two other skulls of Wart-Hogs in the British Museum one from Ukanga, Lake Nyassa (No. 91.5.9,3, ♂ ad.) and

* The interorbital measurements are always counted at the middle of the orbit.

another from Lake Mweru (No. 94.3.8,17, ♂ ad.), are quite similar *inter se*. Their interorbital width is respectively 28·8 °/₀ and 29·3 °/₀, the length of their postorbital portion 12 °/₀ and 12·3 °/₀, and the length of the postorbital flat area 11·1 °/₀ and 11·4 °/₀ of the length of the skull. A third skull from Lake Mweru (No. 94.3.8,18, ♂ jun.) is also similar with regard to the first two dimensions, viz. 30 °/₀ and 12 °/₀, but the postorbital flat area is narrow, 8·7 °/₀, in consequence of its youth. It appears from this as if the Wart-Hogs of the country between Lake Nyassa and Lake Mweru agreed in having a comparatively very narrow interorbital region, narrower than in *Ph. sundevallii*. The width of the flat postorbital portion is similar to that of *Ph. sundevallii*, but the length of the same is somewhat shorter.

With regard to other measurements, it seems as if the skulls from Angoniland, Nyassa, and Lake Mweru had a somewhat longer preorbital portion (distance from tip of nasals to anterior orbital margin) than both *Ph. sundevallii* and *Ph. massaicus*.

Comparative studies of more material of fully adult animals may thus in the future prove that the Wart-Hogs inhabiting the countries adjoining Lake Nyassa and Lake Mweru are racially different both from *sundevallii*, inhabiting Natal and probably Transvaal and the southern parts of Portuguese East Africa, and from *Ph. massaicus*, inhabiting the Masai country in German East Africa.

How widely *Ph. massaicus* is distributed cannot be stated for the present. The skull of a young Wart-Hog of male sex from Uganda in the British Museum (No. 95.4.3.42) agrees so far with *Ph. massaicus* in having a very broad interorbital region, which corresponds to 37 °/₀ of the length of the skull. But, on the other hand, the postorbital portion is rather small, its length being only 11 °/₀ and the width of its flat area only 10·5 °/₀ of the length of the skull. If this smallness be not due to the youth of the specimen, there must exist a separate race of Wart-Hog in Uganda which should be easily recognized by the two combined characteristics: great interorbital width and shortness of the postorbital region.

In the specimen examined the length of the postorbital region exceeds the width of its flat area by 2 millimetres only, but, as experience proves that the latter dimension increases more with age than the former, it is probable that in adult Wart-Hog boars from Uganda the width of the postorbital flat area is greater than the length of the same portion of the skull (as also is the case in *Ph. massaicus*).

In the collections of the British Museum are two Wart-Hog skulls, numbered 0.3.27.16 and 0.3.27.17, which aroused the interest of the present writer more than all the others. Both these, which were presented by Lord Delamere, have no traces of upper incisors, and 0.3.27.16 has no incisors in the lower jaw either, with the exception of two small pea-shaped rudiments lying in corresponding grooves of the jaw-bone; these rudiments appeared to represent the median pair. Specimen 0.3.25.17, on the other hand, is provided with four well-developed incisors in the lower jaw. The lower incisors are thus subject to great variation, but the upper ones appear to be constantly missing, as the premaxillary is too thin to carry any teeth, just as in *Ph. æthiopicus.* The two skulls in question resemble the Cape Wart-Hog (*Ph. æthiopicus*) in other respects, too, both in general shape and with regard to particular features, as will be seen from the following comparison. The postorbital portion of the skull is very short in *Ph. æthiopicus*, about 10·3 °/₀ of the length of the skull in a specimen in the Royal Natural History Museum of Stockholm (brought home by Sparrman), 10·5 °/₀ in specimen 0.3.27.17 and 10·9 °/₀ in specimen 0.3.27.16 in the British Museum. The width of the postorbital flat area is greater than the length of this portion, viz. 13·3 °/₀ in Sparrman's specimen, which is the oldest, and respectively 11·9 °/₀ and 11·5 °/₀ in Lord Delamere's two specimens. The interorbital width is rather greater in Sparrman's specimens, viz. 36·5 °/₀, than in the two others, respectively 33·0 °/₀ and 34·7 °/₀. There was no locality indicated on the labels of Lord Delamere's two Wart-Hog skulls, and I believed, therefore, judging from their resemblance to *Ph. æthiopicus*, that they originated from the Cape. Mr. Oldfield Thomas, however, kindly informed me that this was not the case, as Lord Delamere had travelled in North-eastern Africa, Somaliland, and British East Africa, and the skulls were most probably from Somaliland. This made the matter more complicated, but at the same time more interesting, as it was not probable that the same race of Wart-Hog inhabited two countries so far apart when the intervening countries were occupied by widely different races. A renewed examination revealed also that Lord Delamere's Wart-Hogs differed in some respects from *Ph. æthiopicus*, although the general shape of the skull (especially the postorbital portion) was similar. The nasals of *Ph. æthiopicus* are "anteriorly rather evenly convex, but form in their posterior portion behind the foramina infraorbitalia a roof-like ridge or elevation"*. In Lord Delamere's Wart-Hogs the nasals are rather flat along their whole extent, without forming any ridge posteriorly. The choanæ are broad, much widened posteriorly in Lord Delamere's Wart-Hogs, but in *Ph. æthiopicus* they are not wider behind than in front and the margins are parallel. The sphenoidal pits are completely open, not covered by any bony roof, in Lord Delamere's Wart-Hogs, but the lateral walls formed by the pterygoids are high so that a deep canal is formed. The distance from the hind margin of *foramina palatina* to the hind margin of the palate measured in a straight line is respectively 50 and 51 mm. in the two specimens of Lord Delamere's Wart-Hogs, but only 35 mm. in *Ph. æthiopicus*, although the latter specimen is older and a little larger. As these differences are quite recognizable and more material, no doubt, on direct comparison, will add other characteristics osteological

* Lönnberg, *l. c.* p. 55.

as well as external, I think it will be correct to distinguish this Wart-Hog, presumably from Somaliland, by a separate name, and I venture to propose to call it *Phacochœrus delamerei.*

I hope that sportsmen who visit Somaliland may have their attention drawn to this animal and bring home satisfactory material to fully elucidate this question.

As the Eurasian members of Suidæ are less specialized than the African genera of the same family, it must be assumed that the hogs originated on the Eurasian continent, the more so as the oldest known fossil remains belonging to this family have been found in Europe. The genera of Suidæ less specialized than the Wart-Hog, even *Potamochœrus* and *Hylochœrus*, have the postorbital portion of the skull comparatively much longer and the interorbital region much narrower than the corresponding parts of *Phacochœrus.* Thus a comparatively long postorbital and a narrow interorbital region of the skull in a Wart-Hog indicate a less specialized race. It agrees well both with the geographical distribution and origin that the most northern races of *Phacochœrus*, viz. *Ph. æliani* in Abyssinia and *Ph. africanus* in Senegambia, are the least specialized. *Ph. massaicus* further south has retained a rather long postorbital region of the skull, but acquired a great interorbital breadth. The Wart-Hogs from Lake Mweru and Nyassa, on the other hand, have still a narrow forehead, but their postorbital portion is somewhat shortened, while *Ph. sundevallii* has the forehead broader but the postorbital portion not so much shortened. Finally, in the Cape region, the most specialized of all Wart-Hogs, *Ph. æthiopicus*, with very short postorbital portion and a comparatively broad forehead, is found. It has also completely lost the upper incisors, while the lower ones are absent or rudimentary. *Ph. delamerei*, which at present must be regarded as inhabiting Somaliland, has in that country independently reached a similar stage of specialization as *Ph. æthiopicus* at the Cape. It is probable that this analogy between the Wart-Hogs of the Cape and Somaliland depends upon similar natural conditions of the two countries, and if that be so there might no doubt be found other instances of parallel development within the same geographical areas.

## 4. On Two Chinese Serow-Skulls.

By R. Lydekker.

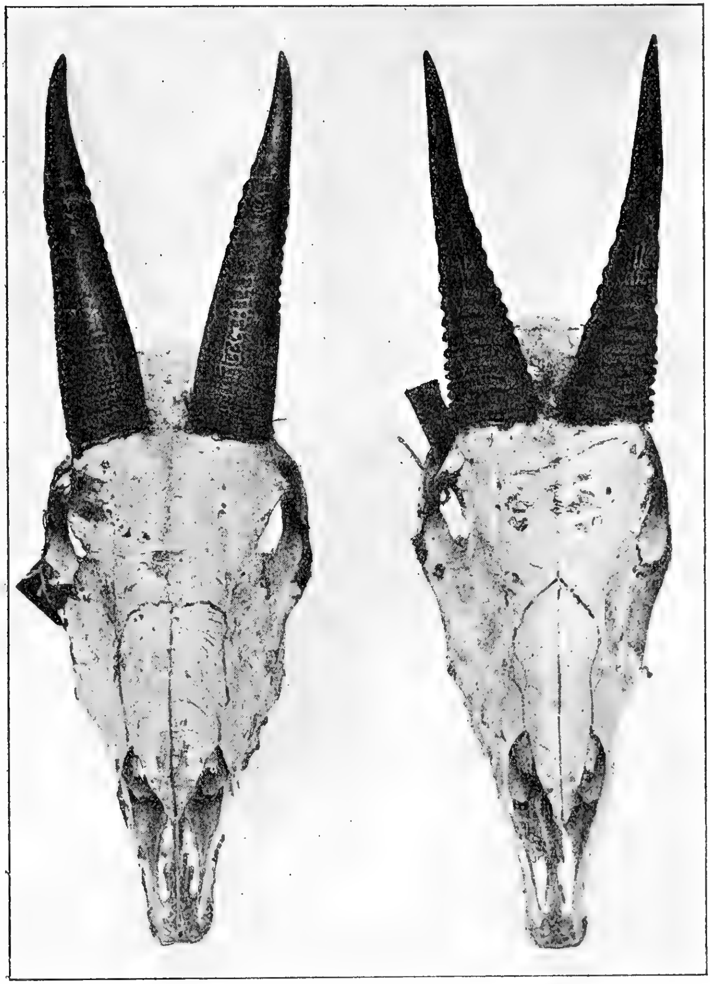
[Received October 3, 1908.]

(Text-figures 191–192.)

When I described the immature specimen of the White-maned Serow (*Nemorhœdus argyrochœtes*) of Sze-chuen in the Society's 'Proceedings' for 1905, vol. ii. p. 329, pl. viii., some doubt was expressed at the meeting as to whether the animal was anything more than a local race of the widespread *Nemorhœdus sumatrensis*;

and it has recently been relegated to that grade*. I am now in a position to demonstrate its right to specific rank.

Text-fig. 191.



A B

Female skulls of *Nemorhœdus sumatrensis milne-edwardsi* (A) and *N. argyrochœtes* (B), from Sze-chuen.

* See Proc. Zool. Soc. 1908, p. 185. I am afraid I cannot follow my friend Mr. Pocock in transferring the name *Nemorhœdus* to the Gorals; it has been too long in use for the Serows.

In September last Mr. J. W. Brooke* presented to the British Museum (Nat. Hist.) the skins and skulls of an adult male and female of the White-maned Serow obtained by himself and Mr. C. H. Mears at Towquan, 60 miles north of Kanshieu, N.W. China. That they belong to this species is evident from the fact that the greater part of the fore-legs and the whole of the hind-legs, inclusive of the lower portion of the thighs, are bright rusty red. Both skins, as indicated by the teeth and horns of the associated skulls, belong to fully adult animals; the horns being much larger than those of the immature mounted specimen in the British Museum. From that specimen, and also from one recently figured by Mr. M. W. Lyon, the new skins differ, however, by the absence of such a distinctly white mane as occurs in the immature female.

Text-fig. 192.

A female of the Sze-chuen race of the Serow, *Nemorhœdus sumatrensis milne-edwardsi*, from a photograph by Mr. J. W. Brooke.

In all the races of the ordinary Serow (*N. sumatrensis*), as is well shown in the figures illustrating the paper by Mr. Pocock already mentioned, the skull is relatively broad and short, with the nasal bones likewise proportionately broad and short, although there is a considerable degree of local variation in this respect. These characters are exemplified in a third skull (text-fig. 191 A, p. 941) sent home by Mr. Brooke. I believe this to belong to the same species as the Serow shown in the annexed reproduction from a photograph (text-fig. 192), which is evidently

* [We much regret to note that since the reading of this communication news of the murder of Mr. Brooke in China has reached England.]

one of the dark-coloured races of *N. sumatrensis* allied to the Malay representatives of that species, the scalp-skin accompanying the skull being of a dark type.

The skull and photograph indicate a Chinese representative of the ordinary Serow, which is doubtless the one to which Père David gave the name *N. milne-edwardsi.* The following dimensions are taken from the skull:—

| | |
|---|---|
| Extreme basal length | 11 inches. |
| ,, zygomatic width | $5\frac{1}{4}$ ,, |
| Length of nasals | $4\frac{1}{8}$ ,, |
| Width of nasals | $2\frac{1}{8}$ ,, |

This skull and scalp belong, it should be added, to a female.

Of a very different type are the male and female skulls from Towquan, these (text-fig. 191, B, p. 941) being narrower and longer with longer and narrower nasals. The dimensions of these two skulls are as follows:—

| | Male. | Female. |
|---|---|---|
| Extreme basal length | 12 | $11\frac{5}{8}$ inches. |
| ,, zygomatic width | 5 | $4\frac{3}{4}$ ,, |
| Length of nasals | $4\frac{1}{2}$ | $4\frac{5}{8}$ ,, |
| Width of nasals | $1\frac{1}{2}$ | $1\frac{1}{2}$ ,, |

From this it will be evident that while in the White-maned Serow the basal length and the nasal length exceed the corresponding dimensions in the ordinary species, the width of the nasals is less. A further important difference is to be found in the basisphenoidal region, which is much narrower in the White-maned than in the ordinary species; while the premaxillæ are also longer and narrower in the former than in the latter.

The following measurements of the two animals taken immediately after death have been supplied by Mr. Brooke. In taking the measurements the tape is stated to have been laid flat on the body without pulling.

Male; shot March 30th, 1908.

Height at shoulder from back of foot 44″.
Nose to root of tail 68″.
Lip (upper) to horn $11\frac{3}{4}$″.
Ear $8\frac{3}{4}$″ (length), ear 7″ (widest part).
Circumference of hind-leg level with the point where the loose skin from the belly joins the leg 23″.
Widest part of body (*i. e.* just behind withers and over breast-bone under body) $45\frac{1}{4}$″.
Neck where it joins the body 27″.
Narrowest part of body in front of hind-legs $38\frac{1}{4}$″.

Female; shot April 1st, 1908.

Height at shoulder from back of foot $43\frac{1}{2}$″.
Nose to root of tail $61\frac{1}{2}$″.
Bottom of upper lip to root of horn 13″.

Length of ear 9″; widest part $7\frac{1}{2}$″.
Hind-leg level with the point where the loose skin joins the belly (as before) 18″.
Widest part of body (as before) 46″.
Narrowest part of body in front of hind-legs $38\frac{1}{2}$″.

These dimensions indicate animals rather larger than Sumatran Serows; and in some degree justify Mr. Henry's statement as to the Chinese animal being as large as a cow.

In my opinion, Mr. Brooke's specimens fully justify the recognition of *Nemorhœdus argyrochœtes* as a valid species, especially as it appears to inhabit the same district as *N. milne-edwardsi*. The ears of the White-maned species appear to be rather larger than those of the other.

Mr. Brooke mentions that the White-maned Serow is known to the natives as "Nikka" and the dark species as "Nik-lu."

The Sze-chuen race of the true Serow has the back black mingled with white; the front of the fore-legs is black to the knees, below which the limb is grey with patches of rusty; the hips and posterior surfaces of the hind-limbs are rufous, the black on the front surface extending some distance short of the hocks. These particulars are taken from a mounted skin presented by Mr. Brooke to the Museum.

I may add that I have given a preliminary notice of the specimens forming the subject of this paper in the 'Field' for October 8th, 1908.

## 5. Warning Coloration in the Musteline Carnivora *. By R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens.

[Received December 15, 1908.]

