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1906.

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ERRATUM.

PLATE XLVII.: Numbers 4 and 5 should be transposed; that is to say, the lower figure represents *Doridopsis nigra* and should be numbered 5, while the upper figure represents *Doriopsilla miniata* and should be numbered 4.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY

OF LONDON.

1906.

PAGES 463-758.

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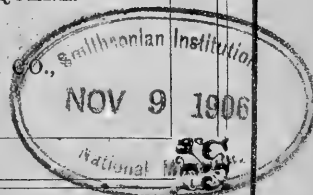
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PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

(May to December, 1906.)

May 1, 1906.

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

The Secretary read the following report on the additions that had been made to the Society's Menagerie in March 1906:—

The registered additions to the Society's Menagerie during the month of March were 124 in number. Of these 52 were acquired by presentation and 6 by purchase, 44 were received on deposit, 12 in exchange, and 10 were born in the Gardens. The total number of departures during the same period, by death and removals, was 182.

Amongst the additions special attention may be directed to:—

A young female Gorilla (*Anthropopithecus gorilla*) from Cape Lopez, purchased on March 30th.

A young male Lar Gibbon (*Hylobates lar*) and a Leopard Cat (*Felis bengalensis*) from Perak, presented by the Perak State Museum on March 31st.

A Narrow-banded Mongoose (*Galidictis vittata*) from Madagascar, new to the Collection, deposited on March 12th.

A female Eland (*Taurotragus oryx*), born in the Menagerie on March 12th.

A new Species of Duiker.

Mr. Oldfield Thomas, F.R.S., exhibited the skin of a Duiker which had been shot in Nyasaland by Mr. S. W. Frank, and presented by him to the National Museum. It proved to be a

most distinct new species, widely different from any known form, and was described as follows:—

CEPHALOPHUS WALKERI Thos.* (Plate XXXV.)

Abstr. P. Z. S. No. 31, p. 1, May 8, 1906.

Size medium, about as in *C. leucogaster*. General ground-colour of body dark greyish brown (between sepia and Prout's brown), the hairs finely speckled with pale buffy; but along the back, over an area about six inches wide, the speckling died out, and the colour darkened to nearly black, the hairs here being "hair-brown" at their bases and dark blackish brown at their tips. Under surface and inner side of limbs little lighter than sides, about "hair-brown." Top of muzzle brownish black; forehead to between ears, including the frontal tuft, deep glossy black. Cheeks and chin pale fawn, a narrow edging to the black above the eyes stronger buffy. Ears large, their backs grizzled brown or blackish, their bases and the fringe along their anterior edges fawn. Nape with a narrow median black line connecting the frontal and dorsal areas of black, edged on each side first with a lighter and then with a rather darker longitudinal band. Limbs wholly dark, before and behind, the digits nearly black. Tail imperfect in the type, its base dark above, dull whitish below.

Length of fore foot, from "knee" to tip of hoof, 180 mm., this being about the same length as in *C. leucogaster* and other middle-sized species. No other exact measurement was obtainable, but the prepared skin was 33 inches from nose to base of tail.

Hab. Tuchila River, about 25 miles from Blantyre, Nyasa.

Type. Adult female; skin without skull. B.M. No. 6.4.21.1. Shot in September 1905, and presented by Mr. Samuel W. Frank.

This interesting Duiker differed so widely from any known species that Mr. Thomas found it difficult to say to what group of the genus it should be assigned. Perhaps it would prove to have an affinity with *C. niger*, but in any case no definite opinion could be expressed until male specimens, with skulls and horns, had been obtained.

In some respects Herr Neumann's description of *C. leucoprosopus* † applied to *C. walkeri*, but the statements that in the former "Bauch, Innenseite der Beine und Kehle sind weiss" and "die Stirn ist roth" conclusively proved that it could not be of the same species.

By Mr. Frank's wish the species had been named after Mr. E. G. Walker, of Ndirandi, Blantyre, who had actually shot the specimen, though Mr. Frank had been the first to see it.

The following papers were read:—

* [The complete account of the new species described in this communication appears here; but since the name and preliminary diagnosis were published in the 'Abstract,' the species is distinguished by the name being underlined.—EDITOR.]

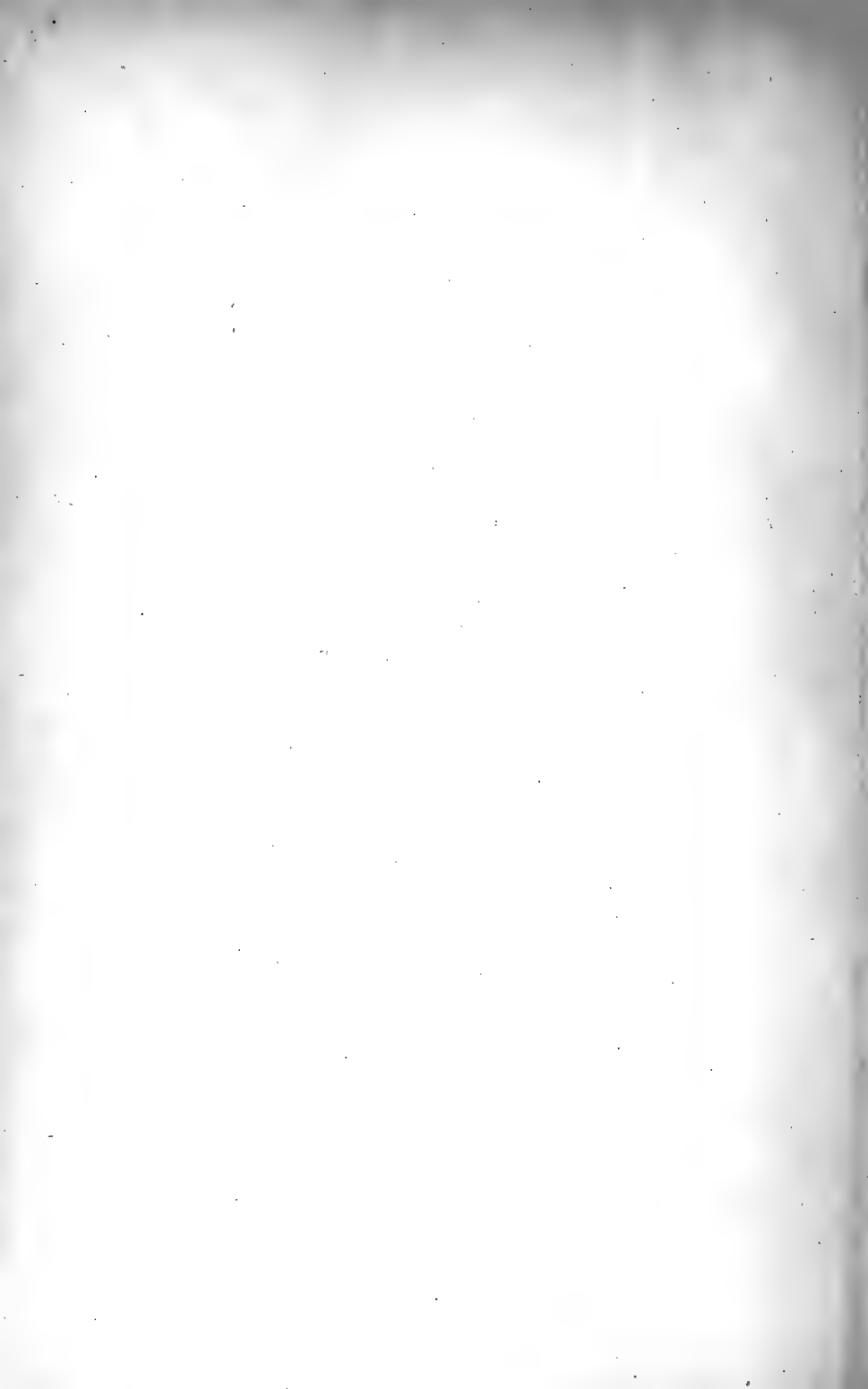
† SB. Ges. nat. Fr. Berl. 1899, p. 18.



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CEPHALOPHUS WALKERI.



1. Further Notes on Anthropoid Apes.

By the Hon. WALTER ROTHSCHILD, Ph.D., F.Z.S.

[Received May 1, 1906.]

Since my former paper (P. Z. S. 1904, vol. ii. pp. 413-440) was read, I have obtained a considerable amount of fresh material including skins, skeletons, and skulls of *Gorilla*, *Simia*, and *Pongo*. I propose, however, here to deal only with a few facts, corrections, and additions in connection with the genera *Gorilla* and *Simia*.