(Text-figures 193–198.)

As long ago as 1846, Hamilton Smith wrote: "The Ratels offer one more instance of the colours of the fur being light on the upper surface of the body and dark beneath, producing a kind of family livery, alike in this and the Grisons, *Taxidea* and *Meles*, and not obliterated in *Eira* [*Galera*] and *Arctonyx*." † The circumstance in fact is so well known that it would be profitless to search literature for earlier and even later records. Some later authors indeed have drawn attention to the style of coloration above described as being uncommon and as a "divergence

* Under the term Musteline I include in this paper both Weasel-like and Badger-like Carnivora, which are generally referred to two distinct subfamilies, Mustelinæ and Melinæ. I have not aimed at making the list of nauseous species complete; but have based my conclusions in the main upon those which have come, as living animals, directly under my own observation.

† Jardine's Nat. Library, xv. Mammalia, pp. 205–206.

from the usual rule" *; and Mr. Lydekker observes: "It is also noteworthy that in the parti-coloured examples [of the Mustelidæ] there is a great tendency for the underparts of the body to be darker than the upper; whereas, it is scarcely necessary to observe, the reverse is the case in the great majority of mammals." †

Before the publication of Mr. Thayer's paper explaining the celative or procryptic significance of the usual style of coloration whereby reflected lights are toned down and shadows obliterated, it was hardly to be expected that any special inquiry would be made as to the meaning of the peculiar livery of the Mustelines in question; but, so far as I am aware, no suggestion has been made on this head since the publication of that luminous idea ‡. Yet the inference seems obvious enough that, since the colours are reversed, their functions must also be reversed; that is to say, if animals which are light below and dark above are concealed on this account under a top light in their normal surroundings, those which are light above and dark below should be made conspicuous under the same conditions. White on the upper side should have the effect of enhancing reflected light, and dark on the under side the effect of emphasising shadows.

A simple experiment demonstrates this to be a fact. If a cork be pinned with a long pin against a sheet of brown paper of its own colour under a top light, it may be made practically invisible, as Thayer has shown, by painting its upper side dark and its under side white. But if the cork be then turned over so that its white side be uppermost and its dark side undermost, its maximum of conspicuousness is achieved. The effect of turning it over is much the same as that produced by immensely increasing the intensity of the top light over the uncoloured cork.

In the case of Mammalia, it is exceptional for the coloration to be of a kind that makes for conspicuousness. In the majority of instances it is procryptic for the purpose of enabling the individual either to escape enemies or to secure prey. Hence, if it be claimed that the livery of these Mustelines belongs, as I think, to the former category, it is necessary to produce in favour of the claim evidence drawn from the bionomics of the species in addition to that deducible from the above mentioned fact that the coloration is the very opposite of that exhibited by a very large number of procryptically coloured forms. Sufficient evidence to justify the adoption of this view as a useful working hypothesis, is, in my opinion, supplied by what is known of the habits of the species discussed in the following pages.

With the exception of mimetic species, animals which are coloured so as to be conspicuous in their natural surroundings are very often protected from enemies by distastefulness arising from a nauseating flavour or odour, or by the possession of poison-

* J. G. Wood, 'Illustrated Nat. History,' Mammalia, p. 372, 1861.
† Royal Natural History, ii. p. 47, 1894.
‡ 'The Auk,' xiii. 1896, pp. 124 & 318.

glands and stings which make them dangerous to meddle with. They also as a very general rule have no need of procryptic coloration to enable them to capture wary or keen-sensed prey. Their movements are usually slow and deliberate, and instead of avoiding they seem rather to court observation, some indeed attracting attention by the emission of characteristic sounds. Very commonly also they are hard, tough, and difficult to kill.

Porcupines of the genus *Hystrix* furnish a good instance of this. Protected by their spine-armature, they are quite conspicuous in the dusk by reason of the predominance of white on the dorsal surface, and they make themselves heard by shaking their caudal rattles and uttering hoarse grunts. This I pointed out last year (see P. Z. S. 1906, p. 902, pubd. April 1907). Subsequently I noticed that the Canadian Tree-Porcupine (*Erithizon*), which which has no rattle, but is conspicuously coloured when its spines are erected, possesses a strong and unpleasant odour recalling that of concentrated human perspiration. This is also very possibly one of the aposematic attributes of the species; and I have recently come across a passage showing that exactly the same discovery was made about forty years ago by that keen naturalist Charles Kingsley in connection with the Brazilian Tree-Porcupine or Coendoo (*Coendu*). He wrote: "More than once we became aware of a keen and dreadful scent, as of a concentrated essence of unwashed tropic humanity, which proceeded from that strange animal, the Porcupine with a prehensile tail, who prowls in the tree-tops all night, and sleeps in them all day, spending his idle hours in making this hideous smell. Probably he or his ancestors have found it pay as a protection; for no Jaguar or Tiger-cat, it is to be presumed, would care to meddle with any thing so exquisitely nasty, especially when it is all over sharp prickles." * It is interesting that the same comparison should have been independently employed both by Kingsley and myself in attempting to describe the scent of these Porcupines; and that he should have anticipated me by so many years in assigning a protective value to it.

Up to the present time the only Mammals, apart from Porcupines, claimed to be warningly coloured, so far as I am aware, are the Skunks of America (*Mephitis*, *Conepatus*, *Spilogale*) and the Zorillas of Africa belonging to the genus *Ictonyx* and known in Cape Colony as Cape Polecats. These are black Mustelines ornamented dorsally, as a rule, with broad clear white longitudinal stripes, which sometimes coalesce or almost coalesce to form a continuous white field. When attacked they increase their apparent size and enhance their conspicuousness by erecting the long hairs of their bodies and by brandishing their bushy white tails. At the same time they eject from their anal glands a volatile fluid, with a most repulsive, acrid and persistent odour. Skunks in captivity are frequently quiet undemonstrative animals;

* 'At Last,' p. 248, ed. 3, 1905; quoted also by J. G. Wood in Waterton's 'Wanderings in South America,' p. 458, MacMillan & Co., 1879.

but I have seen a Cape Polecat behave in the way described above at the sight of a small dog, uttering the while shrill squeals of anger. Both Skunks and Cape Polecats are said to feed naturally upon any small terrestrial vertebrates they can catch, and also upon insects. Merriam indeed describes the North-American Skunk as preeminently an insect-eater, adding that it "destroys more beetles, grasshoppers, and the like, than all our other mammals together," also "he devours vast numbers of mice." But those that have come under my observation in the Zoological Gardens will eat fruits like bananas and dates. Hence they are in all probability omnivorous in their native haunts; and are, therefore, not dependent for food upon the live things they capture.

Text-fig. 193.

Cape Zorilla (*Ictonyx capensis*), left-hand figure, and Cape Weasel (*Pœcilogale albinucha*), right-hand figure.

I have been able to demonstrate experimentally and to my complete satisfaction, that the white on Skunks and Zorillas makes them conspicuous at night, whether it be cloudy or starlit, against the dark background of the soil or of low herbage. I made the experiment with three stuffed skins, one of the Canadian Skunk (*Mephitis mephitica*), one of the Cape Zorilla (*Ictonyx capensis*), and one of the Libyan Zorilla (*Ictonyx libyca*). The Skunk was not a good specimen, having died in bad coat with short hair, yet I could see it at a distance of 15 feet. The others were easily visible at twice that distance *, the Libyan Zorilla being more visible than the Cape specimen on account of the greater amount of white on its dorsal area. The conspicuousness of all three was enhanced when they were made to move. On the other hand, when put upon the snow

* They would clearly be visible at a much greater distance to Carnivora with nocturnal vision.

all are visible, the Skunk being the most conspicuous of the three on account of the greater amount of black in its pelage; and the Libyan Zorilla the least conspicuous for the opposite reason. The interest of this fact lies in the circumstance that the species of Skunk mentioned above frequently has to traverse snow-covered ground; whereas the Libyan Zorilla probably never has to do so. By twilight and daylight the specimens were conspicuous both in vegetation, on the grass, and on snow-covered ground.

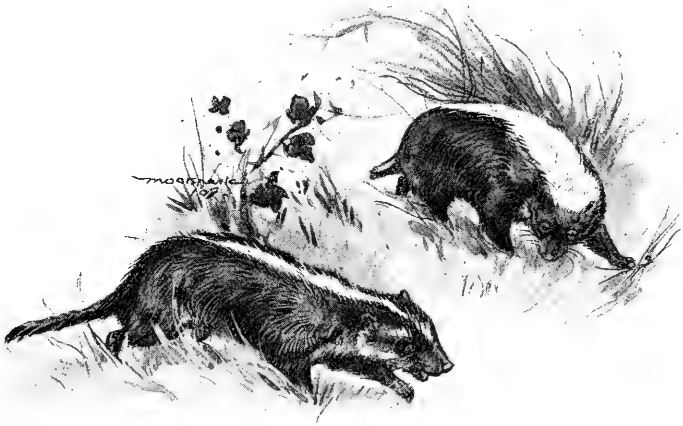
Another Weasel which presents a very unusual type of coloration is the genus *Pœcilogale* of tropical and Southern Africa, the typical form of which is *P. albinucha* of Cape Colony. The livery is of the same style as that of *Ictonyx*, the body being black with four snow-white stripes along the back. On the shoulders these coalesce into two stripes which fuse with a large white patch covering the fore part of the nape of the neck and the top of the head. The tail is white. The resemblance between this animal and *Ictonyx* may be an instance of true (Batesian) mimicry as Mr. Lydekker has suggested *. On the other hand, if *Pœcilogale* is itself protected by an exaggerated development of the subcaudal stink-glands such as are found in the common weasel, stoat, and polecat, it may be that the similarity in question is an illustration of Müllerian resemblance. Very little seems to be known of the habits of this rare animal, but its long and lithe form which is typically weasel-like, suggests that it resembles in mode of life the weasel and the stoat, to which it is more nearly related than to the zorillas. If this be so, it would seem that the peculiar style of coloration, so unlike the protective coloration of weasels and stoats, must have either a true warning (aposematic) or a false warning (pseudaposematic) significance.

Another member of this family which I have no doubt is warningly coloured is the Teledu (*Mydaus*) of Indo-Malaya. The general colour is blackish brown, but a white band commonly extends from the top of the head down the spine to the tail, the tip of which is also white. On the back of the head and neck the area of white is increased by the hairs forming a decided erectile crest. This animal, like Skunks and Cape Polecats, is nocturnal. It is slow in its movements and feeds to a great extent upon insects and worms. It also possesses stink-glands, which exude a fetid volatile liquid. According to Horsfield, "the entire neighbourhood of a village is infected by the odour of an irritated Teledu, and in the immediate vicinity of the discharge it is so violent as in some persons to produce syncope," as has been stated to be the case with the discharge of the Skunk. Mr. Shortridge, who has collected these animals in Java, tells me that he believes they feed upon roots; and he has noticed the night air tainted by their smell. I also owe to Mr. Shortridge the suggestion that in Java at all events the Teledu is mimicked

* Royal Natural History, ii. p. 70, 1894.

by the Ferret-Badger (*Helictis orientalis*). There is unquestionably a close superficial resemblance between them in size, form, and colour, although the white on the nape and shoulders of *Helictis* is less extensive and there is more white on the face than in *Mydaus*. *Helictis*, however, may be itself a protected form, and in this case the resemblance between it and *Mydaus* is probably an instance of common warning coloration usually called Müllerian mimicry.

Text-fig. 194.



Teledu (*Mydaus javanensis*), upper figure, and Ferret-Badger (*Helictis orientalis*), lower figure.

In the genera of Mustelidæ above described the coloration is very specialised, consisting in the Skunks and Zorillas of alternating black and white bands, and in the Teledus and Ferret-Badgers of a single white band running down the back. There are some Skunks, however, in which the entire dorsal area is white, as if the white stripes had extended towards the middle line and coalesced. It is quite possible, however, that the uniform whiteness of the back is the more primitive livery of the two, and that the ancestral Skunk was grey-backed, like a Ratel, later forms becoming white-backed by the gradual whitening of the whole dorsal area, or striped by the sorting of the hairs into black and white bands.

One of the best-known examples of the style of coloration mentioned above, in which the upper side is markedly lighter than the under, is the Ratel (*Mellivora*), which is represented by species or subspecies in India, Arabia, and Africa. The back and head, sometimes white, as a rule are iron-grey, the muzzle, legs, and under side being jet-black. Where the grey or white of the dorsal surface meets the black of the under surface, the contrast between the two is emphasised by a whiter line which is very conspicuous both on the forehead and the sides of the body. One form only is black above as well as below.

There is abundant testimony to the unpleasantness of the odour emitted by Ratels. Writing of the Cape Ratel, Mr. W. L. Sclater says: "It further defends itself by emitting an offensive odour from its anal glands."* In his account of the habits of the Indian species, Blanford does not mention this attribute; but I have been told by Indian sportsmen that the characteristic is well known, and two of the Society's keepers, Dixon and Hoare, who have looked after a male specimen that is still living in the Gardens, tell me that formerly this animal, when threatened or disturbed, would emit an odour, described as suffocating, which could be perceived at a distance, varying according to the estimate of the raconteur, from fifty to one hundred yards.

Text-fig. 195.

White-backed Ratel (*Mellivora ratel*).

Ratels are omnivorous, and can be kept in confinement in health and strength without meat. Their liking for honey is notorious, and is the attribute from which their generic name has been derived. They are known to be desperate fighters and extraordinarily tenacious of life. The skin is not only very thick, but also very loose, so that if seized by almost any part of it the animal can reach and bite its assailant. Of the African species Mr. Sclater says: "It is very difficult to kill, only, it is said, by actually crushing its skull or by stabbing to the heart can this be effected." The very small size of the ears in the Ratel is another noticeable feature bearing on the question of his immunity from attack. Animals which require sharp hearing either to escape enemies or capture prey usually at all events have large ears; and the fact that the animals forming the subject matter of this

* 'The Mammals of South Africa,' i. p. 112, 1900.

paper have small external ears is in keeping with the theory that they have no enemies to fear.

Caged Ratels do not always make use of their scent-glands. For example, two specimens of *M. capensis* in the Society's Gardens never did so; and the keeper in charge, noticing this difference in behaviour between them and the specimen of *M. indica* above mentioned, asked me if it was a specific feature. The explanation no doubt is that when once tamed these animals soon learn that they are safe from enemies, and therefore do not resort to this special mode of defence.

The coloration of the Grison (*Grison furax*=*Galictis vittata*), a South-American musteline, is very similar to that of the Ratel (*Mellivora*). The whole of the upper side of the head and body is greyish, the under side of the body and head and the limbs being black. Across the forehead and along each side of the head towards the shoulder at the junction of the grey and black, there runs a whitish band which is very conspicuous as the animal advances.

I have the independent testimony of two of the Society's keepers, Dixon and Heffer, that when Grisons fight or are disturbed they stink like Skunks and Cape Polecats (*Ictonyx*); and J. G. Wood *, writing apparently of his own knowledge, says: "The odour which proceeds from the scent-glands of the Grison is peculiarly disgusting, and offends human nostrils even more than that of the stoat and polecat." The Grison also has the reputation of being extremely savage and a most dangerous foe to any animal it ventures to attack. It was of this species, and probably the next, that Mr. W. H. Hudson wrote ". . . . there are [on the pampas of La Plata] two quaint-looking weasels, intensely black in colour, and grey on the back and flat crown. One, the *Grison furax*, is a large bold animal that hunts in companies; and when these long-bodied creatures sit up erect, glaring with beady eyes, grinning and chattering at the passer by, they look like little friars in black robes and grey cowls; but the expression on their round faces is malignant and bloodthirsty beyond anything in nature, and it would perhaps be more decent to liken them to devils rather than to humans"; and again: "After watching the weasels dance for some minutes, I stepped up to the mound, whereupon the animals became alarmed and rushed pell-mell into the burrows, but only to reappear in a few seconds, thrusting up their long ebony-black necks and flat grey-capped heads, snarling and chattering at me, glaring with fierce beady eyes." The same author bears testimony to the absence of the hiding instinct in the young of this species. He says: "I once surprised a weasel [*Grison furax*] in the act of removing her young, or conducting them, rather; and when she was forced to quit them, although still keeping close by, and uttering the most piercing cries of anger and solicitude, the young continued

* Illustrated Nat. History, i. p. 372.

piteously crying out in their shrill voices and moving about in circles, without making the slightest attempt to escape, or to conceal themselves, as young birds do."* These passages attest the savage aspect and fearless behaviour of the Grison and the suppression of the instinct to hide in young individuals. These are precisely the attributes one would expect, if the species is specially protected and warningly coloured.

Text-fig. 196.

Grison (*Grison furax*), upper figure, and Patagonian Weasel (*Lyncodon patagonicus*), lower figure.

As is the case with the Ratel and some other mustelines, the

* 'The Naturalist in La Plata,' pp. 15–16, 104, and 385–386, 4th ed. 1903. In the paragraphs above quoted I have substituted the name *Grison furax* for *Galictis barbara*. Mr. Hudson's description of the larger animal, apart from his remark that it is "about the size of a cat," coupled with my own knowledge of the geographical distribution of *Galera barbara* and of *Grison furax*, convinced me that he had applied the wrong specific name to the larger La Plata musteline. I therefore wrote to him on the matter, and he kindly confirmed this, adding that he was misled by a wrong label in the Buenos Ayres Museum and had discovered the mistake subsequently. It is important that the error should be corrected, because although obvious enough to those who know the two species under discussion, it has already made its way into the literature of natural history. In the 'Royal Natural History,' for example, the larger of the two weasels mentioned by Mr. Hudson is cited as the Tayra (*Galera barbara*), and the smaller as the Grison (*Grison furax*): whereas the larger is, as stated, the Grison, and the smaller, I suspect, the Patagonian Weasel (*Lyncodon patagonicus*).

diet of Grisons is mixed. Two now living in the Zoological Gardens feed upon fowls' heads, dried dates, and bread and milk.

The so-called Patagonian Weasel (*Lyncodon patagonicus*), although smaller than the Grison, presents much the same style of coloration. The hair of the body and tail is long and grey. On the nape of the neck there is a large black patch which emphasises a large white patch covering the top and sides of the head and extending laterally along the neck. This is set off both in front and below by the black colour of the muzzle, cheeks, sides of the neck, and lower shoulder. The legs are black. Very little seems to be known of the habits of this animal. It may or may not be offensive like the Grison. If it is, its coloration is, I think, probably genuinely aposematic. If it is not, the resemblance in colour between the two may be an instance of true or Batesian mimicry. The evidence, however, that the two species are found together is not conclusive. In favour of this view it may be added that *Lyncodon* has been recorded in Central Argentina from Mendoza and Azul southwards to the Rio Colorado and Rio Negro, and *Grison* also as far south as the Rio Colorado *; and according to Trouessart's Catalogue both occur in Northern Patagonia.

But exact coincidence in distribution is not essential to the belief that the resemblance between the two animals is an instance of Batesian mimicry or of Müllerian resemblance. It is merely essential to show that enemies that might prey upon small carnivora of this kind are dispersed over the areas inhabited by the two forms. Wide ranging raptorial birds, for example, that knew the Grison by sight in the northern parts of La Plata, might easily mistake the Patagonian Weasel for the young of it in the southern parts of that country.

An interesting parallel is traceable between *Lyncodon* and *Grison* in South America, on the one hand, and *Pœcilogale* and *Ictonyx* in Africa, on the other. In both cases, we have a large musteline which is known to have offensive stink-glands, and a smaller one in which this attribute has not yet been recorded. There are reasons for thinking that in both the larger species the coloration, though widely different, is aposematic; and the smaller form in each case resembles the coloration of its compatriot. The smaller forms also appear to be much scarcer than the larger, a fact which is in favour of their coloration being mimetic.

Singularly enough, too, *Lyncodon* and *Pœcilogale* resemble each other and differ from typical mustelines, including their hypothetical models, in the reduction of the number of cheek-teeth to three on each side in both the upper and the lower jaws, the total number of teeth being 28. In both *Ictonyx* and *Grison*, on the contrary, there are four cheek-teeth in the upper jaw and five in the lower, making a total of 34.

* Matschie, SB. Ges. nat. Fr. Berlin, 1895, p. 190.

Allied to the Grison is another South American musteline, the Tayra (*Galera barbara*). It is a larger animal than the Grison and approaches an otter in size. I cannot find in literature any convincing evidence that this animal stinks to the same nauseating extent as the Grison; but considering the close relationship between the two species, which until lately were referred to the same genus, this must be regarded as probable. Hamilton Smith, however, remarks that it "has a strong musky smell"*. One that lived a few years ago in the Zoological Gardens was extraordinarily tame, and Dixon, the keeper in charge of it, tells me that it never smelt like the Grisons or Ratels, but only "like a Badger." This negative evidence as to its potential offensiveness

Text-fig. 197.

Bush-Dog (*Speothos venaticus*), upper figure, and Tayra (*Galera barbara*), lower figure.

must not, however, be overvalued; for, as has been explained, two tame specimens of the African Ratel that have recently lived in the Gardens were never known to make use of their stink-glands. The same is true of some Canadian Skunks (*Mephitis mephitica*) we now possess, although their glands are entire; and it is well known that Cape Polecats (*Ictonyx capensis*) can be tamed and kept in houses as pets for destroying rats.

The colour of the Tayra varies, some specimens, perhaps always

* Jardine's Nat. Library, xv. Mammalia, p. 202, 1868.

young ones, being white, and others black. As a rule, however, they are dark brown or blackish with the head and neck grey, and there seems to be nearly always a conspicuous large yellow patch upon the chest. They eat a variety of food, and one that lived some years in the Zoological Gardens was fed upon dates, bananas, figs, and a little cooked meat. That the Tayra has in a wild state the same savage disposition when attacking or attacked as other mustelines, hardly admits of a doubt; but very little appears to have been recorded of its habits.

Some years ago Mr. O. Thomas pointed out to me the obvious resemblance between *Galera barbara* and the South-American Bush-dog, *Speothos venaticus*; and it occurred to me that it might be mimetic. But I do not at present know enough of the bionomics of the two species, to feel justified in doing more than put forward this view as a theory for future confirmation or refutation. In its favour it may be urged that there are no reasons for supposing that the dog is protected in any way from larger carnivora, and it is apparently much rarer than *Galera*.

A well-known European carnivore with much the same style of body-coloration as the Grison is the Badger (*Meles meles*), which is hoary grey above and black below and on the legs. The coloration of the head, however, is very different from that of the Ratel, Grison, or Tayra, for it is white with a broad black band extending on each side from the muzzle across the eye to the ear, which is itself white-rimmed; and the chin and throat are black.

Badgers are slow and leisurely in their movements, and have earned a reputation for stupidity by the fearlessness and indifference of their manner towards things in general. Their diet is mixed, but they subsist to a very great extent upon vegetable food. In no sense are they dependent for a livelihood, so far as is known, upon the capture of wary mammals or birds. When attacked, they are notoriously most savage and formidable antagonists, being gifted with exceptionally strong jaws, a thick, highly flexible and loose skin, and wonderful tenacity of life. They also possess stink-glands which exude a powerful and unpleasant odour. The scent of the secretion has given rise to the epithet 'stinking brock,' and forms the basis of the well-known simile 'smells like a badger.'

At dusk, when badgers emerge to feed, they are rendered conspicuous by the whiteness of the head; and looking into our badger's cage in the Gardens in the evening, I have often been struck by the ease with which the whereabouts of the animal could be detected, especially when on the move, by the whiteness of this region.

Other species of *Meles* and the Indian Sand-Badger (*Arctonyx collaris*) seem to agree with the European Badger in all respects essential to the present argument in the matter of coloration and mode of life; and the same I suspect is true of the American form, *Taxidea americana*.

A very unusual style of coloration is also presented by the

Sarmatian, mottled or marbled Polecat (*Putorius sarmaticus*). The whole of the upper side of the body is brown variegated with yellowish-white spots and patches, which on the sides of the neck, belly and thighs tend to run into longitudinal stripes, offering a sharp contrast with the jet-black hue of the throat, legs, and the rest of the under side. The tail is long, bushy, and largely white. The head is mostly black, but the lips and chin are white; a broad white band crosses from beneath the ears over the forehead, and the distal half of the ears is white. Blanford remarks of this species, which is found in Eastern Europe and Western Asia, that it has "the same disagreeable fœtid odour that

Text-fig. 198.

English Badger (*Meles meles*).

is characteristic of the common [European] Polecat, . . . . which is particularly distinguished amongst the weasel tribe for the evil odour generated by the secretion of its anal glands, whence its name of foumart or foul martin."* He also says that it feeds on birds, rats, mice, lizards, beetles, and snails. The coloration of this animal is so different from that of the ordinary weasels, and conforms in a general way so closely with that of some other fetid members of that tribe, the pattern of the head being especially like that of the Libyan Zorilla (*Ictonyx libycus*), that I cannot help thinking it has a warning significance. Very little, however, seems to be known of this species in its native haunts,

* Fauna of Brit. India, Mammalia, pp. 163 & 165, 1888.

the information quoted above from Blanford having been taken from Hutton's account based upon observations of living examples in captivity.

Reference was made above to a black form of Ratel. This occurs in the Ituri Forest and was described by Mr. Lydekker as *Mellivora cottoni* *. This species, or race, has a special interest in connection with the views advocated in this essay, from its bearing upon the theory I have already published †, that where concealment is unneeded animals tend to assume a uniformly dark coloration unrelieved by spots or stripes. As illustrations of this were cited elephants, rhinoceroses, hippopotamuses‡, buffalos, bisons, many bears, moles, ravens, rooks, and others, which, either by their strength and size, their gregarious habits or mode of life, are protected from carnivorous enemies and have no need of procryptic coloration to help them in the capture of prey.

In their habits, many Bears are very similar to badgers and ratels. They are slow and leisurely and bold in their movements, and feed chiefly upon roots, fruits, honey, and other vegetable products, although they will kill and eat living prey. They are not, however, dependent upon it §, as are the Cats, to which they offer the greatest possible contrast both in coloration and mode of life. They have no stink-glands like the Mustelidæ described above, but are well known to be terrible antagonists when fighting. Major Rodon, F.Z.S., has told me that the Himalayan Black Bear (*Ursus torquatus*) is more than a match for leopards, and that he has known one drive a leopard from its kill. Now this species of Bear has a very distinct, somewhat V-shaped white or yellow patch across the chest, which is displayed to full view when the animal stands erect. The Malayan Bear (*Ursus malayanus*) has a similar, usually yellowish, horseshoe-shaped mark; and the Sloth Bear (*Melursus ursinus*) carries the same badge. It is significant that this white mark is shown to an antagonist when the bear assumes its attitude of defence, and it reminds one forcibly of the patch described above possessed by the Tayra (*Galera barbara*); and I venture to suggest that, as in that animal, it acts as a recognition mark and danger signal.

Since the preceding pages were written, I have had the opportunity of discussing with Mr. Abbott H. Thayer the theory of warning coloration in general and its application to Mammalia in particular. Mr. Thayer has already published ‖ his disbelief

* P. Z. S. 1906, p. 112.

† Pall Mall Magazine, Feb. 1904, pp. 179–180.

‡ It is interesting to record that three young hippopotamuses, one from Nigeria and two from German East Africa, when brought to the Gardens, were pink below and protectively countershaded on Thayer's principle. They were believed to be about two years old at the time. During the two subsequent years, as they grew in size and capability, the under side gradually became pigmented.

§ With exception of the Polar Bears, all the bears in our Gardens thrive on a diet of ship's biscuits and upon the bread and buns given to them by visitors.

‖ Trans. Ent. Soc. London, 1903, p. 556.

in warning coloration and his belief that the patterns of nauseous species, to the conspicuousness of which in their natural surroundings several observers have testified, are procryptic. Prof. Poulton has briefly replied to this view so far as butterflies are concerned *. I will here endeavour to do the same as regards the Mammalia.

As stated in a demonstration given at the Gardens and subsequently in conversation with me, Mr. Thayer holds that the white markings of the Skunk, Badger, Ratel, Teledu, and Grison serve to conceal these animals from the ground-prey upon which they feed. The head of a Badger or Ratel, for instance, would lose its shape when looked at from below, because the white tracts would be cut out against the sky; and this obliteration of identity would be beneficial to the carnivore by enabling him to capture field-mice and other ground-living species. Justification for this hypothesis is found in the demonstrable fact that white spots and patches appear as sky-holes, especially in foliage, when viewed from a lower level; and it may be granted that the markings on the mustelines mentioned above may have the significance claimed for them by Mr. Thayer when they are visible from beneath. But I cannot bring myself to believe that his explanation supplies the key to the guiding factor in their evolution. Take, for example, the Teledu, the food of which is said to consist of insects, larvæ, and worms. It cannot be seriously claimed that the Teledu is helped in getting food of this nature by the whiteness of the top of the head and neck, because worms are blind, whilst nocturnal ground-insects at best have feeble powers of vision. Even if the Teledu feeds also upon mice and other vertebrates with vision something like our own, which must be admitted as a possibility, it is not very obvious how the narrow median white spinal stripe can be of any procryptic use in the way claimed. It would for the most part be invisible to the little animals. It would on the contrary be in full view to an enemy of larger dimensions than the Teledu, especially to one lurking in a tree and looking down upon the musteline passing beneath. So, too, with the Badger. This animal, as has been stated, lives for the most part upon vegetable food, and it is difficult to believe that the catching of mice can have had a survival value in the history of any individuals of sufficient importance to the species to guide the evolution of its facial coloration. On the other hand, it is a demonstrable fact that Badgers grubbing or trotting slowly about in the dusk, as is their wont, are quite conspicuous to human eyes at a distance that could be covered by a wolf's or lynx's spring, simply in virtue of the black and white bandings on the head. It is quite easy to believe, however, that this same pattern must be procryptic against a suitable background of white rocks with black interstices or of foliage with light shafts breaking through, especially if the animal be still; and it is quite

* 'Essays in Evolution,' 1908, p. 321.

evident that the two explanations are not mutually destructive; but if we have to make a choice between the two, that is to say, between the theory that the coloration of the mustelines mentioned in this paper is aposematic or that it is procryptic, I think the balance of evidence is in favour of the former. We have no experimental proof of either so far as these particular species are concerned. We do not know that any Badgers, or Ratels, or Teledus have escaped destruction by their peculiar coloration; but we are justified in inferring its usefulness to the survival of the species if it has had that effect. So, too, we do not know that any Badgers or Ratels or Teledus have succeeded in capturing living prey in virtue of their peculiar coloration; but if they have done so we are justified in inferring the comparative uselessness of the occurrences to the survival of the species, because these mustelines feed mostly upon food which is insensible to the patterns in question. The fearlessness, fierceness and tenacity of life of these carnivora must also be reckoned with in this connection.

The theory of warning coloration is intimately connected with that of warning sounds. And it is a fact that many poisonous animals like snakes, scorpions, and very large spiders stridulate or rattle, or produce other sounds, when on the defensive or when frightened. It is believed that they advertise themselves by this means and warn their enemies to let them alone. If this be so, and no other explanation has been offered of the fact, we are justified in inferring that advertisement that appeals to the ear is useful to these specially protected species. The bearing of this argument on the likelihood of the occurrence of advertisement that appeals to the eye, is quite obvious.

I will only mention one more fact completely in accord with the aposematic as opposed to the procryptic significance of the coloration of the mammals discussed in this paper. A frightened Skunk or Zorilla with long black and white hairs on end presents exactly the same style of coloration as a common terrestrial Porcupine with black and white quills erected. No one can maintain that the coloration of Porcupines is procryptic for the purpose of capturing prey, because they do not feed upon living animals. And no one who has seen them in the dusk, can dispute that the whiteness of the quills makes them conspicuous. In addition to this they rattle and grunt and stamp, and appear to advertise themselves in all ways at their disposal, and are extremely unpleasant animals to deal with. There seems to me to be no escape from the conclusion that their coloration is aposematic. If so, that of Skunks and Zorillas, with the same style of coloration, and equal though different unpleasantness, is also probably aposematic; and from Skunks and Zorillas we pass to Badgers, Teledus, Ratels, and Grisons, all of which are more or less patterned with white and all gifted with an unpleasant odour.