I have received several fresh skulls of *Gorilla gorilla matschiei* from the Camaroons collected by Mr. Bates, and they fully confirm both the distinctness of this geographical race and my diagnostic characters. A point in connection with these Gorillas I omitted to mention in my original article is that both *Gorilla gorilla* from Gaboon and *Gorilla gorilla matschiei* from S. Camaroons have individuals with red heads and others with dark heads with no red. In the case of the typical Gaboon *Gorilla gorilla* the red-headed individuals outnumber the dark ones by 4 to 1, but of the S. Camaroons race, although we have a large number of skulls, the skins are too few to enable me to gauge the proportion.

In *Gorilla gorilla* the dark-headed specimens have the head of a brownish-olive colour, while in *G. g. matschiei* the dark-headed individuals have a rufous-brown head. A striking difference between red-headed specimens of *G. gorilla* and *G. g. matschiei* is that in the former the red colour is sharply defined, while in the latter the brown forehead passes gradually into a deep rufous red on the crown and occiput.

In a former collection Mr. Bates sent a skull of Professor Matschie's *G. gorilla diehli* and in his last collection is a not very perfect skin of this race of Gorilla. As Prof. Matschie described the race from skulls only, this specimen completes the diagnosis.

GORILLA GORILLA DIEHLI Matschie.

Differs from the dark-headed specimens of other races in having the head almost entirely black, only the forehead having a few brown hairs. Black colour of arms and shoulders very intense. Back, belly, legs, and chest ashy grey, but darker than in *G. gorilla* and *G. g. matschiei*. Beard on chin much longer than in *G. g. matschiei*, thus proving that *G. beringeri* of Kirunga is only a local race of *G. gorilla* and not a distinct species; the latter must stand as *Gorilla gorilla beringeri* Matschie. Beard on sides of face black, instead of yellowish grey as in *G. g. matschiei* or ashy grey as in *G. gorilla*.

Professor Matschie has recently described (Sitzungsber. naturforsch. Fr. Berl. Nr. 10, pp. 279-283, 1905), under the name of *Gorilla jacobi*, another race of *Gorilla gorilla*. The type came from the station at the mouth of the Lobo River, near the influx of the River Djong, in the Dscha river-system, West Central Camaroons. The characters given depend on the immensely broad bones of the

skull, compressed face, and large size; the measurements given here explain this:—

GORILLA GORILLA MATSCHIEI.	GORILLA GORILLA JACOBI.
<i>Hind surface of Head:</i>	
Greatest breadth at the mastoid processes 170 mm.	182 mm.
Length of skull from <i>arcus superciliaris</i> to front of <i>premaxilla</i> 160 mm.	138 mm.
<i>Premaxilla</i> across canine alveolæ 90 mm.	78 mm.
Width at last molar tooth 67 mm.	70 mm.
Width outside upper edge of eye 145 mm.	154 mm.

We thus know at present 5 geographical races of Gorilla as follows:—

Gorilla gorilla. Gaboon.

Gorilla gorilla matschiei. South Camaroons.

Gorilla gorilla jacobi. West Central Camaroons.

Gorilla gorilla diehli. North and Central Camaroons.

Gorilla gorilla beringeri. Kirunga, German East Africa.

I give here three comparative measurements of the 5 races of *Gorilla gorilla*, which show how very widely the proportions of the skulls differ:—

<i>Hind surface of Head.</i> Greatest width.	From centre of <i>Crista lambdoidea</i> to anterior edge of <i>Foramen magnum</i> .	Length of skull from <i>Arcus superciliaris</i> to end of <i>Premaxilla</i> .
<i>Gorilla gorilla</i> 166 mm.	136 mm.	174 mm.
<i>Gorilla gorilla diehli</i> 178 mm.	115 mm.	144 mm.
<i>Gorilla gorilla beringeri</i> 145 mm.	105 mm.	134 mm.
<i>Gorilla gorilla jacobi</i> 182 mm.	.....	138 mm.
<i>Gorilla gorilla matschiei</i> 177 mm.	140 mm.	160 mm.

It may appear ridiculous to some that the Gorillas of the Camaroons should be divided into 3 races, but I must remind my readers that these large Apes, like the Orangs, probably cannot swim and therefore these races are separated and entirely isolated by the large rivers. I have in my possession 1 *Gorilla gorilla diehli* and 4 *Gorilla gorilla* and skulls of each, and also 2 skulls of *Gorilla gorilla matschiei*.

Besides much other material of great interest, I have received a

fully adult skin and skeleton and several skulls of *Simia vellerosus fuliginosus* (Schauf.), and from these I am able to point out the most striking differences between the skulls of this form and of an adult *Simia vellerosus* and to give measurements of both. The specimens came from Sette Cama.

SIMIA VELLEROSUS.

Crista sagitalis:
Slightly developed; greatest height 3 mm.

Supra- and exoccipital ankylosed:
Ovoid; from top of *crista* to base of *foramen magnum* 47 mm.; width 83 mm.

Parietals (together):
Length 62 mm.; breadth 95 mm.

Frontals (together):
Length 76 mm.; breadth at *arcus superciliaris* 114 mm.

Nasals:
Length 36 mm.; breadth 15 mm.

Premaxilla:
Length 30 mm.; breadth across *canines* 62 mm.

Length of *skull* front of *arcus superciliaris* to front of *Premaxilla* 97 mm.

Hinder surface of head:
Greatest breadth at *mastoid processes* 123 mm.
Breadth above *mastoid processes* 85 mm.

Foramen magnum:
Length 30 mm.; breadth 25 mm.
Breadth outside *occipital condyles* 39 mm.

Basioccipital:
Length from front edge of *foramen magnum* 28 mm.

Occipital condyles:
Breadth at base 38 mm.
Breadth at anterior edge 29 mm.

Vomer:
Length 24 mm.
Breadth 9 mm.

Pterygoid processes of sphenoid:
Length 35 mm.
Breadth singly 13 mm.
Breadth across 50 mm.

Articular condyle of lower jaw:
Width 26 mm.

Coronoid process:
Greatest width 18 mm.

Width between *coronoid process* and *articular condyle* 24 mm.

Width from outside *coronoid process* to outside *articular condyle* 54 mm.

Width between *canines of upper jaw* 39 mm.

Lower jaw from base of canine to outer edge of articular condyle 128 mm.

Width of *facial part of skull* at *zygoma* 124 mm.

SIMIA V. FULIGINOSUS.

Strongly developed; greatest height 9 mm.

Triangular; from top of *crista* to base of *foramen magnum* 47 mm.; width 77 mm.

Length 72 mm.; breadth 87 mm.

Length 76 mm.; breadth at *arcus superciliaris* 106 mm.

Length 30 mm.; breadth 16 mm.

Length 33 mm.; breadth across *canines* 58 mm.

95 mm.

126 mm.
84 mm.

Length 25 mm.; breadth 21 mm.

41 mm.

28 mm.

37 mm.
26 mm.

23 mm.
10 mm.

41 mm.
11 mm.
42 mm.

24 mm.

29 mm.

58 mm.

32 mm.

135 mm.

106 mm.

Besides the very striking differences in the supra- and exocci-

pital portion of back of the head, the measurements show that most of the bones of the skull are differently proportioned. The width of the face in *S. vellerosus*, moreover, is very much greater than in *S. v. fuliginosus*.

2. On Mammals collected in South-west Australia for Mr. W. E. Balston. By OLDFIELD THOMAS, F.R.S.*

[Received March 7, 1906.]

Following the generous example of our President and Mr. C. D. Rudd, Mr. W. E. Balston has been good enough to defray the expenses of a zoological collector, working for the benefit of our National Museum. The country chosen is Western Australia, where Mr. Balston has many personal interests, and where few Mammals have been collected since Mr. Gilbert, about 1842, made a collection for Mr. Gould, who was then preparing his great work on the Mammals of Australia.

For his exploration of Western Australia Mr. Balston has secured the services of Mr. Guy C. Shortridge, who had already had experience in Pondoland, South Africa, where he had collected Mammals and Birds for the South African Museum.

The collections worked out in the present paper were obtained during the end of 1904 and the course of 1905 from the following localities:—

King River, on Mr. Balston's estate near Albany, King George's Sound, where Mr. Shortridge had the assistance of Mr. Balston's sons.

Wagin, on the railway halfway towards Perth.

Beverley, just south of York, about 70 miles east of Perth.

York, Northam, Toodyay, and the Wongan Hills, all near together, are the localities which most frequently occur on Mr. Gilbert's labels.

Southern Cross, on the Eastern Railway, about 220 miles east of Perth.

Kalgurli, the gold-mining town, 140 miles further east, and about 200 miles from the south coast.

Laverton, 150 miles N.E. of Kalgurli, and about 470 miles inland from the west coast at Geraldston.