# 6. On a new River-Crab of the Genus *Gecarcinucus* from New Guinea. By W. T. Calman, D.Sc., F.Z.S., British Museum (Natural History).

[Received November 8, 1908.]

(Plate LXVIII.*)

The genus *Gecarcinucus* was established in 1844 by H. Milne-Edwards † for a species, *G. jacquemontii*, which occurs in various localities in the neighbourhood of Bombay. Milne-Edwards referred the genus to the family Gecarcinidæ, and in this he was followed by Dana ‡, Wood-Mason §, and Ortmann ||. Alcock ¶, however, has pointed out that, in spite of its great resemblance to the Land-Crabs, the proper place of the genus is with the River-Crabs (Potamonidæ) and it is included by Miss Rathbun ** in her monograph of the latter family.

Sir William Ingram, B.A., F.Z.S., has recently presented to the Natural History Museum several specimens of a new Crab from New Guinea which I refer to the same genus and in which the Gecarcinoid facies is even more strongly marked than in the Indian species.

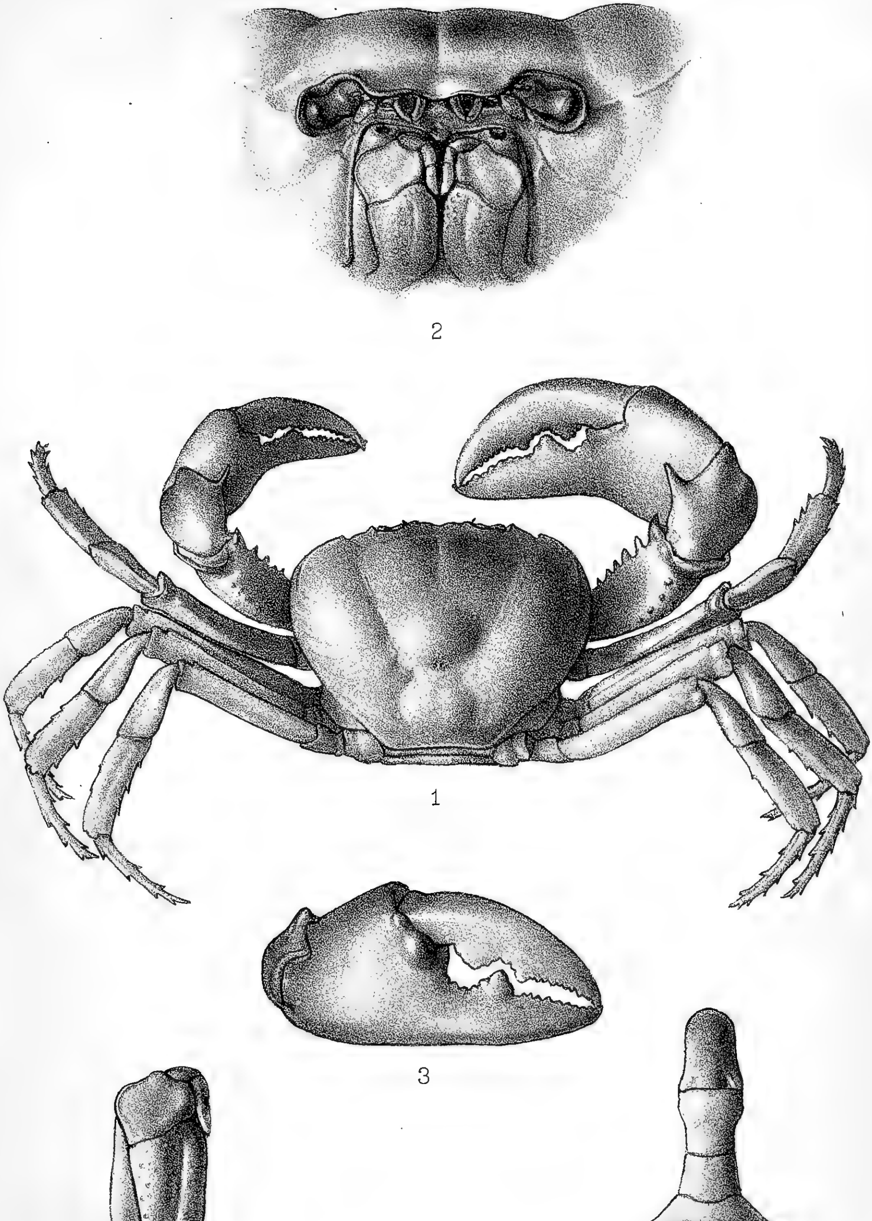
Gecarcinucus ingrami, sp. n.

Carapace about three-fourths as long as broad, very deep, very convex antero-posteriorly, less so from side to side. Cervical groove strongly marked, its lateral limbs nearly longitudinal, becoming obscure just before reaching the antero-lateral margin. Cardiac region partly defined posteriorly. A transverse groove behind each branchial region. Mesogastric groove short, deep, not forked. Branchial regions strongly convex, the gastric and cardiac less so. Epigastric lobes prominent and rounded, separated from front by a transverse groove which runs behind the orbits; surface smooth, very faintly rugose near lateral margins.

Front generally a little less than one-fourth of width of carapace, nearly vertically deflexed, its margin smooth. Seen from above its outline is concave; from in front, its lower edge is slightly convex and its lateral margins convergent; in the middle it is strongly bent inwards, touching the epistome between the antennular fossæ. Orbits not entirely raised above lateral margin of carapace, roughly quadrilateral, wider than high. Seen from in front, they are inclined downwards and outwards, but are not produced at the outer corner into a gutter-like sinus as in *G. jacquemontii*.

Outer orbital angle hardly dentiform as seen from above; a

* For explanation of the Plate see p. 963.
† Voyage dans l'Inde, par V. Jacquemont, Zool. Crustacés, p. 4, pl. i., 1844.
‡ U.S. Expl. Exp., Crust. i. p. 375, 1852.
§ Jour. Asiat. Soc. Bengal, xl. pt. 2, p. 190, 1871.
|| Zool. Jahrb., Abth. Syst. vii. p. 732, 1894; Bronn's Thierreich, Crust. p. 1178, 1899.
¶ Jour. Asiat. Soc. Bengal, lxix. pt. 2, p. 279, 1900.
** Nouv. Arch. Mus. Paris, (4) viii. p. 66, 1906.




G. M. Woodward del. et lith.

West, Newman imp.

GECARCINUCUS INGRAMI.

slight ridge runs backwards from it along the antero-lateral margin, interrupted by the cervical groove and then forming a small epibranchial tooth; almost immediately behind this the ridge runs on to the dorsal surface of the branchial region and dies away at about the anterior third of the length of the carapace.

The lower margin of the orbit is concave as seen from below; it has no tooth at its inner angle, which is indistinctly separated from the inner suborbital lobe. On the lower surface of the carapace the pterygostomial groove is well-marked and a faint continuation of the cervical groove separates the sub-hepatic and sub-branchial regions.

The epistome has the middle lobe more rounded than in *G. jacquemontii* and the lateral portions less concave but more prominent anteriorly. The lobe of the first maxillipeds forming the floor of the branchial channel is considerably more exposed than in that species. The third maxillipeds have the ischium strongly grooved along its whole length, the merus broader than long, its anterior edge oblique and slightly concave; the exopodite extends a little way beyond the ischium.

Chelipeds very unequal, the larger one very massive in the male. Merus long, nearly the whole of it visible from above beyond the carapace, each of its three edges carrying a row of sharp spiniform teeth. Carpus with a strong spiniform tooth on the inner side, behind which the inner edge has, at most, one or two minute granules; the lower double tooth, present in *G. jacquemontii*, is here wanting. Chelæ smooth, with some faint rugosities on the outer surface; the upper and lower margins are rounded and there is a single blunt tooth at the proximal end of the lower edge. The palm of the larger chela is but little longer than high; between the bases of the fingers on the outer side is a large rounded or subconical tubercle. The fingers are strongly compressed and deep, equal to or shorter than the palm; there is one large serrated tooth on the immovable finger and two, smaller, on the dactylus. The palm of the smaller chela is much longer than high, the tubercle on the outer side is small, the fingers are more slender and their teeth are less prominent.

The walking-legs are very long and slender, the second pair the longest. The merus has a small subterminal tooth above; the propodus has a few spines on its lower, and some, more minute, on its upper edge; the dactylus has four rows of spines.

The abdomen of the male differs greatly from that of *G. jacquemontii*; it is strongly constricted a little way from the base, the narrowest part being at the junction of the fifth and sixth somites; the sixth somite is widened distally and the telson is linguiform. The anterior part of the thoracic sternal surface of the male is not setose as it is in *G. jacquemontii*.

*Locality.* "Madeu, St. Joseph River, British New Guinea, 2000–3000 feet, W. Stalker coll." Mr. Stalker informs me that the species probably burrows in swampy ground, although he did not actually see specimens taken from the burrows.

*Measurements* in millimetres:—

| | ♂. | ♂. | ♀. | ♀. |
|---|---|---|---|---|
| Length of carapace | 29 | 26 | 29 | 28 |
| Breadth of carapace | 39 | 34 | 37 | 35 |
| do. front | 9 | 8 | 8·5 | 9 |
| do. fronto-orbital margin | 18·5 | 18 | 18 | 19 |
| Length of larger cheliped | 76 | 60 | 63 | ... |
| do. second walking-leg | 79 | ... | ... | 72 |
| do. third walking-leg | 75 | 63 | ... | 68 |

For comparison I give the corresponding measurements of three specimens of *G. jacquemontii* * in the Natural History Museum:—

| | ♂. | ♂. | ♀. |
|---|---|---|---|
| Length of carapace | 33 | 30 | 31 |
| Breadth of carapace | 48 | 44 | 45 |
| do. front | 8·5 | 8 | 8 |
| do. fronto-orbital margin | 21 | 19 | 21 |
| Length of larger cheliped | 74 | 68 | 68 |
| do. second walking-leg | 68 | 63 | 67 |
| do. third walking-leg | 64 | 58 | 61 |

*Remarks.*—*G. ingrami* agrees with *G. jacquemontii* in the strongly inflated branchial regions and in the form of the efferent branchial orifices. The latter are bounded above by a prominent lip formed by the everted edge of the epistome and below by the enlarged terminal lobe of the first maxillipeds, which is left largely exposed when the third maxillipeds are closed. Whether these characters are adequate to justify the alliance in one genus of two species so widely separated geographically may perhaps be disputed when the systematic arrangement of the Potamonidæ comes to be more closely examined than it has hitherto been. For the present, the genus appears to be as well defined as are most of those forming the family. It seems to me doubtful, however, whether the subfamily Gecarcinucinæ, formed for its reception by Miss Rathbun, can be sustained. The proportionate width of the front, selected by that author as the most important distinction in her key to the subfamilies and genera (Nouv. Arch. Mus. Paris, (4) vi. p. 247), does not hold good, as the measurements given above show, even for *G. jacquemontii*, and it is still less distinctive in the new species. On the other hand, it seems probable that there are still to be discovered among the Potamonidæ characters more trustworthy as indications of affinity than those hitherto employed. For example, the remarkable form of the mandibular palp, as figured by Milne-Edwards for *G. jacquemontii*, recurs not only in the species here described

* These specimens, presented by Mr. R. C. Wroughton, are from Kaman River, Bombay. As the measurements show, they are smaller than the type-specimens of Milne-Edwards redescribed by Miss Rathbun, and have the carapace relatively narrower, but in other respects they agree so closely with Milne-Edwards's figures as to leave no doubt that they belong to the same species.

but also in several other Oriental Potamonidæ—I find it in *Potamon* (*Potamonautes*) *cunicularis* and in *P.* (*Parathelphusa*) *tridentatum*, but not in African species referred to these two subgenera,—and the clue thus afforded might, if followed up, lead to results important for the classification of the family.

EXPLANATION OF PLATE LXVIII.

Fig. 1. *Gecarcinucus ingrami*, male, from above, natural size.
2. " " " anterior part of body, seen from in front.
3. " " " larger chela, from the outer side.
4. " " " third maxilliped.
5. " " " abdomen.

## 7. The Duke of Bedford's Zoological Exploration in Eastern Asia.—XI. On Mammals from the Provinces of Shan-si and Shen-si, Northern China. By Oldfield Thomas, F.R.S., F.Z.S.*

[Received December 15, 1908.]

The collection dealt with in the present paper is a continuation of that described in the last part (*suprà*, p. 635), which contained a certain number of Shan-si Mammals, collected up to February 1908. After despatching that series Mr. Anderson, now accompanied by Mr. A. de C. Sowerby, an English resident in Shan-si, commenced work again immediately after starting from Tai-Yuen-Fu, whence he moved westwards and southwards, across the Hoang-ho, down to Yen-an-fu, in Shen-si. He then turned northwards again, crossed the Great Wall at the south-eastern corner of the Ordos Desert, which I had asked him to visit, and from there worked back again to the centre of Shan-si, where, except for the interesting topotypical series of *Eutamias asiaticus senescens*, picked up on the way to Peking, the collecting of this set came to an end.

The collection as a whole is of extreme interest and value as being the first we have received from the far eastern edge of the inland desert area of Central Asia. It therefore gives us the exact Eastern limit on this latitude of certain of the Central Asian desert forms, such as *Meriones*, *Dipus*, and *Ochotona*, while in other cases it shows the effect that this raised desert area has on such forms as have penetrated to it from the lower country still further east to the coast. This effect is mainly in a general paling of colour, without alteration in structure, only one species †,

* [The complete account of the new species described in this communication appears here; but the names and preliminary diagnoses of those underlined were published in the 'Abstract,' No. 63 (Dec. 15, 1908).—Editor.]
† The Hedgehog.

in the sense that I use that term, representing here a different one from further east, all the others being what I should term locally modified subspecies.

Besides these modified subspecies of the coast forms, there are of course several interesting new species in the collection, notably the beautiful little desert Hamster which I have named after the Duchess of Bedford, and the curious Vole *Microtus inez*. In all twelve new forms are described in the present paper (see footnote p. 963).

So far Mr. Anderson has made magnificent use of the Duke of Bedford's generosity, the amount and completeness of his collections already almost equalling those made during the Rudd exploration of S. Africa, and the results obtained being equally epoch-making both for our knowledge of Eastern Asian Mammalia, and for the improvement of our National Museum. Japan, from Saghalien to Yaku-shima, Tsu-shima, Korea, and Quelpart, and the chief areas of North-eastern China, have now all been visited in turn, and such collections made as to multiply a hundredfold our knowledge of the mammals of the region and to form a really sound basis for further work on the subject.

No such complete and systematic survey has ever been made in Eastern Asia before, and for this fine service to Science zoologists have to thank the generosity of our President.

Mr. Anderson gives me the following note on the characteristics of Shan-si and Shen-si, the two provinces dealt with in the present paper:—

"The provinces of Shan-si and Shen-si are quite different in character. The former may be briefly described as a mountainous country with occasional large upland plains. Some peaks in Shan-si rise above 10,000 ft., and are massive rocky mountains with only a comparatively thin coating of loess soil. Where the loess figures mostly is in the plains, of which that of Tai-Yuen-Fu, that of Ta-Tung-fu, and that of Hsiu-clou are the best examples. The streams of Shan-si flow only in the rainy season, with the exception of the larger rivers. Northern Shen-si, on the other hand, is a region of loess hills of almost uniform height; the skyline of Shen-si, seen from the mountains of its eastern neighbour, is a straight line declining very gradually as it passes from north to south. The portion of Shen-si visited appears indeed like an extension of the plateau of which Ordos is part, only this extension has been cut into by a great many perennial streams, a process which is now taking place in southern Ordos."

1. MYOTIS sp.

♂. 1875. Pao-teh-chow, Shan-si. 3500′.

A very old specimen with worn teeth. Related to *M. mystacinus*.

"Bats were very rare throughout the area visited, this being the only one seen."—*M. P. A.*

2. ERINACEUS MIODON.

Thos. Abstr. P. Z. S. 1908, p. 44 (Dec. 15).

♂. 1846, 1853, 1855, 1856, 1857, 1862, 1869, 1871, 1873. Yu-lin-fu, Shen-si. 4000′.

A pale-brown species allied to *E. dealbatus* Swinhoe; no wholly white spines intermixed with the brown-ringed ones. $P^3$ much smaller than in *E. dealbatus*.

Size about as in *E. dealbatus*. Spines of back about 22–24 mm. in length, white for two-thirds their length, then broadly ringed with blackish brown, the ring about 4 mm. in breadth, the terminal 3–4 mm. white (or the very extreme point darker again, but not enough to affect the general tone). No wholly white spines present. The resulting general colour * of the whole animal is near "drab." Ears well haired. Head, sides, limbs, and tail varying from dull whitish, or brownish white, to distinctly brown ("broccoli-brown"), the colour of the hairy part being evidently a character of little value. Belly always lighter, sometimes quite white.

Skull of about the same general proportions as in *E. dealbatus*. Zygomata rather more abruptly expanded anteriorly. Premaxillæ extending backwards in a narrow point, which in most cases reaches a forwardly projecting point of the frontals, thus completely cutting off the maxillæ from the nasals; in two cases, however, the premaxillary and frontal points do not reach each other, so that there is a short naso-maxillary suture, and it is evident that the details of these sutures should only be used with very great caution as distinguishing characters. In the four specimens that I refer to *E. dealbatus* there is a long naso-maxillary suture.

Teeth at once distinguishable from those of *E. dealbatus* by the conspicuously smaller size of $p^3$, and in a lesser degree of $p_3$ and the upper and lower canines. $P^3$ forms a nearly equal-sided triangle, its greatest diameter rarely exceeding 2 mm., while in *E. dealbatus* it is much broader than long, its transverse diameter being 3·4 mm. (in the type) and upwards.

Dimensions of the type, measured in the flesh:—

Head and body 215 mm.; tail 42; hind foot 40 (range from 35); ear 34·5.

Skull—condylo-basal length 53 mm.; greatest breadth 36; nasals 14·5 (diagonally) × 3; interorbital breadth 18; palatal length 29; front of $i^1$ to back of $m^3$ 27.

*Hab.* as above.

*Type.* Adult male. B.M. No. 9.1.1.9. Original number 1871. Collected 11 May, 1908.

This Hedghog looks externally very like Swinhoe's *E. dealbatus*,

* Even so speckled an animal as a Hedghog, when seen far off, may be said to have a "general colour" resulting from the intermingling of all the colours on the surface, and it is in this sense that I always use the term when describing mammals. Some writers speak of "general colour" for what I should term "ground-colour," a very different thing.

but is readily distinguishable by the much smaller size of $p^3$. In this respect Swinhoe's Chefoo example, and the two obtained in the same place by Mr. Anderson, closely agree with the type of *E. dealbatus*; and so far as our material goes I should not consider Prof. Matschie's *E. tschifuensis* distinct from Swinhoe's species, especially as the present series shows how variable the characters of the nasal sutures may be. The Chefoo specimens have from 10 to 20 per cent. of their spines wholly white, such spines being in *E. miodon* conspicuous by their absence.

Dr. Satunin * has described two Hedghogs from Chingan and Ussuri respectively, but both have many white spines mixed with the dark ones. He makes no reference to the earlier described and evidently closely related *E. orientalis* Allen †, from Vladivostok, the describer of which in turn ignores *E. dealbatus* Swinhoe.

"There appear to be large areas in North China where the Hedghog is not found at all, and some places, of which the neighbourhood of Yu-lin-fu is one, where they are remarkably common. At the time we were at Yu-lin (April to May) the neighbouring desert was alive with several species of beetle upon which the Hedghog fed.

"The Hedghog seemed to be unknown in the vicinity of Pau-teh-chow, Shan-si, but at Ning-wu-fu we heard reports of them, though we saw none ourselves.

"Chinese name, 'Tsi-wei' ‡ (*tsi-* a thorn or spine)."—*M. P. A.*

The British Museum also contains another Hedghog from Shen-si Province, collected by Father Hugh, and this again seems distinct from any hitherto described. It may be called

ERINACEUS HUGHI.

Thos. Abstr. P. Z. S. 1908, p. 44 (Dec. 15).

A very dark-coloured, finely speckled species, quite unlike any of the other Chinese Hedghogs. Spines light basally as in *E. miodon*, but the dark ring is much broader, and is followed by quite a narrow light ring, only about 0·5 to 0·8 mm. in length, the point for about the same length being again dark. As a result the whole animal is very dark with a fine whitish ticking, and has quite a different appearance to the broadly washed whitish of the other species. Head, limbs, and belly brown.

Hind foot of type 38 mm.

*Hab.* Paochi, Shen-si.

*Type.* Adult female. B.M. No. 0.6.27.2. Presented and collected by Father Hugh.

The only species which this Hedghog might have been referred to is *E. hanensis* Matsch., but I owe to the courtesy of Prof. Matschie some spines from the type of that animal, and these show quite a marked difference in the general coloration,

* Ann. Mus. Pétersb. xi. pp. 170–173, 1907.
† Bull. Amer. Mus. xix. p. 179, 1903.
‡ For the Chinese names given in this paper we are indebted to Mr. A. de C. Sowerby.

the bases of the spines being dark where they are white in *E. hughi*, while the terminal 3 mm. of the spines are light horn-colour without a dark tip. The coat is also liberally mixed with wholly white spines, which are practically absent in *E. hughi*.

3. Felis catus L. (*domestica* auct.*).

1866 (skin without skull). Ordos near Yu-lin-fu, Shen-si.

A remarkably fine long-haired Cat, with a considerable resemblance to a European Wild Cat. These cats are said to be common in Northern China.

4. Canis lupus tschiliensis Matsch.

♂. 1699. Yen-an-fu, Shen-si. 3000′.

This Wolf would appear to represent Prof. Matschie's *Lupus tschiliensis*.

"Uncommon. Much feared by the Chinese goat and sheep herders.

"Chinese name, 'Lang'."—*M. P. A.*

5. Vulpes vulpes subsp.

♀. 1666. 30 miles W. of Fen-chou-fu, Shan-si. 4500′.

"Common. Much hunted by the Chinese for the sake of its skin.

"Chinese name, 'Hu-li' or 'Hu-tzi'."—*M. P. A.*

6. Martes flavigula borealis Radde.

♂. 1704, ♀. 1703 (native skins without skulls). ♂. 1727 (skull only). Yen-an-fu, Shen-si. 3000′.

The fine skull no. 1727 agrees closely in dimensions with Radde's specimens, and is very considerably larger than an old male skull of *M. f. kuatunensis* Bonh.

"Rather common, its tracks often seen.

"Chinese name, 'Hwang-yao'."—*M. P. A.*

7. Meles leptorhynchus M.-Edw.

♀. 1870. Yu-lin-fu, Shen-si. 4000′.

Although Yu-lin-fu is in the direction of the region where Prof. Matschie's *Meles hanensis* and *siningensis* were procured, I fail to see any reason why this Badger should not be referred to Milne-Edwards's species, which was described from Peking.

"While difficult to capture the Badger is not a particularly uncommon animal, as I have seen its tracks numbers of times both in Shan-si and Shen-si.

"Chinese name, 'Huan-tzi'."—*M. P. A.*

8. Sciurotamias davidianus M.-Edw.

♂. 1654. ♀. 1655, 1656. 15 miles N.W. of Fen-chou-fu, Shan-si.

* *Cf.* Pocock, P. Z. S. 1907, p. 149.

♂. 1720, 1824. ♀. 1716, 1722. Near Yen-an-fu, Shen-si. 3800′.

♀. 1981. 20 miles S.W. of Ning-wu-fu, Shan-si, 6600′.

"So far always found living among the rocky precipitous sides of canyons where bushes are plentiful and some trees exist. Nowhere common. One of their foods is the kernel of the wild peach.

"This squirrel has cheek-pouches like those of Chipmunks."—*M. P. A.*

9. Eutamias asiaticus senescens Mill.

♂. 2004, 2005, 2006, 2007. ♀. 2008. Mon-tou-ko, 15 miles W. of Peking. 500′. *Topotypes.*

This interesting series of topotypes, which Mr. Anderson obtained at my special request, and those next following, form a most valuable addition to our collection of Asiatic Chipmunks and have enabled me to gather a general idea of their local characteristics.

In the first place, it appears evident that none of the forms other than the original *E. asiaticus* can be properly called species, as all grade into one another, each series varying to a certain extent, and overlapping the members of the next. All seem to be in fact members of one widely distributed species, modified by local conditions, and one sees no sign of what is often found in North America, where representatives of quite distinct species may be found taking each other's place in neighbouring localities. Of course in N. America a much greater richness in different types is present to be drawn upon, while here all are modifications of *E. asiaticus*.

These main modifications appear to be four in number, so far as we yet know:—(1) The sharply defined black and white five-lined *asiaticus* of Russia and Siberia; (2) a more rufous form inhabiting Saghalien, Hokkaido, the Amur region and Korea, to which the names of *uthensis*, *lineatus*, and *orientalis* are assignable; (3) the grey-mantled *senescens* of the Peking region, which passes through an intermediate link into (4) the desert form, found on the western edge of Shan-si and in northern Shen-si where it borders on the Ordos Desert.

10. Eutamias asiaticus ordinalis.

Thos. Abstr. P. Z. S. 1908, p. 44 (Dec. 15).

♂. 1798, 1799, 1803, 1830, 1867, 1872. ♀. 1804, 1874. Yu-lin-fu, Shan-si. 4000′.

♂. 1888, 1941. ♀. 1887. Mts. 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

A pallid, semi-desert race allied to *E. a. senescens.*

Colour much paler throughout than in *senescens*. Crown paler and more approaching pinkish buff; shoulders and nape with almost no grey in them, scarcely more grey-grizzled than the cream-buff cheeks and sides; rump more or less ochraceous-buff, markedly brighter than in *senescens*, where it is "raw umber"; dark dorsal stripes lightened in intensity by their hairs being largely tipped with ochraceous; their porportionate lengths as in *senescens*.

Dimensions of the type, measured in the flesh:—

Head and body 139 mm.; tail 125; hind foot 39; ear 19·5.

Skull—greatest length 41 mm.

*Hab.* of type. Yu-lin-fu, Shen-si. 4000′.

*Type.* Adult female. B.M. No. 9.1.1.36. Original number 1804. Collected 1 May, 1908.

"Live in low bushes, not climbing trees.

"Not until the latter part of April, about the time we reached Yu-lin-fu, did the weather become warm enough to attract the Chipmunks from their holes. They frequent the sides of the loess gullies mostly, and are usually fairly common where found at all. Besides the places where specimens were collected, two were seen at Pao-teh-chow, and, I believe, from the people's accounts, that they occur at Yen-an-fu. Mr. Sowerby states that Chipmunks are common near Tai-Yuen-Fu.

"A large proportion of Chipmunks, wherever we found them, had their tails broken short."—*M. P. A.*

It is only in accord with the usual order of things that the Chipmunks of the country edging the Ordos Desert should reflect their surroundings by being markedly paler than their allies near Peking. So great is the difference indeed that an intermediate link in the series might suitably have a special subspecific name, as follows:—

11. Eutamias asiaticus intercessor.

Thos. Abstr. P. Z. S. 1908, p. 44 (Dec. 15).

♀. 1971, 1972, 1998, 2002. Ning-wu-fu, Shan-si. 6000.

♂. 1984, 1987, 1992, 1993. ♀. 1982, 1985, 1986, 1989, 1990, 1991. 20 miles S.W. of Ning-wu-fu. 6000′.

Intermediate in intensity of colour between the dark grey-mantled *senescens* and the pallid *ordinalis*. Ground-colour of shoulders light greyish, more grizzled than in *ordinalis*, less than in *senescens*; cheeks and sides buffy. Rump darker in tone than in *ordinalis*, but in this respect nearer that form than *senescens*, the general colour near clay-colour. Proportions and intensity of dorsal stripes about as in *senescens*, though the dark ones are rather more numerously grizzled with ochraceous.

Dimensions of the type, measured in the flesh:—

Head and body 145 mm.; tail 133; hind foot 30; ear 19.

Skull—greatest length 42 mm.

*Hab.* of type. Ning-wu-fu, Shen-si. 6000′.

*Type.* Adult female. B.M. No. 9.1.1.42. Original number 1972. Collected 14 June, 1908.

With 7 authentic examples of *senescens* before me, with 14 of this intermediate form, and 11 of the desert *ordinalis*, I have felt justified in indicating their respective degrees of differences by subspecific names. All are of course members of the widely spread species *E. asiaticus*, with the eastern *uthensis* type of which the Imperial Tombs specimens mentioned in a previous paper tend to connect the true *senescens*.

The country in which this Chipmunk is found is mountainous and broken, while *E. a. ordinalis* inhabits the flat region bordering the sandy Ordos.

12. Citellus mongolicus M.-Edw.

♂. 1731. Ching-pien, N.W. Shen-si. 5100′.

♂. 1738. ♀. 1734, 1746. Ordos Desert, N.W. of Ching-pien. 4900′.

♂. 1747, 1851, 1863, 1864, 1868. ♀. 1748, 1858, 1865. Yu-lin-fu, Shen-si. 4000′.

These specimens agree closely in their general sandy coloration with Milne-Edwards's figure of *mongolicus*, and with the example obtained by Swinhoe near Suen-hwa-fu in 1863,* which may be accepted as a topotype, for David collected a number of his "Mongolian" specimens at this latter place, which is below, not on, the true Mongolian plateau.

On the other hand, our Mongolian plateau specimens, both those collected by Mr. C. W. Campbell at Hara Ussu in 1898, and by Mr. Anderson at Taboul in 1907 †, are so markedly darker in colour that they might be recognized as a special plateau subspecies as follows:—

Citellus mongolicus umbratus.

Thos. Abstr. P. Z. S. 1908, p. 44 (Dec. 15).

Size and proportions as in true *mongolicus*. Colour much darker and greyer, speckled with blackish and buffy, so as to result in a tone rather darker than Ridgway's "isabella." Crown near broccoli-brown, markedly darker and less fawn than in *mongolicus*. Under surface broadly washed with buffy, lips and chin white. Sides of neck, front of forearms, and back of lower legs more strongly suffused with tawny or tawny ochraceous than in *mongolicus*, in which the colour is sandy or buffy. Tail-hairs much shorter than in *mongolicus*, though this is probably a seasonal character, cream-buff at their bases and tips, their middles black, none of the strong ochreous-buff colour showing on the upper side; below the middle line is ochraceous buff, but far narrower and less conspicuous than in *mongolicus*.

Dimensions of the type, measured in flesh:—

Head and body 197 mm.; tail 62; hind foot 37.

Skull—greatest length 46·3 mm.; basilar length 37; zygomatic breadth 28; length of upper tooth-series 10.

* See P. Z. S. 1870, p. 445.
† See P. Z. S. 1908, p. 105.

*Hab.* Mongolian Plateau. *Type* from Taboul, about 100 miles N.W. of Kalgan. Alt. 5000′.

*Type.* Young adult male. B.M. No. 8.3.5.5. Original number 1499. Collected by M. P. Anderson, 1 August 1907, and presented by the Duke of Bedford, K.G.

The difference in general colour between *umbratus* and *mongolicus* might have been thought to be seasonal in its nature, as both Mr. Campbell's and Mr. Anderson's specimens of the former were collected in July and August, and the present series in April and May. But some of the latter have already got their summer pelage on the crown, while Mr. Swinhoe's topotypica example of *mongolicus* was killed in September.

From the region inhabited by Büchner's two species, *C. alaschanicus* and *C. obscurus*, the Mongolian plateau is separated by the western parts of the range of *C. mongolicus*.

"Fairly common. Usually living in valley-bottoms, or in stretches of plain where more or less grass exists.

"Chinese name, 'Sa-hsu' = Sand-rat."—*M. P. A.*

13. Meriones auceps Thos.

♂. 1670, 1675, 1676, 1677, 1678, 1684, 1685, 1693, 1695. ♀. 1679, 1683, 1694, 1701, 1702. Yen-an-fu, Shen-si. 3000′.

♂. 1736, 1737. Ordos Desert, N. of Ching-pien, Shan-si, 4900′.

♂. 1878, 1880. ♀. 1877, 1881, 1882. Pao-teh-chow, Shan-si. 3500′.

♀. 1917, 1958. Mts. 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

♂. 1960. Ning-wu-fu. 6000′.