While the collections made at the first four places are full of interest and value, it has been a great disappointment to find that the gold-field country, at the two last-named localities, does not contain any desert mammal fauna, Mr. Shortridge having found that practically all mammals were absent except Bats. This seems to be due to the fact that the whole area is saline, without fresh water of any sort. Still further east, on the *Spinifex* flats, Mr. Shortridge has hopes of finding a desert fauna

* [The complete account of the new species described in this communication appears here; but since the names and preliminary diagnoses were published in the 'Abstract,' such species are distinguished by the name being underlined.—EDITOR.]

comparable with that occurring in Central Australia, the region of *Notoryctes*.

But even in the fertile south-west area, although the country supports a mammal-fauna rich in individuals, that richness is unfortunately now largely made up of introduced animals—cats, rabbits, rats, and mice, which appear to be the dominant members of the fauna at most places. Many of the smaller species, found in numbers by Mr. Gilbert in 1842, would seem to have been almost or quite exterminated by these introduced pests, and Mr. Shortridge has had great difficulty in catching any but the latter.

The following extract from a letter of his from Beverley will give some idea of the character of the country and his trapping experiences:—

“There are so many trappers about that I am beginning to get a good idea of the distribution of most of the larger mammals. With the exception of *Pseudochirus occidentalis*, I think I have obtained all the well-known larger mammals around Albany.

“There is a very well-defined coast-belt extending about 25 to 30 miles inland, which is generally low and rather swampy, thickly covered with Jarrah and Red-Gum trees intermixed with very thick undergrowth. On following the railway northwards from Albany, the country makes a sudden change at about Mount Barker, where the grass-land begins; it then remains very much the same as far as York, the White Gum being the most plentiful tree and the undergrowth being replaced by grass. The country in the grass-region is much easier to hunt in, as there are patches of undergrowth here and there where the animals collect. In this district there are many species which are quite unknown around Albany; in fact, all the mammals and birds which I got during a fortnight's stay at the Arthur River, 20 miles west of Wagin, were different to those collected around Albany. I secured specimens of *Macropus eugenei*, *Onychogale lunata*, *Thalacomys lagotis*, and *Bettongia lesueuri*, and I heard that Spiny Anteaters, Dasyures, and *Chæropus castanotis* were also plentiful around the district.”

The collection now described contains examples of 32 species, of which two bats have proved to be new, while I have also given subspecific names to the Dasyure and Echidna, which have been previously known from Western Australia, but not distinguished from their eastern allies.

It is, however, not the novelties which give to this fine collection its very great value to the Museum, but the excellent series of specimens belonging to species of which the original examples have become deteriorated by time, and in many cases by that most destructive agency of all, exhibition in a public gallery. These good modern specimens, for which we are indebted to the generosity of Mr. Balston, will now form a basis on which further scientific work can be done on the fauna of this most interesting region.

1. NYCTOPHILUS TIMORIENSIS Geoff.

♀ (Bat *b*). King River, King George's Sound. Near sea-level. 190, 191. Southern Cross. 1160'.

Forearms 44-45 mm.

2. NYCTOPHILUS GEOFFROYI Leach.

♂. 166. Jaurdi Hills, near Kalgurli. 1250'.

♂. 175. ♀. 176, 189. Laverton. 1650'.

These specimens are of much interest, for they conclusively prove the correctness of Mr. Tomes's assertion that the small *N. geoffroyi* of Leach, with a forearm of about 35-36 mm., is a different species from *N. timoriensis*. Tomes's specimen No. 1, from Albany, King George's Sound, recently acquired with his collection by the British Museum, may be treated as typical of Leach's species, whose type was without locality.

Mr. Shortridge's specimens agree very well with this Albany individual in proportions, but are rather browner in colour.

3. VESPERTILIO PUMILUS Gray.

♂ (Bat *a*). 2 & 3. King River, King George's Sound. Near sea-level. February.

♂. 139, 141, 142, 143. Parker's Range, Southern Cross. 1163'. 9-17 August.

♂. 161, 164. ♀. 140, 148, 162, 163, 167. Jaurdi Hills, Kalgurli. 1250'. 21 Sept.-5 Oct.

"The most plentiful bat around Albany."—*G. C. S.*

4. PIPISTRELLUS TASMANIENSIS Gould.

Noctulina tasmanensis Gray, List Mamm. B. M. p. 194 (1843) (*sine descr.*).

Vespertilio tasmaniensis Gould, Mamm. Austr. iii. pl. xlviii. (1858).

Vesperugo krefftii Peters, MB. Ak. Berl. 1869, p. 404; Dobson, Cat. Chir. B. M. p. 232 (1878).

♀ (Bat *c* 1). King River, King George's Sound, 26 February, 1905. Near sea-level.

This is a very rare bat, no previous specimen having reached the Museum since the original type referred to by Gray and Gould. Another example, from Tasmania, is in the Tomes collection.

5. PIPISTRELLUS REGULUS, sp. n.

Bats 4, 5. King River, King George's Sound. Sea-level.

A medium-sized species of the group with minute outer incisors. Size rather larger than in *P. kuhlii*. Fur rather long and shaggy (hairs of back slightly over 5 mm. in length), extending thickly as a well-defined band on the interfemoral above for its basal half-inch to the level of the knees. Below, the same area is more thinly covered, and there are a few hairs on the membrane near the sides of the body. General colour above dark Prout's

brown, the terminal third of the hairs lighter and more approaching russet, especially posteriorly, the basal two-thirds blackish. Below, the ends of the hairs are nearer wood-brown, except on the interfemoral band, where they become whitish. Ears small, too much shrunk and distorted for exact description, but their inner margin appears to be unusually convex; tragus not broadened. Wings to the base of the toes. A narrow post-calcareal lobule present.

Skull long and narrow, with an unusually low flattened brain-case; no occipital helmet, the lambdoidal crests commencing rather low down on each side.

Inner upper incisor bifid, with a well-marked external secondary cusp near its tip, wearing off in older specimens. Outer incisors small, not reaching halfway from the cingulum to the outer cusp of the inner incisors; hollowed out behind to receive the tip of the lower canine; a small secondary cusp on its internal edge. Small premolar quite minute, crushed in the angle between the canine and second premolar, which press against each other outside it; it is evidently in an extreme state of reduction, and has become altogether lost on one side in the type. Lower incisors tricuspid, transverse, overlapping.

Dimensions of the type, measured in skin:—

Forearm 38 mm.

Head and body (c.) 47 mm.; tail 44; third finger 65; lower leg and foot (c.u.) 26.

Skull—greatest length to base of incisors 12·7; basal length in middle line 9·5; mastoid breadth 7·2; intertemporal breadth 3; palate length 4·6; front of canine to back of m^3 4·7; front of lower canine to back of m_3 5.

Type. No. 4, sex not ascertainable. B.M. No. 6.8.1.18.

Although without any very strongly marked characteristics, this dull-looking little bat does not agree with any species hitherto described. Altogether Australia is poor in members of this widely distributed genus, the only other Pipistrelles being one from N. Australia, referred to *P. abramus*, and the large and aberrant *P. tasmaniensis*.

The two specimens of *P. regulus* sent home by Mr. Shortridge were not captured by him, but were made into skins from old mounted specimens.

6. CHALINOLOBUS GOULDI Gray.

♂. 144, 145, 146, 147. Parker's Range, Southern Cross. 1163'. 9–17 August.

♂. 150, 151, 152, 153, 154, 155, 156, 157, 159. ♀. 149, 158, 160. Jaurdi Hills, near Kalgurli. 1250'. 21–24 September.

♂. 169. ♀. 168. North Pool, Laverton. 1650'. 28 October. Not previously recorded from Western Australia.

7. CHALINOLOBUS MORIO Gray.

♂. 50 (in spirit). King River, King George's Sound.

8. *SCOTEINUS BALSTONI* THOS.

Abstr. P. Z. S. No. 31, p. 2, May 8, 1906.

♂. 173. ♀. 170, 171, 172. North Pool, Laverton, 1650'.
19-26 October, 1905.

♀. 177 (in spirit). Hawksnest, Laverton. 1650'. 7 November.

Allied to *S. greyi* Gray; the fur bicolor instead of unicolor.

General characters and size very much as in *S. greyi* *. Fur of medium length; hairs of back about 4.5 mm. in length. General colour above, when the hairs are smoothed down, pale brown (varying from a tone between wood-brown and fawn to one between fawn and drab), this colour occupying the terminal third of the fur, the basal two-thirds being dark smoky brown, contrasting markedly with the light tips. Below, the hairs are equally dark at base, with their tips pale pinkish buff. Hairs of chin, throat, and pubic region nearly or quite pale to their bases. Ears and membranes pale brown throughout.

Ears slightly larger than in *S. greyi*, but very similar in shape. Wings to the base of the outer toe. A well-marked postcalcareal lobule present.

Skull broad, stout and flat, as usual in this group; larger and flatter than in the alcoholic topotype *a* of *S. greyi*. A well-marked occipital "helmet" present, but the anterior ridge from it does not run forward on to the middle line of the frontals, where, indeed, there is a slight longitudinal concavity. Brain-case rather small in proportion to the size of the skull.

Teeth about as in *S. greyi*. Upper incisors standing rather further away from the canines.

Dimensions of the type, the starred measurements taken in the flesh:—

Forearm 36 mm. (four other specimens 34-35).

*Head and body 55; *tail 40; *hind foot 7; *ear 15 (13 in a spirit-specimen).

Skull—greatest length to base of incisors 15; basal length in middle line 10.8; zygomatic breadth 10.1; front of upper canine to back of m^3 5.2; front of lower canine to back of m_3 5.9.

Type. Adult female. B.M. No. 6.8.1.41. Original number 170.

Although the essential characters of this bat are very much as in *S. greyi*, its conspicuously different bicolor fur readily separates it from that species, whose fur is quite unicolor, dark brown or chestnut. No doubt better material of *S. greyi*, for comparison, would show further points of difference.

I have had much pleasure in naming this well-marked species in honour of Mr. Balston, to whose generosity science is indebted

* The alcoholic specimen *a* of *S. greyi*, called "*type*" by Dobson (who was under the impression that the species was first described by himself), is rather smaller than the skin figured by Gray in the 'Voyage of the Erebus and Terror,' specimen *b* of Dobson's Catalogue. Now that a named figure is recognised as conferring priority, the species will stand to Gray's credit, with specimen *b* the type of it. Even were Gray's naming invalid, however, Gould's description in the 'Mammals of Australia' (1858) would antedate Dobson's.

for the valuable results due to Mr. Shortridge's expedition to Western Australia.

9. *NYCTINOMUS AUSTRALIS* Gray.

♀. 176. North Pool, Laverton. 29 October, 1905. 1650'.

This is the first record of this fine species in Western Australia. The specimen does not seem to differ in any important respect from the type described by Gray.

That type, however, is not specimen *α* of the Catalogue, a spirit example presented by Mrs. Stanley in 1855, but specimen *δ*, which was purchased in 1861 at Stevens's sale-rooms, from the collection of the United Service Museum, to which it had been given in or before 1838 by Major Macarthur. Both the original description by Gray in 1838, and an independent one by Gould in the 'Mammals of Australia' (1858), agree so closely with this specimen as to show that no error has been made in tracing its history.

Mr. Shortridge says: "These Bats come out rather late and are swift flyers. When passing over water they often dive right into it, probably in pursuit of water-beetles. The stomach contained remains of beetles."

10. *MUS RATTUS* L.

♂. 53, 61, 62. ♀. 60. King River.

11. *MUS NORVEGICUS* Erxl.

♂. 69. ♀. 59. King River.

12. *MUS MUSCULUS* L.

♂. 126, 129, 130, 131. ♀. 127, 128. Cookerdine Lake Southern Cross. 1163'.

♂. 133. ♀. 132. Parker's Range, Southern Cross.

♂. 165. Jaurdi Hills, near Kalgurli. 1250'.

♀. 174. North Pool, near Laverton. 1650'.

♀. 178. Hawksnest, near Laverton. 1650'.

♂. *1, 4, 5, 6, 39, 52, 64. ♀. 3, 9, 17, 33, 38, 51. King River.

13. *MUS FUSCIPES* Waterh.

♂. 9, 12, 14, 15, 31. ♀. 6, 7, 10, 11, 32, 54, 63. King River.

These specimens are clearly Waterhouse's *M. fuscipes* †, of which they are practically topotypes, while the aquatic Rat figured and described by Gould as *M. fuscipes* in the 'Mammals of Australia' ‡ should bear Gray's name of *M. lutreola* §.

* The figures in italics represent specimens numbered by species before Mr. Shortridge commenced the continuous notation of his skins.

† Zool. Voy. 'Beagle,' Mamm. p. 66, pl. xxv. (1839).

‡ Vol. iii. pl. xi. (1851).

§ Grey's 'Expeditions in Australia,' ii. Appendix, p. 409 (1841).

14. *HYDROMYS FULIGINOSUS* Gould.

♂. 8, 57. ♀. 4, 65. King River.

♂. 4, 6. ♀. 5. Big Grove, King George's Sound.

"Trapped near water. Feeds chiefly on fresh-water Crustacea."
—*G. C. S.*

These specimens all agree in their dark colour with the original specimens described by Gould.

15. *MACROPUS GIGANTEUS* Zimm.

♀. 18. King River. 100'.

Represents the *M. ocydromus* of Gould.

"Caught by dog. Not plentiful around King River."—*G. C. S.*

16. *MACROPUS RUFUS* Desm.

♂. 182, 183, 184, 185, 186, 188. ♀. 180, 181, 187. Hawks-
nest, near Laverton. 1650'.

One of these specimens, a male, is abnormal in having a well-marked rudimentary pouch in the position of that of the female. Only one of the testes of this example had descended into the scrotum.

Although at the date of the 'Catalogue of Marsupials' the Red Kangaroo was not known with certainty to occur in Western Australia, it has since been recorded by several observers, and Mr. Rothschild has given a subspecific name to a form of it from the north-west corner of the continent.

17. *MACROPUS IRMA* Jourd.

♂. 23. Mount Barker, Southern Cross. 500'.

♂. 4, 44. ♀. 16. King River. 100'.

"Local name, 'Brush Kangaroo.' Seldom seen in the daytime, comes out to feed in the evening."—*G. C. S.*

18. *MACROPUS EUGENEI* Desm.

♀. 1. Arthur River, Wagin.

19. *MACROPUS BRACHYURUS* Quoy & Gaim.

♂. 19, 20, 23, 34, 56. ♀. 58, 67, 68. King River.

♂. 10, 11, 12, 13, 15. ♀. 9, 14, 16. Big Grove, King
George's Sound.

"Seems to be found only along the coast districts. Trapped in marshy ground with maize as bait."—*G. C. S.*

20. *ONYCHOGALE LUNATA* Gould.

♂. 2. ♀. 1. Arthur River, Wagin.

21. *BETTONGIA PENICILLATA* Gray.

♂. 5, 6. ♀. 3, 4, 35, 40. King River.

"Trapped with oatmeal."—*G. C. S.*

22. *BETFONGIA LESUEURI* Quoy & Gaim.

♀. 1, 2. Arthur River, Wagin.

23. *TARSIPES SPENSERÆ* Gray.

♂. 70. ♀. 2. King River.

"No. 70. Caught in the bottom of a well."

"No. 2. Had one young in the pouch; probably just born, being about the size of a grain of wheat."—*G. C. S.*As Mr. Palmer has shown*, Gray's name *spenseræ* has priority of publication over that of *rostratus* given by Messrs. Gervais and Verreaux.24. *DROMICIA CONCINNA* Gould.

♀. 192. Southern Cross.

25. *TRICHOSURUS VULPECULA* Kerr.

♂. 24, 25, 27, 28, 30. ♀. 26, 29. Mt. Barker.

♂. 41, 48, 49, 55, 73, 74. ♀. 3, 4, 20, 36, 42, 45, 46, 47, 66, 71, 72. King River.

"Trapped among Red Gums. Bait, oatmeal."—*G. C. S.*The majority of these specimens have the end of the tail white, thus corresponding with Ogilby's *Phalangista xanthopus*†.

Mr. Shortridge says that "specimens without the white tip to the tail are considered rare."

26. *THALACOMYS* ‡ *LAGOTIS* Reid.*Peragale lagotis* of the 'Catalogue of Marsupials.'

♂. 1. Arthur River, Wagin.

♀. 134. Parker's Range, Southern Cross.

"The tail seems to be slightly prehensile."—*G. C. S.*27. *ISOODON OBESULUS* Shaw.*Perameles obesula auctorum.*

♂. 21. ♀. 1. King River.

♂. 3, 5. ♀. 4. Big Grove, King George's Sound.

♂. 6. Arthur River, Wagin.

"Native name, 'Waint.'

"Trapped in marshy country."—*G. C. S.*

It appears to me that it would be more in accordance with the modern estimate of the value of genera to subdivide the old genus

* Index Gen. Mamm. p. 664, footnote (1904).

† P. Z. S. 1831, p. 135.

‡ Mr. Palmer (Index Gen. Mamm. p. 677, 1904) criticises my adoption of the term *Thalacomys* for this genus on the ground that it is an "obvious misprint" for *Thylacomys*, which latter was used (but as a *nomen nudum*) in the 'Athenæum' two years before Blyth put *Thalacomys* in a tenable manner in his 1840 edition of Cuvier. But we ought to be very chary of changing names, supposed to be misprints, unless their obviousness as such is quite clear, and in this case I do not think we are justified in calling *Thalacomys* a misprint, when it was the second of the two forms to occur, as though it had been "corrected," and was again twice repeated by its author in subsequent editions (*cf.* Ann. Mag. N. H. [7] v. p. 222, 1900).