This handsome species, one of the discoveries of the present exploration, was described in my previous paper from a single specimen, so that this good series is very welcome. The skins are on the whole very uniform, with the exception that the tail is sometimes white below, prominently bicolor, and sometimes wholly ochraceous, all intermediate stages between the two being present.

It is possible that Milne-Edwards may have mixed up some specimens of *M. auceps* in his account of *M. psammophilus*, as the two species are so similar; but I have taken as representing his species the example unquestionably belonging to the smaller form, which he sent to the British Museum in 1867.

"One of the commonest mammals of North China. At Yen-an-fu they were abundant, burrowing in the farm fields; in the grassland north of Ching-pien they were also plentiful, but here they lived in the grassy plains, or in the bushy areas along the edges of the plains. This rodent was not found at Yu-lin-fu, and was comparatively rare near Ko-lan-chow, while at Ning-wu-fu I did not see them.

"Chinese name, 'Hwang-hsu' = Yellow rat."—*M. P. A.*

14. Meriones psammophilus M.-Edw.

♂. 1652. ♀. 1653. Tai-Yuen-Fu, Shan-si. 2700′.

Distinguishable from *M. auceps* mainly by its smaller size, shorter tail, and smaller bullæ.

15. Meriones unguiculatus M.-Edw.

♂. 1739, 1740. ♀. 1741, 1742. Ordos Desert, N.W. of Ching-pien, Shen-si. 4900′.

This Gerbil is readily distinguishable from the other two Chinese species by its black claws, grey-based belly-hairs, and buffy instead of ochraceous tail. Mr. Anderson had previously obtained a good series of it at Taboul on the Mongolian plateau.

Its skull is very like that of *M. psammophilus*, but the bullæ are smaller, and do not abut on or overlap the hinder corners of the zygomata.

16. Mus confucianus luticolor.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♂. 1689, 1698, 1710. Yen-an-fu, Shen-si. 3000′.

A pale race of *M. confucianus*, smaller and more delicately built than the Shantung *M. c. sacer*.

Size rather less than in *sacer*. Fur soft and fine, without spines. General colour above pale buffy (between cream-buff and buff of Ridgway) lined with brown along the dorsal area. Sides clearer buffy. Under surface and inner side of limbs pure, sharply defined, buffy white, whiter on the chin, more creamy on the belly. Ears large, pale greyish brown with white edges. Upper surface of hands and feet white. Tail well-haired, the scales being practically hidden, pencilled terminally, the hairs at the tip 6–7 mm. in length; brown above proximally, white terminally and below, the amount that is white varying from one-third to two-thirds the length of the tail.

Skull smaller and more delicately built throughout than that of *M. c. sacer*, the brain-case smoother and more rounded and the ridges less developed; palatal foramina shorter; bullæ rather larger; molars smaller.

Dimensions of the type, measured in the flesh:—

Head and body 130 mm.; tail 167; hind foot 27; ear 23.

Skull—greatest length 35·3 mm.; basilar length 27·4; greatest breadth 17; nasals 12·7; interorbital breadth 5·3; palatilar length 14·7; palatal foramina 6·5; upper molar series 5·6.

*Hab.* as above.

*Type.* Adult male. B.M. No. 9.1.1.92. Original number 1689. Collected 13 March, 1908.

This is a more or less desert form of the widely spread *M. confucianus*, smaller than *M. c. sacer*, paler coloured than the true *confucianus*.

"A rare animal in Shen-si, where we found it living in some rocky barren gullies. This rat is apparently not dependent on cultivation; wherever I have found it, namely in Shantung, Chih-li, Shan-si, and Shen-si, it has lived in rocky places among trees and bushes."—*M. P. A.*

17. MUS WAGNERI MONGOLIUM Thos.

♀. 1663. 30 miles W. of Fen-chou-fu, Shan-si. 4500′.
♂. 1777. ♀. 1778. Yu-lin-fu, Shen-si. 4000′.

"Found in hill-side fields near Fen-chou-fu; at Yu-lin-fu common in fields upon the river-bank."—*M. P. A.*

18. APODEMUS SPECIOSUS subsp.

♂. 1705, 1706, 1707, 1718. ♀. 1709, 1719. Near Yen-an-fu, Shen-si. 3800′.

♂. 1893, 1894. 1895, 1900, 1912, 1926, 1927, 1937, 1938, 1943. ♀. 1901, 1902, 1910, 1928, 1939, 1940, 1957, 1959. Mountains 12 miles N.W. of Ko-lan-chow, Shen-si. 7000′.

♀. 1983, 1995. 20 miles S.W. of Ning-wu-fu, Shan-si. 6600′.

"This mouse is another form which seems not to depend on cultivation at all. It is found only in those rare spots in North China where trees and bushes are numerous. At Yen-an-fu it was only fairly common, but in the mountains 12 miles north-west of Ko-lan-chow we found this animal abundant."—*M. P. A.*

19. APODEMUS AGRARIUS PALLIDIOR Thos.

♂. 1657. 30 miles W. of Fen-chou-fu, Shan-si. 4500′.
♂. 1713. ♀. 1717. Near Yen-an-fu, Shen-si. 3800′.
♂. 1936. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

Quite similar to the typical series from the Shantung Peninsula.

"In cultivated fields. Very rare in this part of China."—*M. P. A.*

20. CRICETULUS TRITON INCANUS.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♂. 1708, 1714. ♀. 1715, 1725. Yen-an-fu, Shen-si. 3000′
♂. 1898. ♀. 1945. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

A paler, clearer grey race of the Shantung *C. triton* De Wint.

External characters as in true *C. triton* except that the colour is distinctly paler and more drabby (drab-grey) as compared to the darker "smoke-grey" *triton*; the head and fore back pale clear grey, "grey No. 3," markedly different from the comparatively dark grey of *triton*.

Skull essentially as in *triton*, but rather more delicately built the nasal region, interorbital space, and brain-case all slightly narrower.

Dimensions of two specimens, measured in the flesh:—

| | | | | |
|---|---|---|---|---|
| ♂. | Head and body 155 mm.; | tail 85; | hind foot 25; | ear 21. |
| ♀ (type) | ,, 168 ,,; | ,, 98; | ,, 24; | ,, 21. |

Skull of type—condylo-basal length 41 mm.; basilar length 36; zygomatic breadth 22·8; nasals 15·7; interorbital breadth 5·4; palatilar length 17·5; palatal foramina 7·2; length of upper molar series 5·1.

Another fully adult skull only measures 37·3 mm. in condylo-basal length, while an example of true *triton* reaches 39 mm. The type skull of *C. triton*, which has worn teeth, is only 33 mm. in the same measurement, so that members of this group evidently vary very much in the size that their skulls may attain to.

*Hab.* of type. 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

*Type.* Old female. B.M. No. 9.1.1.123. Original number 1945. Collected 3 June, 1908.

This is evidently a pale inland dry-country form of the coast *C. triton*.

"This large Hamster is rare. They usually reside under bushes at the edge of some farmfield from which they take their food. I have sometimes found green leaves in their pouches, but more often they carry some grain. Their clean-cut burrows usually descend vertically into the earth.

"Chinese name, 'Pan-Tsang-er.'"—*M. P. A.*

21. Cricetulus andersoni Thos.

♂. 1660, 1664. ♀. 1658, 1661, 1665. 30 miles W. of Fen-chou-fu, Shan-si. 4500′.

♂. 1667, 1668, 1671, 1672, 1682, 1691, 1723. ♀. 1669, 1690, 1692, 1700, 1711, 1712, 1721. Yen-an-fu, Shen-si. 3000–3800′.

♂. 1883. ♀. 1876, 1879, 1884. Pao-teh-chow, Shan-si. 3500′.

♂. 1889, 1903, 1904, 1905, 1906, 1914, 1922, 1923, 1924, 1925. ♀. 1885, 1886, 1890, 1899. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

♀. 1961. Ning-wu-fu, Shan-si. 6000′.

There is surprisingly little difference either in colour or length of fur between these summer specimens and those obtained by Mr. Anderson the previous winter, when he first discovered this well-marked little species.

"I consider the grey dwarf Hamster the most abundant mammal of Shan-si and Shen-si. It was common at all our collecting grounds within these provinces, with the single exception of Yu-lin-fu, where it seems not to exist. We failed to find it in Ordos also."—*M. P. A.*

22. Cricetulus griseus M.-Edw.

♀. 1815. Yu-lin-fu, Shen-si. 4000′.

23. Cricetulus bedfordiæ.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♂. 1757, 1758, 1773, 1774, 1775, 1801, 1805, 1806, 1808, 1823, 1831, 1842, 1843, 1844, 1854, 1860, 1861. ♀. 1731 (in spirit), 1756, 1802, 1807, 1809, 1810, 1814, 1818, 1832, 1833, 1834, 1835, 1836, 1845, 1859. Yu-lin-fu, Shen-si. 4000′.

♀. 2003. Wu-chai, 23 miles W. of Ning-wu-fu, Shan-si. 6100′.

A small, very short-tailed species with completely hairy soles and pure white belly.

Size very small. Fur soft and fine, hairs of back about 9 mm. in length. General colour above drab-grey, becoming on the flanks and posterior back more distinctly drab ("ecru-drab," in some cases approaching "pinkish buff"). Whole of under surface, lower part of sides, all four limbs, and tail pure snowy-white, the line of demarcation, which runs from just below the eyes to the top of the base of the tail, well defined, more or less serpentine, convex upwards at the shoulders and hips, downwards on the flanks. A prominent white patch over each eye. Ears of medium size, their proectote dark brown, their metentote white; a whitish patch behind their posterior bases. Palms and soles completely covered with white hairs, except for a naked patch at the base of the pollex. Tail short and stumpy, about the length of the hind-foot, well-haired, completely white.

Skull smaller in all dimensions than that of *C. roborovskii*, apparently the nearest ally of the present species.

Dimensions of four specimens, taken in the flesh:—

| | | | | |
|---|---|---|---|---|
| ♂ 1773. | Head and body 81 mm.; | tail 14; | hind foot 12; | ear 13. |
| ♂ 1861 (type). | ,, 77 ,, ; | ,, 12; | ,, 12; | ,, 14. |
| ♀ 1756. | ,, 77 ,, ; | ,, 12; | ,, 12; | ,, 14. |
| ♀ 1807. | ,, 73 ,, ; | ,, 11; | ,, 11·5; | ,, 12. |

Skull of type—greatest length 23·1 mm.; basilar length 18; greatest breadth 13·2; length of nasals 7·7; interorbital breadth 3·6; brain-case breadth 10·8; palatilar length 9·6; diastema 6·2; palatal foramina 3·9; upper molar series 3·1.

*Type locality.* Yu-lin-fu, Shen-si. 4000′.

*Type.* Old male. B.M. No. 9.1.1.165. Original number 1861. Collected 8 May, 1908.

This very beautiful little Hamster, which I have named in honour of the Duchess of Bedford, is most nearly allied to the Nan-Shan *C. roborovskii* Satunin,* with which it appears to agree in colour and structure. But it is very markedly smaller, the type of *C. roborovskii* (stated to be young) having a head and body length of 90 mm., and a larger skull throughout, the molar series being 3·8 mm. in length.

"The Desert Hamster is a common animal in the region of Yu-lin-fu, where it is found in the sandhills of the desert. I was unable to find the burrows of these animals, and it seems probable that the shifting sand closes their entrances as soon as the animal has passed through.

"One specimen, No. 2003, came from Wu-chai, Shan-si, a town

* Ann. Mus. Zool. St. Pétersb. vii. p. 571, 1902.

some 23 miles west of Ning-wu-fu, and situated upon a portion of the Mongolian Plateau which extends into Shan-si.

"The Desert Hamster eats millet very greedily.

"Chinese name, 'Mi-tsang-er' (Mi=millet)."—*M. P. A.*

24. Microtus mandarinus M.-Edw.

♂. 1907, 1918, 1929, 1950. ♀. 1908, 1951. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

These specimens agree very fairly with Milne-Edwards's description, and with his type, which I have examined in Paris. The species was described from Chinese Mongolia, and its occurrence here in Shan-si is therefore quite natural.

These are the first examples of the true *M. mandarinus* that the Museum has received, those from Afghanistan previously referred to the species being undoubtedly different. The latter are members of the subgenus *Phaiomys*, and have the connection between the second and third enamel-space of the first lower molar which is characteristic of *Pitymys* and of true *Phaiomys*, and may in fact be taken as equally diagnostic of the latter. But if this be done, *Microtus brandti* and *mandarinus*, both of which have five closed triangles in $m_1$, cannot be considered members of *Phaiomys*, and would either be referable to *Microtus*, in spite of their long fore-claws, or Lataste's subgenus *Lasiopodomys*, founded on *M. brandti*, should be revived to contain them.

The following are flesh measurements of *M. mandarinus* :—

| | | | | |
|---|---|---|---|---|
| ♂. | Head and body 95 mm.; | tail 23; | hind foot 17; | ear 7. |
| ♀. | " 90 " ; | " 20; | " 16; | " 8. |

"A rare thing: found only upon the mountain tops (7000 feet) among bushes and grass, or in open fields. Their burrows much resemble those of the 'gray dwarf hamster' (*C. andersoni*); we trapped dozens of hamsters in our endeavour to secure more of these voles."—*M. P. A.*

25. Microtus (Eothenomys) inez.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♂. 1896, 1919, 1921, 1930, 1949, 1952, 1954, 1956. ♀. 1891, 1892, 1897, 1909, 1920, 1946, 1947, 1948, 1953, 1955. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

A small pale-brown Vole with a certain skull-resemblance to *M.* (*Eothenomys*) *melanogaster*.

Fur soft and fine, hairs of back 8-9 mm. in length. General colour above a peculiar pinkish brown, rather browner than Ridgway's "fawn-colour," lined with darker brown on the head, and often rather paler on the fore-back. Under surface pale "wood-brown," the slaty bases of the hairs showing through. Ears about the length of the fur, not distinguishable by colour from the general tone. Upper surface of hands and feet dull whitish; fore claws slightly longer than hind; soles with 6 pads. Tail of average length and hairiness, brown above, lighter below, not sharply contrasted. Mammæ 0—2=4.

Skull with a marked general resemblance in form to that of *M. melanogaster*, having the same unusually broad interorbital region, and smooth unridged surface with the angles and crests scarcely developed, not even the oldest specimen showing any trace of frontal crests. Palatal foramina medium. Posterior palate more complete than in that species, the lateral grooves reduced to small or minute disconnected foramina, the posterior border squarely transverse, running completely across to the molars; ridges bounding mesopterygoid fossa running above (dorsal to) this posterior border, and curving down to join it on its dorsal aspect. Bullæ of average size.

Teeth with the triangles tending throughout to be completely closed, thus contrasting with those of *M. melanogaster* in which they are mostly open. $M^1$ with the usual 5 spaces, 3 external and 3 internal salient angles, and $m^2$ with 4, 3 and 2 respectively, and each tooth with a tendency to the development of a small extra postero-internal angle, very different to the large extra angle of the allied form. $M^3$ narrow, rather elongate, with five separated spaces, three external and three internal salient angles, and a long posterior lobe. First lower molar normally with four closed triangles, and the partly open one in front of them joining the anterior trefoil, but this is sometimes also closed, making a fifth closed triangle. $M_2$ either without closed triangles, or the middle space separated into two.

Dimensions of four specimens, measured in the flesh:—

| | | | | | |
|---|---|---|---|---|---|
| ♂. | Head and body | 88 mm.; | tail 31; | hind foot 16; | ear 10·5. |
| ♂. | ,, | 89 ,, ; | ,, 33; | ,, 16; | ,, 11. |
| ♀ (type) | ,, | 90 ,, ; | ,, 35; | ,, 15·5; | ,, 11. |
| ♀. | ,, | 88 ,, ; | ,, 33; | ,, 16; | ,, 11. |

Skull of type—greatest length 23·5 mm.; basilar length 20; zygomatic breadth 15·5; length of nasals 6·7; interorbital breadth 4·2; height of crown from front of alveolus of $m^3$ 7·2; palatilar length 10·1; palatal foramina 4·1; length of upper molar series (crowns) 5·7.

*Hab.* as above.

*Type.* Adult female. B.M. No. 9.1.1.188. Original number 1892. Collected 28 May, 1908.