Perameles into four, corresponding to the groups A, c, e', and f' of the cranial synopsis of the species in the 'Catalogue of Marsupials.' These are all natural groups of species, easily distinguishable both by external and by well-marked cranial characters, as follows:—

ISOODON Desm.

Type, *I. obesulus*. Other species, *macrurus*, *moresbyensis*, *auratus*, *barrowensis*.

Incisors $\frac{5}{3}$. Bullæ large, complete, pear-shaped.

ECHYMIPERA Less.

Type, *E. doreyana*. Other species, *cockerelli*.

Incisors $\frac{4}{3}$. Bullæ small, hemispherical, more or less incomplete.

PERORYCTES, g. n.

Type, *P. raffrayanus*. Other species, *broadbenti*, *longicaudatus*, *ornatus*.

Incisors $\frac{5}{3}$. Bullæ as in *Echymipera*. Brain-case normal. Lacrymal bone rounded externally.

PERAMELES Geoff.

Type, *P. nasuta*. Other species, *gunni*, *bougainvillei*, *eremiana*.

Incisors $\frac{5}{3}$. Bullæ small, hemispherical, complete. Brain-case abnormally short. Lacrymal forming a sharp overhanging edge externally.

All the Australian species thus fall into *Isoodon* and *Perameles*, which were long ago recognised as very different groups by Gould. The other two genera are Papuan.

With regard to the name used for the first genus, *Isoodon*, I find on reconsideration that my selection of *obesula* as the type of *Thylacis* Illiger was incorrect, as it is in opposition to the sound principle supported by Dr. Allen*, that if a genus contains exactly the same species as an earlier one it is a synonym of that one, and no elimination or selection of different types can make it valid. For *Thylacis* (and *Thylax* Oken also) consisted of *obesula* and *nasuta*, which were likewise the constituent members of the original *Perameles*, so that neither *Thylacis* nor *Thylax* can be withdrawn from their positions as full synonyms of that genus, and the next name in date, *Isoodon*, has to be taken for the common Australian Bandicoot.

28. DASYURUS GEOFFROYI FORTIS, subsp. n.

♂. 1, 2. Arthur River, Wagin. Alt. 840'.

Similar in essential characters to true *geoffroyi*, but larger, the difference specially marked in male skulls. Externally *fortis* has the belly hairs whiter terminally, while in true *geoffroyi* they are more or less tinged with creamy yellow. The underside of the tail is dark for a rather greater extent. Skin of palms,

* Bull. Am. Mus. N. H. xvi. p. 116 (1902). See also Thos., P. Biol. Soc. Wash. xv. p. 153 (1902).

sides and underside of digits wholly blackish; in *geoffroyi* there is generally a whitish tinge on these parts.

In the skull the only point to be noticed, besides the superior size, is that the bullæ are decidedly larger in *fortis* than in *geoffroyi*.

Dimensions of the type, measured in the flesh:—

Head and body 650 mm.; tail 350; hind foot 63; ear 50.

Skull—basal length 72 mm.

Type. Male. B.M. No. 6.8.1.340. Original number 1. Collected 1 July, 1905, by G. C. Shortridge.

In the 'Catalogue of Marsupials' I drew attention to the greater size of the West Australian representatives of the Black-tailed Dasyure; and now that Mr. Shortridge's specimens fully confirm the difference, I think the animal should have a subspecific name. More detailed skull-measurements are given in the Catalogue.

In the female sex there does not seem to be so marked a difference between the two forms, but the material available for comparison is at present very imperfect.

29. PHASCOGALE FLAVIPES LEUCOGASTRA Gray.

♂. 1, 4. ♀. 2, 3, 5. King River.

These fresh examples of the West Australian form of *Ph. flavipes* are very welcome, as the few skins contained in the Museum collection are much deteriorated. Mr. Shortridge's specimens, coming from the rainy south-west district, are of a rather more "saturate" colour than the old skins, but how much these latter have faded it is not easy to say.

30. SMINTHOPSIS MURINA Waterh.

♂. 1, 2, 3. King River.

"Trapped on marshy ground in Ti-tree scrub."—G. C. S.

31. MYRMECOBIUS FASCIATUS Waterh.

♀. 1. Arthur River, Wagin.

32. TACHYGLOSSUS* ACULEATUS INEPTUS Thos.

Abstr. P. Z. S. No. 31, p. 2, May 8, 1906.

♂. 122, 123, 124. ♀. 125. Parker's Range, Southern Cross.

A very spinous form, with small brain-case and short snout.

Coat completely spinous, no hairs perceptible on the upper surface at all, except the well-marked tuft over each ear. Below also the fur consists wholly of flattened bristles. Colour above more mottled than usual, owing to the large proportion of white or black and white spines. Third hind claw not lengthened, little longer than the fourth, as usual in typical *aculeatus*.

Skull small, with a fairly broad but not greatly inflated brain-case and very short snout. As a result the index of breadth is as high as in the large Tasmanian *T. a. setosus* (average of three

* Not *Echidna*. See Ann. Mus. Genov. [2] xviii. p. 621 (1897).

skulls 45·1), while the rostral index (78·8) is very considerably less than in any specimens hitherto recorded.

The following measurements, when compared with the table I published in 1885*, will show these differences better than any description :—

	Greatest length.	Greatest breadth.	Index of breadth.	Length of brain-case.	Length of rostrum.	Rostral index.	Inter-orbital breadth.
123 ♂ ...	104	47·8	45·9	56·5	43·5	76·9	15·5
124 ♂ ...	103·5	46·7	45·1	54·5	43	78·8	15
125 ♀ ...	103·8	46	44·3	54·5	44	80·7	15·5
Averages...	103·7	46·8	45·1	55·1	43·5	78·8	15·3
Averages in true <i>aculeata</i> }	110·9	45·7	41·2	53·4	53·2	99·7	—

As usual in mainland specimens there are no condyloid vacuities. Nasal and anterior palatine foramina short. Postorbital projection unusually strongly marked. Anterior, cylindrical, part of zygomatica bowed downwards, so as to form a more or less downwardly projecting angle; as a result of this, when the skull is laid on a flat surface the tip of the muzzle stands up some way above the surface, as though the muzzle itself were bent upwards; in true *aculeata* it lies perfectly flat.

External dimensions of the type, taken in the flesh :—

Head and body 420 mm.; tail 90; hind foot 55.

Type. Adult male. B.M. No. 6.8.1.363. Original number 123. Collected 16 August, 1905.