This interesting little Vole would appear to be most nearly allied to *M.* (*Eothenomys*) *melanogaster*, but differs strikingly in the closure of many of the dental triangles open in that animal. Its palate is also much more complete posteriorly, and its fore instead of its hind claws are slightly the longer.

In colour *M. inez* is also unique, its peculiar pinkish-brown colour being quite unlike that of any other Vole in the Museum collection; indeed, owing to its colour, it was mistaken for a "Redback" by Mr. Anderson.

"In the mountains N.W. of Ko-lan-chow, Shan-si, this Redback was found rather common in the bottoms of certain narrow, wooded and bushy gullies. They, in company with *Apodemus speciosus*, burrow in the soft loose soil beneath the bush."—*M. P. A.*

26. CRASEOMYS SHANSEIUS Thos.

♂. 1931. ♀. 1932, 1933, 1934, 1935, 1942. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

Practically topotypes of this striking species, described from Mr. Anderson's previous collection.

The summer fur is hardly shorter than that of winter, and is quite similar in colour and texture.

"Much less common than the last, but like it found in the bush-overgrown gullies and canyons."—*M. P. A.*

27. MYOSPALAX FONTANIERI M.-Edw.

♂. 1733. Ordos Desert, 8 miles N. of Ching-pien, Shen-si. 4900′.

♂. 1916. Mts. 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

♂. 1966, 1973, 1997. ♀. 1965, 1996, 2001. Ning-wu-fu, Shan-si. 6000′.

♂. 1988. ♀. 1980, 1994. 20 miles S.W. of Ning-wu-fu, Shan-si. 6600′.

These specimens all agree in possessing some evidence of the white face-markings figured by Milne-Edwards in his type, but believed by him to be inconstant. He may have mixed up with *M. fontanieri* examples of the next species, in which the white crown-streak is rarely present.

Specimens of the remarkable Mole-rats of this genus are exceedingly rare in Museums, so that this fine series of a species new to the Museum, and those next referred to form a most valuable accession to the Museum collection. In addition we have lately received from Mr. E. B. Howell some examples of *M. psilurus* M.-Edw., so that the Museum now possesses examples of every described species of the genus, including really good series of the two now obtained.

28. MYOSPALAX CANSUS Lyon.

*Myotalpa cansus* Lyon, Smiths. Misc. Coll. l. p. 134, 1907.

♀. 1729, 1730. Yen-an-fu, Shen-si. 3000′.

♂. 1794, 1795, 1800, 1811, 1816, 1817, 1819, 1821, 1828, 1838, 1849, 1850. ♀. 1751, 1791, 1796, 1797, 1812, 1820, 1822, 1827, 1837, 1839, 1840, 1841, 1847, 1852. Yu-lin-fu, Shen-si, 4000′.

This species differs from the last mainly in size, the largest skull, which agrees closely with the figure given by Mr. Lyon, being 45·3 mm. in condylo-basal length. Face-markings are less developed, only five out of 28 specimens having small frontal streaks, while the buffy nose-patch is small and often almost obsolete.

In this series there is a marked difference between the sexes, the male skulls being markedly larger, more rugged and heavily ridged than the female. Mr. Lyon had stated that his specimen was a female, but on my sending him a pair of the present series for comparison, he has been good enough to inform me that the male agreed precisely with the type, and that the latter was evidently wrongly sexed.

"This small rodent mole is rather common, for traces of it, old or new, may be found in nearly every field in those parts of Shan-si and Shen-si visited. It is, however, difficult to trap; we secured the present series chiefly by hiring peasants to dig the animals out and bring them to us. In walking on the surface of the ground the rodent mole turns the long claws of the fore-feet under the soles and walks upon the backs of the claws; they make but slow progress. When frightened or angered this animal utters a peculiar little squeal. We had many live ones in the course of our work at Yu-lin-fu and elsewhere, but did not find them inclined to be savage.

"Chinese name, 'Ha-whei' or 'Ha-lao.'"—*M. P. A.*

29. Dipus sowerbyi Thos.

♂. 1743, 1744. ♀. 1745. Ordos Desert, 30 miles W. of Yu-lin-fu, Shen-si. 4700′.

♂. 1750, 1752, 1753, 1755, 1760, 1761, 1762, 1763, 1764, 1765, 1766, 1768, 1770, 1771, 1772, 1776, 1782, 1783, 1784, 1785, 1787, 1788, 1789, 1792, 1824, 1825. ♀. 1749, 1754, 1767, 1786, 1793, 1826. Yu-lin-fu, Shen-si. 4000′.

*Dipus sowerbyi* was obtained by Mr. Sowerby at Yu-lin-fu and described in a special paper *. It is the first three-toed Jerboa discovered in the Far East, the five-toed *Allactaga mongolica* having been hitherto the only known Chinese Jerboa. Reasons for the separation of the genus *Dipus* from the earlier *Jaculus* are given in the paper quoted.

The species is probably characteristic of the Ordos Desert and its vicinity.

"Inhabits the sand-dunes."—*M. P. A.*

30. Allactaga mongolica Radde.

♂. 1978. Ning-wu-fu, Shan-si. 6000′.

"Inhabits the loess plain near Ning-wu-fu, where its tracks are fairly plentiful. On the plateau west of Ning-wu we saw tracks which were probably made by this animal, but we were unable to identify its burrow, and could not secure a second specimen."—*M. P. A.*

31. Lepus swinhoei subluteus.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♂. 1674, 1681, 1696. ♀. 1686. Yen-an-fu, Shen-si. 3000′.

* Ann. Mag. N. H. (8) ii. p. 307, 1908.

♂. 1735. Ordos Desert, N. of Ching-pien, Shen-si. 4900′.
♂. 1759 (young). Yu-lin-fu, Shen-si. 4000′.

A pale race of *L. swinhoei*.

General colour throughout, of head, body, and chest-band, much paler than in true *swinhoei*, near "pinkish-buff" of Ridgway, instead of the richer colour of *swinhoei*, which approaches "ochraceous buff." Sides of rump with a greater tendency to the development of grey patches. Other characters as in true *swinhoei*.

Dimensions of the type, measured in the flesh:—

Head and body 466 mm.; tail 91; hind foot 111; ear (from notch) 95.

Skull—greatest length 86·5 mm.; basilar length 70.

*Type* locality. Southern Ordos Desert.

*Type*. Adult male; B.M. No. 9.1.1.261. Original number 1735. Collected 14 April, 1908.

This Hare is a pale Ordos Desert race of *L. swinhoei*, which ranges in its normal form from Chefoo and Nanking westwards to Southern Shen-si. It unfortunately happened that the type specimen was darker than has since proved to be usual with Chefoo specimens, and deceived therefore by the description I gave of it in 1894, before any of Mr. Anderson's specimens had arrived, Prof. Matschie has recently distinguished a Hare from Hing-an-fu, Southern Shen-si, as *Lepus filchneri*. His description, however, quite fits Mr. Anderson's topotypical series from Chefoo, and I think there is no doubt *L. filchneri* should be referred to *L. swinhoei*.

I regret that Prof. Matschie should have been led into error by my description of what has since proved to be the abnormal colour of the typical specimens.

With regard to his *L. stegmanni* from Kiau-chow, I would note that a certain proportion of the specimens of *L. swinhoei*, otherwise indistinguishable, show the peculiar light speckling of the upper tail-surface which Prof. Matschie uses as a primary character. One example from Chefoo shows this very clearly, as does another from Tung-chow, E. of Peking.

Dr. Satunin has recently * described a number of Hares from Central Asia, but I cannot find any among them similar to this Ordos Hare. I note, however, that his *L. kozlovi*, from Kam, can hardly escape being the same as *L. sechuenensis* de Wint.†, almost from the same district, of which he makes no mention.

"This is the common Hare of China. Although specimens were taken at only two localities on our long journey, they were seen at all stages. They live generally wherever there is cover. In the Ordos, north-west of Ching-pien, and in the mountains near Ko-lan-chow they were exceedingly abundant.

"Chinese name, 'Tu-tzi.'"—*M. P. A.*

* Ann. Mus. St. Pétersb. xi. p. 162, 1906.
† P. Z. S. 1899, p. 576.

32. OCHOTONA BEDFORDI.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♂. 1673, 1680. ♀. 1687, 1688, 1697. Yen-an-fu, Shen-si. 3000′.

♂. 1915. ♀. 1944. Mountains 12 miles N.W. of Ko-lan-chow, Shan-si. 7000′.

♂. 1967, 1969, 1974, 1975, 1976, 1999. ♀. 1962, 1963, 1968, 1977, 2000. Ning-wu-fu, Shan-si. 6000′.

A Pika allied to *O. dauurica*, but with larger bullæ. Size rather larger than in *O. dauurica*. General colour above of summer specimens pale wood-brown, tending to ochraceous-buffy on the sides of the neck, the under surface approaching pinkish-buff. Winter specimens rather paler and greyer. Patches behind ears inconspicuous, ochraceous-buff; ears with their proectote black proximally paling to dull buffy terminally; metentote buffy; lips and chin white, without darker markings. Hands and feet creamy or buffy above, the long hairs of the palms and soles whitish brown.

Skull with the general characters of *O. dauurica*, the type of the subgenus *Ochotona* (see below), but larger, less strongly convex on the forehead, with the brain-case larger, broader, and running out to more definite postero-external angles, and the bullæ very markedly larger, perhaps the largest in the genus. Molars broader.

Dimensions of four specimens, measured in the flesh:—

| | | | | |
|---|---|---|---|---|
| ♂. | Head and body 192 mm.; | hind foot 30; | ear 19. |
| ♂. | ,, 192 ,, ; | ,, 31; | ,, 19. |
| ♀ (type). | ,, 185 ,, ; | ,, 31; | ,, 22. |
| ♀. | ,, 175 ,, ; | ,, 32; | ,, 21. |

Skull of type—greatest length 44·2 mm.; basilar length 36·6; zygomatic breadth 21; length of nasals 15; interorbital breadth 3·5; breadth of brain-case 17·4; palatal foramina 12·3; oblique diameter of bullæ in plane of basioccipital 13·5; length of upper tooth-series (alveoli) 8·5.

*Type* locality. Ning-wu-fu, Shan-si. 6000′.

*Type*. Adult female. B.M. No. 9.1.1.278. Original number 2000. Collected 23 June, 1908.

This Pika is very nearly allied to the Siberian and Mongolian *O. dauurica*, which it closely resembles in colour, but is distinguished by its rather larger size, much larger bullæ, and broader molars.

With regard to *Ochotona huangensis* Matsch., from Western Kan-su, Prof. Matschie has been good enough to send me the dimensions of its bullæ, and these appear closely to agree with those of *O. dauurica*, and are therefore markedly smaller than the unusually large bullæ of *O. bedfordi*.

I have named this fine and distinct species in honour of His Grace the Duke of Bedford, K.G., the importance of whose assistance in the exploration of Eastern Asia is indicated by the fact that the type-specimen is No. 2000 of the Mammals collected during the Exploration.

"At Yen-an-fu we found these animals about a few bush-grown burying-grounds in the main valley. They proved to be very shy, for after trapping a few we suddenly found we could catch no more. My belief is that the remainder of the colony deserted the place. North-west of Ching-pien Mr. Sowerby found Pika-burrows again, but we secured no additional specimens till we reached Ko-lan-chow, Shan-si. In this locality we did not find them common, but in the vicinity of Ning-wu-fu they are fairly abundant. No. 2000, taken 23 June, contained four young with hair, and evidently about to be born.

"Chinese names: 'Ti-tu' = Ground-Hare (at Yen-an-fu); 'Hao-tu' = Rat-hare (at Ko-lan-chow)."—*M. P. A.*

In a previous paper* attention was called to the confusion which had followed from the giving of two names, *O. ogotona* and *O. dauurica*, to the same animal by Pallas; and it now appears that this confusion has further resulted in the naming of Mr. Lyon's subgenera † being inaccurate. The latter had assumed that the animal described by Waterhouse as *Lagomys ogotona* was really Pallas's species of that name, and consequently called the subgenus to which it belonged the typical *Ochotona* Link, based on Pallas's animal. As already noted, however, Pallas's *ogotona* was the same as his earlier *dauurica*, and this is one of the species assignable to Mr. Lyon's *Conothoa*, so that the latter name becomes a synonym of *Ochotona*.

The nomenclature of the subgenera would therefore appear to be as follows:—

1. OCHOTONA Link. Type, *O. dauurica* Pall.
   *Conothoa* Lyon. " *O. roylei* Og.
   (Incisive and palatal foramina united, open.)
2. PIKA Lac. 1799. Type, *O. alpina* Pall.
   *Lagomys* G. Cuv. 1800 (nec Storr, 1780). Type, *O. alpina* Pall.
   (Incisive and palatal foramina separate. Frontal outline not abnormally bowed.)
3. OGOTOMA Gray, 1867. Type, *O. pallasi* Gray.
   (Incisive and palatal foramina separate. Frontal outline abnormally bowed.)

   The last-named also includes *O. ladacensis* Günth.

33. OCHOTONA SORELLA.

Thos. Abstr. P. Z. S. 1908, p. 45 (Dec. 15).

♀. 1979. 20 miles S. of Ning-wu-fu, Shan-si. 6600′. 10 June, 1908. B.M. No. 9.1.1.279. *Type.*

A very small species allied to *O. cansa* Lyon.

* P. Z. S. 1908, p. 109. † Smiths. Misc. Coll. xlv. p. 438, 1904.

Size even smaller than in *O. cansa*. General colour brown, rather darker than Ridgway's "broccoli-brown," a lighter patch across the nape. Under surface rather lighter, soiled cream-buff, a more ochraceous-buffy area down the centre of the belly; the slaty bases to the hairs showing through; sides of neck more tawny. Ears blackish grey with white edges. Upper surface of hands and feet cream-buff, their thickly furred palms and soles slaty brownish.

Skull most like that of *O. cansa*, as figured by Lyon *, but the upper outline is more convex, the nasals are longer and narrower, the palatal foramina are more widely open, and the bullæ are markedly smaller.

Dimensions of the type, an adult female, measured in the flesh:—

Head and body 140 mm.; hind foot 27; ear 18.

Skull—greatest length 36·4 mm.; basilar length 29; greatest breadth 17; nasals 11·8 × 4; interorbital breadth 4; breadth of brain-case 14; height of crown from alveolus of $m^2$ 10·7; diastema 8; palatal foramina 8·8 × 4·3; diagonal length of bullæ 9·2; length of upper tooth-series (alveoli) 6·7.

*Hab.* and *Type* as above.

This little Pika belongs to the *O. pusilla* group, and is no doubt most nearly allied to Mr. Lyon's *O. cansa*, from Kan-su, of which the Museum possesses a specimen from the Province of Sze-chuen. It differs, however, in the skull-characters above detailed, and clearly cannot be referred to it.

"The single specimen was taken by Mr. Sowerby in a wood upon an abrupt hillside, where this, and probably another, had its burrow. The burrows, which were long and intricate, were subsequently dug up without another specimen being found. Examination showed No. 1979 to be an adult female, with the uterus indicating that young had recently been born, and the mammary glands secreting."—*M. P. A.*

* Smiths. Misc. Coll. l. pl. xv., 1907.

No. 61.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

**November 3rd, 1908.**

Frederick Gillett, Esq., Vice-President, in the Chair.

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The Secretary read a report on the additions that had been made to the Society's Menagerie during the months of June, July, August, and September, 1908.

Prof. E. A. Minchin, M.A., V.P.Z.S., exhibited a series of drawings of Trypanosomes obtained from British Freshwater Fishes.

Mr. Geoffrey Meade-Waldo, B.A., exhibited a living specimen of a Toad that he had obtained in Sumatra, and described it as belonging to a species new to science.

The Secretary exhibited a photograph of a young Malayan Tapir, and remarked that he had been unable to find accurate drawings of the young of this species. The photograph had been given to him by the Right Hon. Sir Cecil Clementi Smith, P.C., G.C.M.G., M.A., Honorary Member of the Society, and had been taken from a living example which had been a pet in his house.

A paper was read by Messrs. Oldfield Thomas, F.R.S., F.Z.S., and Guy Dollman, B.A., on Mammals from Inkerman, near Townsville, North Queensland, collected by Mr. W. Stalker and presented to the National Museum by Sir William Ingram, Bart. and the Hon. John Forrest.