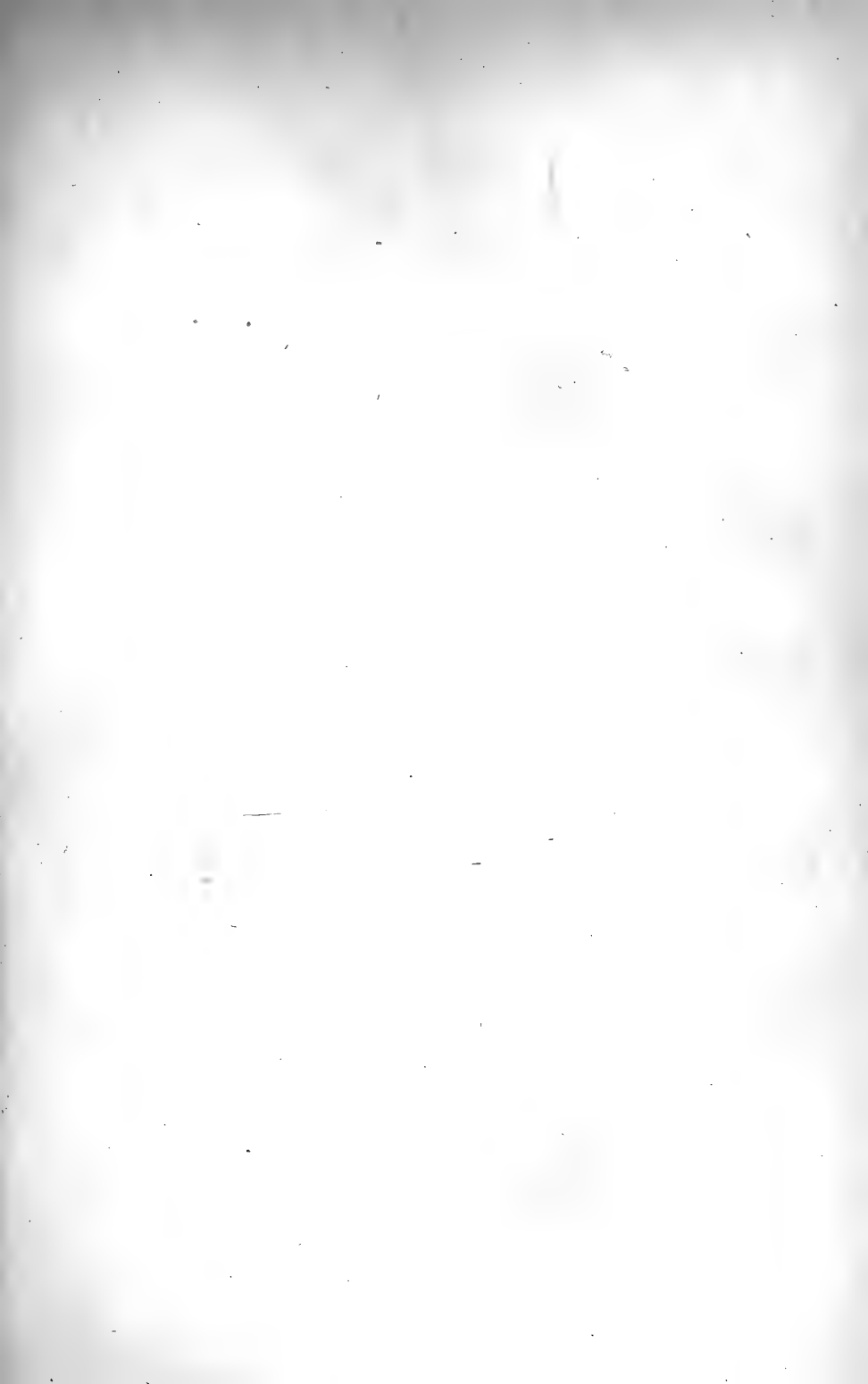
The first discoverer of the *Echidna* in Western Australia was Mr. Gilbert, who, in collecting for Mr. Gould about 1840, obtained specimen *h* of the 'Catalogue of Marsupials.' Another example, in every way similar to those now sent by Mr. Shortridge, was presented to the Museum by Baron F. von Müller in 1888. The animal has therefore long been known to inhabit this region, but for a knowledge of its correct affinities we are indebted to the uniform series presented by Mr. Balston.

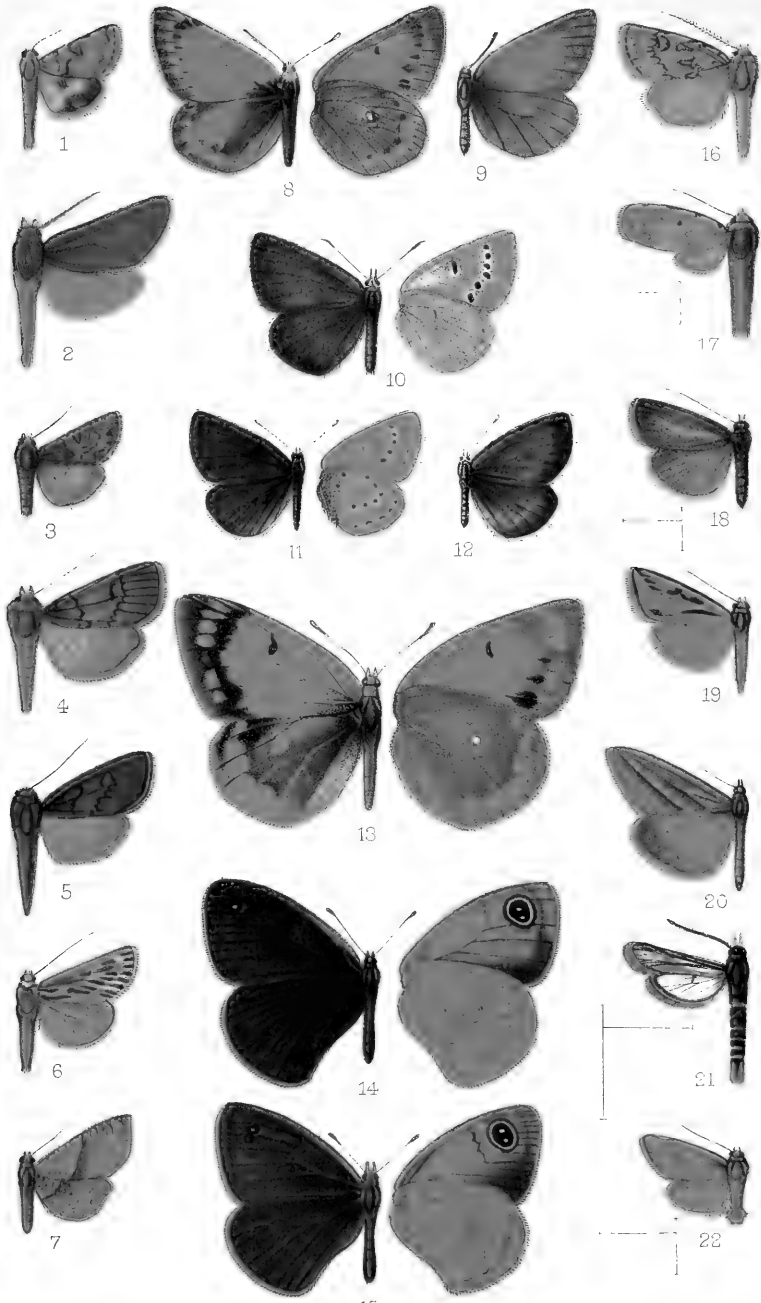
That West Australia should possess a special race is only natural, since New Guinea, Eastern Australia, and Tasmania have each a characteristic form.

In Mr. Rothschild's recent description of *Echidna hystrix multiaculeata* † no reference is made to the skull; but from the locality (South Australia) and the presence of hairs between the spines it would appear to have nothing to do with *T. a. ineptus*.

* P. Z. S. 1885, p. 335.

† Nov. Zool. xii. p. 306 (1905).





Horace Knight del. et lith.

West, Newman chromo.

3. On the Lepidoptera collected by the Officers on the recent Tibet Frontier Commission. By H. J. ELWES, F.R.S., F.Z.S., Sir GEORGE HAMPSON, Bt., F.Z.S., and J. HARTLEY DURRANT, F.E.S.

[Received May 1, 1906.]

(Plate XXXVI.*)

BUTTERFLIES.

By H. J. ELWES, F.R.S.

A large collection of Butterflies was sent to the British Museum in 1905 made by various officers who took part in the Tibet Frontier Commission in 1903 and afterwards accompanied the Expedition to Lhasa. The localities in which they were taken have been so fully described by Capt. H. J. Walton, who was Medical Officer and Botanist to the Commission, in 'The Ibis' for January 1906, that I need not say much about the country; but remembering that the expedition was, during a large part of the time, in a state of actual warfare and that there was no entomologist with the party, it will be understood that this collection must be regarded as only representing a part of the species which exist there.

The localities are as follows:—Tungu, a valley near the head of the Lachen River in Native Sikkim close to the Tibetan frontier, elevation 15,000–16,000 feet; Lhanak, a valley to the west of this at an equal or greater elevation; Khamba Jong, a Tibetan fort fifteen miles beyond the Kongra-lama Pass, at an elevation of 15,000–16,000 feet, where the Commission stayed during the summer of 1903; on the march from Phari to Gyantze in June and July 1904; Gyantze, where the Mission was besieged for some time and the greater part of the insects were collected; and at and near Lhasa, where a few specimens were afterwards taken in August. With a few exceptions most of the species enumerated are known to occur in Ladak.

My paper on Butterflies from Sikkim, P. Z. S. 1882, p. 398, should be referred to; also Col. Fawcett's paper, *op. cit.* 1904, ii. p. 134.

1. *PAPILIO MACHAON* var. *SIKKIMENSIS* Moore, J. A. S. B. 1884, p. 47.

Seems to be common in Alpine Sikkim and at Khamba Jong; some specimens have shorter tails than usual, approaching the variety *ladakensis* Moore.

2. *PARNASSIUS EPAPHUS* var. *SIKKIMENSIS* Elwes, P. Z. S. 1882, p. 399, pl. xxv. f. 4; rectius *jacquemonti* var., *id. op. cit.* 1886, p. 36.

Though Staudinger, Oberthür, and other writers have used the

* For explanation of the Plate, see p. 498.

name of *epaphus* for this insect, I venture to maintain the opinion expressed in my paper on the genus above cited, that it should properly be called *jacquemonti* Bdv. A few specimens only from Tungu and Lhanak.

3. PARNASSIUS IMPERATOR VAR. AUGUSTUS.

P. augustus Fruhstorfer, Insekten Börse, xx.

A fair series of specimens taken at Tungu and Khamba Jong seems to show that this form is not sufficiently unlike *imperator* to be distinguished, though some of the specimens are more yellowish in tint and more heavily marked than those from East Tibet, to which they come closer than to the form *imperatoria* Alph., with which Fruhstorfer compares it.

4. PARNASSIUS HARDWICKEI Gray.

Several specimens from Tungu; small and as variable as usual from this district.

5. PIERIS (APOBIA) DUBERNARDI Obth., var. CHUMBIENSIS Nicév. J. A. S. B. lxvi. p. 563, pl. i. f. 6.

A number of specimens from Gyantze, taken in June 1904, are smaller on the average than the type, and come nearer to the form from N.E. Tibet which has been called *koslovi* by Alphéraky.

6. PIERIS BRASSICÆ L.

A few specimens from Gyantze do not differ from those found in Alpine Sikhim and usually called var. *sikkimensis*.

7. PIERIS CANIDIA Sparrm. var. PALÆARCTICA Stgr. Stett. ent. Zeit. 1886, p. 198.

A good deal of variation is shown in the series sent from Tungu, Gyantze, and Lhasa, most of them being heavily marked and dark on the under side.

8. PIERIS MELETE VAR. AJAKA Moore, P. Z. S. 1865. p. 490.

A few from Tungu and Gyantze.

9. COLIAS BERYLLA Fawcett, P. Z. S. 1904, ii. p. 139, pl. ix. f. 8, ♀. (Plate XXXVI. fig. 13 ♂.)

C. nina, id. *op. cit.* p. 140, t. 9. f. 9, ♀.

A large series of this fine species from Khamba Jong and Gyantze shows so much variation that I am inclined to believe that *C. nina* is nothing more than an extreme form of the female. A much greater range of variation is found in some of the Tibetan Colias, especially in the females of *eogene*; and some females of the var. *arida* Alph. from N.E. Tibet are very similar to this. The specimens taken at Gyantze are on the average much darker in colour than those from Khamba Jong, and without the intermediate forms one might be able to distinguish them.

10. *COLIAS DUBIA*, sp. n. (Plate XXXVI. figs. 8♂, 9♀.)

Though very unwilling to add a new name to this difficult genus, which already suffers from much synonymy, I am unable to avoid so doing under the following circumstances, which I will describe chronologically:—

1. In 1865 Felder described from Ladak as *C. eogene* a large brilliant form which is now known to have a very wide range in Central Asia and to vary extremely, though the males without exception have a black unspotted marginal band on both wings.

2. In 1878 Moore described as *C. stoliczkana* a small high-Alpine form of this or possibly a distinct, species (*cf.* Elwes in J. A. S. B. 1898, p. 465).

3. In 1893 Grüm, in Hor. Soc. Ent. Ross. xxv. p. 477, described as *eogene* var. *leechi* a female collected by McArthur in Ladak, of which the type is now in the British Museum.

4. In 1904 Col. Fawcett (*cf.* P. Z. S. 1904, ii. pl. ix. figs. 10, 10 *a*) referred a species which now turns out to be quite distinct to var. *leechi* Grüm. I may say that *Colias cocandica* var. *leechi* Elwes, J. B. N. H. S. xi. p. 466, though it belongs to the same section and comes from the same valley in Ladak, the Chonging Valley, is a distinct species of a much paler colour and different pattern.

5. In 1903 Fruhstorfer described first in the 'Insekten-Börse' and afterwards in the 'Iris,' vol. xvii. p. 48, t. 1. 3♂, 4♀, a *Colias* from Alpine Sikhim as *C. eogene miranda*, which was stated by Col. Fawcett to have been described from his figures; but Mr. W. Rothschild has kindly lent me for comparison three specimens sent him by Fruhstorfer, of which two males are undoubtedly *stoliczkana*, and the female marked type is apparently the same species, but not the specimen figured by Fawcett, of which the female figured in the 'Iris' might be a bad copy. In J. B. N. H. S. 7. c. I mentioned as probably closely allied to *stoliczkana* a pair of small *Colias* from Alpine Sikhim, of which the male, being badly rubbed, did not show clearly what I now see in fresher specimens, namely, that the borders are distinctly spotted. In 1904, writing of these specimens in the 'Iris,' p. 390, and having no fresh male of the species before me, I still confused them with the specimens sent as *miranda* by Fruhstorfer to Mr. Rothschild; but now, on receipt of a pair, of which the male is from Khamba Jong and the female from the Lhanak Valley, I find them identical with my old pair, and, so far as Mr. Heron, Col. Bingham, and myself can judge, they must have a new name.

The species might be regarded as a distant relative of *cocandica*, but the orange colour is much deeper than in any specimen of that species; and as the variety which, geographically, comes nearest (var. *leechi* Grüm) is most unlike *dubia* in colour, I dismiss this theory. If we could adopt the assumption that *stoliczkana* was in this locality sexually dimorphic, having the males with spotted bands like the females, the difficulty would be solved; but with the exception, perhaps, of *C. boothii* Curt. we

know of no species in which sexual dimorphism exists in the male, and I am thus driven to give a name to an insect of which my knowledge is not sufficiently complete to enable me to describe it properly.

11. *COLIAS FIELDII*.

A large series from Tungu and Gyantze shows a good deal of variation as usual.

12. *CALLEREBIA WALTONI*, sp. n. (Plate XXXVI. figs. 14 ♂, 15 ♀.)

This is one of the group named *Paralasa* by Moore, to which *shallada*, *kalinda*, and *mani* belong, but it seems to be sufficiently distinct to be described as a new species. It is smaller than any of the above-named, and above shows only a faint trace of chocolate on the fore wing, where the ocelli are very small and sometimes absent; the hind wing is plain dark brown. Below, the fore wing is chocolate with the apex and outer margin pale fawn-colour, a large apical ocellus with two black spots surrounded by a yellowish ring. Hind wing below pale fawn freckled with darker spots, an indistinct submarginal band, having obscure whitish spots on its outer edge in the same position as those of *shallada*. Female like the male, but showing more or less chocolate on the fore wing above. 2 ♂ and 1 ♀ come nearer in all characters to *C. kalinda*, of which they might be considered a small, starved form.

13. *CENEIS PUMILUS* var. *SIKKIMENSIS* Stgr. Cat. 1901, p. 53.

C. pumilus Elwes, P. Z. S. 1882, pl. xxv. f. 3.

Numerous specimens from Tungu agree with the figure above cited, which has been considered by Staudinger and others sufficiently distinct from the paler form from Ladak and that from the Pamirs and N.E. Tibet (*pallearcticus* Stgr.) to require a varietal name.

14. *CENONYMPHA SINICA* Alph. Stett. ent. Zeit. 1888, p. 66.

A few taken at Chaksam on the Brahmaputra River at 12,000 feet on July 30 agree with those in Leech's collection from near Ta-tsien-lu.

1 ARGYNNIS PALES var. *SIFANICA* Grüm, Hor. Soc. Ent. Ross. xxv. p. 456.

Four specimens from Tungu agree with two previously received by me from Alpine Sikkim, where it seems to be rare, and belong to a race which occurs in Eastern Tibet near Ta-tsien-lu and at Amdo in N.E. Tibet, so named by Grüm.

16. ARGYNNIS LATHONIA var. *ISÆEA* Elwes (*ex* Gray), Trans. Ent. Soc. Lond. 1885, p. 556.

A few specimens of the usual Himalayan type.

17. ARGYNNIS CLARA Blanch. Jacq. Voy. iv. p. 20, Ins. t. (1844).

A. claudia Fawcett, P. Z. S. 1904, ii. p. 136, pl. ix. f. 3.

Specimens from Khamba Jong and Gyantze seem to be intermediate between the typical form from Kashmir and the smaller, paler form described as *clarina* by Staudinger from N.E. Tibet. I venture to think that if Col. Fawcett had seen a series of both he would not have described *A. claudia*.

18. ARGYNNIS GEMMATA Butl. Ann. N. H. 1881, vii. p. 32.

Numerous specimens from Khamba Jong and Tungu.

19. ARGYNNIS ALTISSIMA Elwes, P. Z. S. 1882, p. 403.

Many specimens from Tungu and the Lhanak Valley.

20. MELITÆA SINDURA var. SIKKIMENSIS Moore.

M. tibetana Fawcett, P. Z. S. 1904, ii. p. 135, pl. ix. f. 3.

A very long series of specimens from Khamba Jong and Gyantze leaves me in doubt whether to treat the insects as varieties of the same species: those from the former locality being the same as those which I formerly described and figured in my 'Catalogue of the Butterflies of Sikkim' as a variety of *sindura*, afterwards called *sikkimensis* by Moore; whilst those from Gyantze, being larger, might be referred to *balbita* Moore by those to whom names are dearer than Nature. I confess my inability to draw a line between them on account of the great variation in both sexes. Anyone who will examine carefully the magnificent series of *Melitæa* from Asia now incorporated in the British Museum Collection must see that any attempt to define many of them in such a way that they can be recognised with any degree of certainty will be a failure, and Staudinger's Catalogue, full as it is of marks of interrogation, proves the truth of what he told me himself, namely, that their classification must be largely a matter of personal opinion.