Almost no material from this part of Australia had previously been received by the British Museum, so that this collection, which consisted of over 200 specimens, belonging to 26 species, was of particular value.

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* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; 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 collection clearly showed that the Townsville region belonged faunistically to North Australia, the species being nearly identical with those of New South Wales and Victoria. Several species and subspecies were described as new.

Mr. R. Lydekker, F.R.S., F.Z.S., communicated papers on Takins from Sze-chuen and Bhutan, and on an Indian Dolphin and Porpoise.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 17th November, 1908, at half-past Eight o'clock P.M., when the following communications will be made:—

1. N. Annandale, D.Sc., C.M.Z.S.—A new Genus and Species of Slow-Lemurs from the Lushai Hills, Assam.

2. Prof. G. C. Bourne, D.Sc., F.L.S., F.Z.S.—Contributions to the Morphology of the Group Neritacea of Aspidobranch Gastropods.—Part I. The Neritidæ.

3. Ruwenzori Expedition:—

Report on Mammalia by Oldfield Thomas, F.R.S., F.Z.S., and R. C. Wroughton, F.Z.S.

Report on Fishes, Batrachians, and Reptiles by G. A. Boulenger, F.R.S., V.P.Z.S.

Report on Mollusca by E. A. Smith, I.S.O., F.Z.S.

Report on Lepidoptera Heterocera by Sir George F. Hampson, Bt., F.Z.S.

Report on Coleoptera: Part I. Lamellicornia, by Gilbert J. Arrow, F.E.S.; Part II. Buprestidæ, by C. O. Waterhouse, P.E.S.; Part III. Curculionidæ, by Guy A. K. Marshall, F.Z.S.

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The following communications have been received:—

1. F. E. Beddard, M.A., F.R.S., F.Z.S.—Some Notes on the Muscular and Visceral Anatomy of the Batrachian Genus *Hemisus*, with Notes on the Lymph Hearts of this and other Genera.

2. G. A. Boulenger, F.R.S., V.P.Z.S.—Description of a new Species of *Lacerta* from Persia.

3. Dr. Einar Lönnberg, C.M.Z.S.—Remarks on some Wart-Hog Skulls in the British Museum.

4. R. Lydekker, F.R.S., F.Z.S.—On two Chinese Serow Skulls.

5. Prof. Alexander Meek, F.Z.S.—The Development of the Lesser Black-backed Gull, *Larus fuscus*, L.

6. R. I. Pocock, F.L.S., F.Z.S.—Warning Coloration in the Musteline Carnivora.

7. Prof. G. O. Sars, C.M.Z.S.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Copepoda.

8. W. T. Calman, D.Sc., F.Z.S.—On a new River-Crab of the Genus *Gecarcinucus*, from New Guinea.

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Communications intended for the Scientific Meetings of the Zoological Society of London should be addressed to

P. CHALMERS MITCHELL,
*Secretary.*

3 Hanover Square, London, W.
*November* 10*th*, 1908.

No. 62.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

## November 17th, 1908.

Prof. E. A. Minchin, M.A., Vice-President, in the Chair.

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The Secretary read a Report on the additions that had been made to the Society's Menagerie during the month of October 1908.

Mr. E. E. Austen, F.Z.S., exhibited some living tropical flies, captured in Manchester, and remarked on the agency of man in extending the distribution of insects.

Dr. N. Annandale, C.M.Z.S., communicated a paper on "A new Genus and Species of Slow-Lemurs from the Lushai Hills, Assam." The animal is known only from a photograph of two individuals taken in 1889 by Mr. T. D. La Touche, and resembles *Nycticebus* in appearance, but has a long bushy tail, which distinguishes it from all known Oriental Lemurs.

Mr. G. C. Bourne, D.Sc., F.L.S., F.Z.S., Linacre Professor of Comparative Anatomy in the University of Oxford, presented a Memoir entitled "Contributions to the Morphology of the Group Neritacea of Aspidobranch Gastropods.—Part I. The Neritidæ." As a result of the comparative study of the anatomy of several species of marine, estuarine, and freshwater Neritidæ, the Author found that the forms hitherto classed in the genera *Nerita*, *Neritina*, and *Septaria* fall into three well-marked groups of subgeneric value, the chief distinctive characters relating to the

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accessory genital organs. The investigation had been pursued by the study of sections as well as by dissections, and a number of important anatomical results were set forth. The ganglion on the visceral loop identified by Lacaze-Duthiers and Bouvier as sub-intestinal was shown to be the true sub-intestinal ganglion, whilst the ganglion described under that name by Boutan and B. Haller was shown to be the enlarged right end of an elongate and diffuse visceral ganglion. The cœlomic cavity was shown to be larger in extent in the Neritidæ than in any other adult Gastropods, and to be divisible into a left pericardial and a right garadial division. The macroscopical and microscopical characters of the accessory genitalia were described in full, and in conclusion the relationships of the Neritidæ *inter se* were discussed.

## Ruwenzori Expedition.

Mr. W. R. Ogilvie-Grant, F.Z.S., gave an account of the expedition which he had organized to collect in the Ruwenzori range of mountains in Equatorial Africa. He had obtained sufficient funds through the generosity of H.G. The Duke of Bedford, President of the Society, the Earl of Dartmouth, Viscount Iveagh, the Hon. N. C. Rothschild, Sir Alexander Baird, Sir Ludwig Mond, Mr. W. A. Bell, Mr. C. Czarnikow, and Mr. W. H. St. Quintin, Fellows of the Society, Lord Strathcona and Mount Royal, the Trustees of the Percy Sladen Fund, and the Worshipful Company of Fishmongers. It had been agreed that the first set of specimens collected should be presented to the British Museum of Natural History. The expedition had been led by Mr. R. B. Woosnam and had consisted of that gentleman, Mr. R. E. Dent, the Hon. Gerald Legge, and Mr. Douglas Carruthers, with Mr. A. F. R. Wollaston as Medical Officer and botanical collector. The results had been extremely successful, amongst the specimens obtained having been 404 Mammalia, 2470 Aves, 135 Reptiles and Batrachia, 31 Pisces, and a very large number of Invertebrates.

Mr. R. B. Woosnam gave an account of the Expedition illustrated by lantern-slides.

The following Memoirs on the Zoological Results of the Ruwenzori Expedition were presented to the Meeting and will be published in the Scientific Transactions of the Society:—

O. Thomas, F.R.S., F.Z.S., and R. C. Wroughton, F.Z.S.—Report on Mammalia.

G. A. Boulenger, F.R.S., V.P.Z.S.—Report on Fishes, Batrachians, and Reptiles.

E. A. Smith, I.S.O., F.Z.S.—Report on Mollusca.

A. S. Hirst, F.Z.S.—Report on Arachnida.

G. J. Arrow, F.E.S.—Report on Coleoptera: Pt. I.

C. O. Waterhouse, Pres.E.S.—Report on Coleoptera: Pt. II.

C. J. Gahan.—Report on Coleoptera: Pt. III.

G. A. K. Marshall, F.Z.S.—Report on Coleoptera: Pt. IV.

The late Col. C. T. Bingham, F.Z.S.—Report on Hymenoptera.

Sir George Hampson, Bt., F.Z.S.—Report on Lepidoptera Heterocera.

F. A. Heron.—Report on Lepidoptera Rhopalocera.

E. E. Austen, F.Z.S.—Report on Diptera.

W. L. Distant, F.E.S.—Report on Rhynchota.

W. F. Kirby, F.L.S., F.E.S.—Report on Neuroptera.

W. F. Kirby, F.L.S., F.E.S.—Report on Orthoptera.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 15th December, 1908, at half-past Eight o'clock P.M., when the following communications will be made;—

1. Frederick Gillett, V.P.Z.S.—A Hunting-trip to Thian-Shan, illustrated by lantern-slides.

2. F. E. Beddard, M.A., F.R.S., F.Z.S.—Some Notes on the Muscular and Visceral Anatomy of the Batrachian Genus *Hemisus*, with Notes on the Lymph Hearts of this and other Genera.

3. G. A. Boulenger, F.R.S., V.P.Z.S.—Description of a new Species of *Lacerta* from Persia.

4. Dr. Einar Lönnberg, C.M.Z.S.—Remarks on some Wart-Hog Skulls in the British Museum.

5. R. Lydekker, F.R S., F.Z.S.—On two Chinese Serow Skulls.

6. R. I. Pocock, F.L.S., F.Z.S.—Warning Coloration in the Musteline Carnivora.

7. W. T. Calman, D.Sc., F.Z.S.—On a new River-Crab of the Genus *Gecarcinucus*, from New Guinea.

8. Oldfield Thomas, F.R.S., F.Z.S.—The Duke of Bedford's Exploration of Eastern Asia.—XI. On Mammals from the Provinces of Shan-si and Shen-si, Northern China.

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The following communications have been received:—

1. Prof. G. O. Sars, C.M.Z.S.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Copepoda.

2. Prof. E. A. Minchin, M.A., V.P.Z.S.—Studies on the Flagellate Blood Parasites of Freshwater Fishes.

3. T. Goodey, B.Sc.—A further Note on the Gonadial Grooves of a Medusa, *Aurelia aurita*.

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Communications intended for the Scientific Meetings of the Zoological Society of London should be addressed to

P. CHALMERS MITCHELL,
*Secretary*.

3 Hanover Square, London, W.
*November 24th*, 1908.

No. 63.

# ABSTRACT OF THE PROCEEDINGS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.*

December 15th, 1908.

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

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The SECRETARY read a Report on the additions that had been made to the Society's Menagerie during the month of November 1908.

Mr. FREDERICK GILLETT, V.P.Z.S., gave an account of his recent Hunting Trip to the Thian Shan, illustrated by lantern-slides.

Mr. R. I. POCOCK, F.L.S., F.Z.S., Superintendent of the Society's Gardens, exhibited photographs of a male Sumatran Tiger recently purchased by the Society, remarking that the Society has at present, living in the Gardens, examples of three out of four known races of Tigers.

Mr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, communicated a paper entitled "Some Notes on the Muscular and Visceral Anatomy of the Batrachian Genus *Hemisus*, with Notes on the Lymph Hearts of this and other Genera."

Mr. G. A. BOULENGER, F.Z.S., V.P.Z.S., described a "New Species of *Lacerta* from Persia."

A communication was received from Dr. EINAR LÖNNBERG, C.M.Z.S., "On some Wart-Hog Skulls in the British Museum."

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* This Abstract is published by the Society at 3 Hanover Square, London, W., on the Tuesday following the date of Meeting to which it refers. It will be issued, free of extra charge, to all Fellows who subscribe to the Publications, along with the 'Proceedings'; 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. R. Lydekker, F.R.S., F.Z.S., communicated a paper "On two Chinese Serow Skulls."

Mr. R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Society's Gardens, read a paper entitled "Warning Coloration in the Musteline Carnivora," and exhibited skins of Skunk, Badger, &c., to illustrate his argument.

Dr. W. T. Calman, F.Z.S., communicated a paper "On a new River-Crab of the Genus *Gecarcinucus*, from New Guinea."

Mr. Oldfield Thomas, F.R.S., F.Z.S., read a paper on Mammals collected in the Provinces of Shan-si and Shen-si, Northern China, by Mr. M. P. Anderson, for the Duke of Bedford's Zoological Exploration of Eastern Asia. 33 species were included, represented by 335 specimens, presented, as before, to the National Museum by His Grace.

The following were described as new:—

Erinaceus miodon, sp. n.

Near *E. dealbatus*, but penultimate upper premolar much smaller, 2 mm. in diameter.

*Hab.* Yu-lin-fu, Shen-si.

*Type.* Male. Original number 1871.

Erinaceus hughi, sp. n.

Very dark-coloured, the usual light ends to the spines reduced to a minute subterminal light band.

*Hab.* Paochi, Shen-si.

*Type.* Female. B.M. No. 0.6.27.2.

Eutamias asiaticus ordinalis, subsp. n.

Allied to *E. a. senescens*, but much paler throughout.

*Hab.* Yu-lin-fu, Shen-si; at edge of Ordos Desert.

*Type.* Female. Original number 1804.

Eutamias asiaticus intercessor, subsp. n.

Intermediate in general tone between subspp. *senescens* and *ordinalis*.

*Hab.* Ning-wu-fu, Shan-si.

*Type.* Female. No. 1972.

Citellus mongolicus umbratus, subsp. n.

General colour much darker than in true *mongolicus*, near "isabella" of Ridgway.

*Hab.* Taboul, Mongolian Plateau.

*Type.* Male. B.M. No. 8.3.5.5.

Mus confucianus luticolor, subsp. n.

Very pale. Size smaller than in the Shantung *M. c. sacer*.
*Hab.* Yen-an-fu, Shen-si.
*Type.* Male. No. 1689.

Cricetulus triton incanus, subsp. n.

Paler and clearer grey than in true *C. triton*. Skull narrower.
*Hab.* Near Ko-lan-chow, Shan-si.
*Type.* Female. No. 1945.

Cricetulus bedfordiæ, sp. n.

Clear drab-grey, with pure white under surface. Tail very short. Feet hairy. Head and body 77 mm.; tail 12; hind foot 12.
*Hab.* Yu-lin-fu, Shen-si.
*Type.* Male. No. 1861.

Microtus inez, sp. n

Pinkish brown above, wood-brown below. Head and body 90 mm.; tail 35; hind foot 15·5. Molars with the triangles mostly closed.
*Hab.* Near Ko-lan-chow, Shan-si.
*Type.* Female. No. 1892.

Lepus swinhoei subluteus, subsp. n.

General colour pinkish buff, much paler than in true *swinhoei*.
*Hab.* Southern Ordos Desert.
*Type.* No. 1735.

Ochotona bedfordi, sp. n.

Allied to *O. dauurica*, but larger and with much larger bullæ. Skull, greatest length 44·2 mm.
*Hab.* Ning-wu-fu, Shan-si.
*Type.* No. 2000.

Ochotona sorella, sp. n.

Near *O. causa*, but even smaller. Skull length 36·4 mm.
*Hab.* Near Ning-wu-fu, Shan-si.
*Type.* No. 1979.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, the 12th January, 1909, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Prof. G. O. Sars, C.M.Z.S.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1905.—Report on the Copepoda.

2. Prof. E. A. Minchin, M.A., V.P.Z.S.—Studies on the Flagellate Blood Parasites of Freshwater Fishes.

3. T. Goodey, B.Sc.—A further Note on the Gonadial Grooves of a Medusa, *Aurelia aurita*.

4. A. E. Brown, D.Sc., C.M.Z.S.—The Tuberculin Test in Monkeys; with Notes on the Temperature of Mammals.

5. Prof. R. Collett, F.M.Z.S.—A few Notes on *Balæna glacialis* and its Capture in recent Years in the North Atlantic by Norwegian Whalers.

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The following communications have been received:—

1. F. Wood-Jones, B.Sc., F.Z.S.—The Fauna of the Cocos-Keeling Atoll.

2. Grouse-Disease Commission Reports:

(*a*) A. E. Shipley, M.A., D.Sc., F.R.S., F.Z.S.—The Ectoparasites of the Grouse.

(*b*) A. E. Shipley, M.A., D.Sc., F.R.S., F.Z.S.—The Thread-Worms (Nematoda) of the Red Grouse (*Tetrao scoticus*).

(*c*) A. E. Shipley, M.A., D.Sc., F.R.S., F.Z.S.—The Tape-Worms (Cestoda) of the Grouse. Appendix: Parasites of Birds allied to the Grouse.

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Communications intended for the Scientific Meetings of the Zoological Society of London should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

3 Hanover Square, London, W.

*December* 22*nd*, 1908.

CONTENTS (*continued*).

## December 15, 1908.

# LIST OF PLATES.

1908, pp. 783–983.



## NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1908, p. . . . The Distribution is as follows:—

Papers read in January and February, issued in June.
,, ,, March and April, ,, ,, August.
,, ,, May and June, ,, ,, October.
,, ,, November and December, ,, ,, April.

'Proceedings,' 1908, pp. 431–782, were published on Oct. 30th, 1908.

**The Abstracts of the papers read at the Scientific Meetings in November and December are contained in this Part.**