21. VANESSA KASHMIRENSIS Koll. Hügel, Kaschmir, p. 442, t. 9.

A few specimens from Tungu, Khamba Jong, and Gyantze.

I cannot follow Staudinger in placing *V. kashmirensis* as a variety of *urticæ*, which is represented in the Western Himalayas by var. *rigana*, and in the east by var. *chinensis*, which, however, has not yet been taken, so far as I know, in Sikkim.

22. VANESSA URTICÆ var. CHINENSIS Leech, Butt. China &c. p. 258, pl. xxv. f. 1.

A few specimens from Gyantze.

23. VANESSA LADAKENSIS Moore, Ann. Nat. Hist. 1878, p. 227.

A few specimens from Khamba Jong and Gyantze.

24. PYRAMEIS INDICA Herbst.

One specimen from Khamba Jong.

25. PYRAMEIS CARDUI Linn.

Several specimens from Gyantze.

26. POLYGONIA C-ALBUM var. TIBETANA Elwes, Trans. Ent. Soc. Lond. 1888, p. 197, pl. x. f. 1.

A few specimens from Gyantze agree with those formerly received from the Chumbi Valley.

27. CHRYSOPHANUS PHLEAS Linn.

Specimens from Lhasa and Gyantze might be called var. *chinensis* Felder; but this variety is not constant.

28. LYCÆNA YOUNGHUSBANDI, sp. n. (Plate XXXVI. fig. 10 ♂.)

Nearest to *L. felicis* Ob. (Ét. Ent. xi. p. 21, t. 7. f. 52; Lecch, Butt. China, ii. p. 307) from Eastern Tibet. Both sexes, however, differ from that species in being dark leaden grey instead of greyish brown above, and in having the marginal spots on the hind wing absent or but very faintly marked; and on the under side in having the second external band of marginal spots on the fore wing absent or only faintly marked.

This may stand a good species until intermediate forms are obtained, and though allied to *felicis* it has no other near ally known to me. It was abundant at Gyantze, and was also taken further south on the march from Phari.

I name this species in recognition of the great assistance given by Sir F. Younghusband to the officers of the Mission in their scientific explorations.

29. LYCÆNA ORION Pall., var.

A single specimen only from between Phari and Gyantze is not separable from *orion*, though it might be called var. *orithyia* Grüm, of which the types, from Amdo, are before me.

30. LYCÆNA SEMIARGUS Rotb. var. ANNULATA, var. n. (Plate XXXVI. figs. 12 ♂, 11 ♀.)

Though this may be distinguished from all the numerous varieties of *semiargus* known to me by the well-marked white ring round the central spot on the fore wing below, yet this is hardly a character of sufficient importance to be specific, being found as a local variation in some others of the genus. The males are of the same dull blue above, but the border is darker than usual in *semiargus*, and the under side is more silvery as in *sebrus*. There is also a more or less well-marked series of marginal black spots on both wings below as in var. *bellis*, the eastern form of *semiargus*, but no orange ocelli on the hind wing below as in that form. The females are dark brown above as in *semiargus*.

This variety was taken abundantly at Gyantze. No form of *semiargus* has hitherto been found in Tibet, so far as I know, though it is found in the Pamir and Thianshan Mountains.

31. *LYCÆNA PHERETES* Hübn.

Two forms of this species, which seem distinguishable, were taken. One is from Gyantze, and is large, and, like the form from East Tibet, of a duller blue above than the European insect. The other, var. *asiatica* Elwes (*L. pheretes* var. *pharis* Fawcett, P. Z. S. 1904, ii. p. 138, pl. ix. ff. 5, 6), from Tungu, Khamba Jong, and the Lhanak Valley, is smaller and has the hind wing below suffused with blue on the inner half of the wing, by which when fresh it may be distinguished from the West-Tibetan form *lehanus* Moore. Some specimens are of a brighter more silvery blue above than the majority, but I do not think this is constant, and it may be due to a change of colour in the relaxing-box. The characters by which Col. Fawcett has tried to distinguish his var. *pharis* seem to me to be merely individual variation.

32. *LYCÆNA ICARUS*, var.

Specimens from Lhasa are larger than the next species, and agree with the form which Leech calls *icarus* from West Tibet in having black margined spots on the hind wing above. The forms of *icarus* in Central Asia, of which Grüm described several, seem extremely variable.

33. *LYCÆNA STOLICZKANA* Feld.

L. ariana var. *arene* Fawcett, P. Z. S. 1904, ii. p. 137, pl. ix. f. 4

Specimens from Gyantze and Khamba Jong agree best with this species from Ladak, but are on the average larger. Two or three of them are marked below almost as in *arene*, which I cannot look upon as a distinct form. Staudinger thought that *stoliczkana* might be a form of *venus*, of which I have a good series from various places in Turkestan, and all these may perhaps best be treated as allies of *eros*, which has many local variations in Central Asia.

There were no specimens of Hesperiidæ in the Collection.

LEPIDOPTERA-PHALÆNÆ.

By Sir GEORGE F. HAMPSON, Bt., B.A., F.Z.S., &c.

The Moths taken by the Tibet Expedition were unfortunately few in number, under 150 specimens in all, and of these about half came from low elevations in the Teesta Valley and are of comparatively small interest. Those, however, from Alpine Sikhim and the Tibet Plateau, belonging to the Palearctic fauna, which I mark by an *, contain a large proportion of new and interesting species, and larger collections from the same district would be certain to contain many new forms.

SYNTOMIDÆ.

ERESSA MULTIGUTTA Wlk. i. p. 134 (1854); Moths Ind. i. p. 220.
SIKHIM, Gantok, vi. 03. 1 ♀.

ARCTIADÆ.

LITHOSIANÆ.

ASURA STRIGIPENNIS Herr.-Schäff. Aussereur. Schmett. f. 437
(1855); Moths Ind. ii. p. 111.

SIKHIM, Gantok, vi. 03, 1 ♀; Raitdong, vi. 03, 1 ♀.

ARCTIANÆ.

*DIACRISIA BRETAUDIAUI Oberth. Et. Ent. xx. p. 55, pl. x. ff. 179,
180 (1896); Moths Ind. iv. p. 491.

SIKHIM, Tungu, vii. 03. ♂.

DIACRISIA IMPLETA Wlk. xxxi. 286 (1864); Moths Ind. ii. p. 24.
SIKHIM, Raitdong, vi. 03. 1 ♂.

ESTIGMENE IMBUTA Wlk. iii. 614 (1855); Moths Ind. ii. p. 21.

SIKHIM, Gantok, vi. 03. 1 ♀.

PERICALLIA GALACTINA Hœv. Tijdschr. Nat. Ges. Phys. vii.
p. 280, pl. vi. f. 5 (1840); Moths Ind. ii. p. 25.

SIKHIM, Raitdong, vi. 03. 2 ♀.

AGARISTIDÆ.

EXSULA VICTRIX Westw. Cab. Or. Ent. pl. 33. f. 3 (1848);
Moths Ind. ii. p. 150.

SIKHIM, Raitdong, vi. 03. 1 ♀.

NOCTUIDÆ.

AGROTINÆ.

*ANARTOMORPHA FLAVESCENS, sp. n. (Plate XXXVI. fig. 3.)

♂. Head and thorax clothed with black, brown, and grey scales and hair; palpi whitish banded with brown; lower part of frons whitish; fore tibiæ and tarsi with white rings; abdomen ochreous white irrorated with fuscous. Fore wing black-brown suffused with greyish; subbasal line indistinctly double filled in with grey, angled inwards in cell and extending to vein 1; antemedial line indistinctly double filled in with grey, oblique from costa to submedian fold, then erect; claviform moderate, defined by black; orbicular and reniform with brown centres and slight whitish annuli defined by black, the former oblique elliptical, the latter angled inwards on median nervure and touching the former; an indistinct dentate whitish mark below end of cell on vein 2; postmedial line double filled in with greyish, bent outwards below costa, oblique to vein 5, where it is angled, then inwardly oblique and

minutely waved; subterminal line whitish slightly defined by black on outer side, angled outwards at vein 7 and to termen at veins 4, 3, incurved at discal and submedian folds; a terminal series of slight black lunules; cilia whitish and brown with a blackish line through them. Hind wing white strongly tinged with ochreous; the basal area suffused with fuscous; a black discoidal lunule; a terminal fuscous band, rather broad at costa, narrowing to a point at tornus; some black striæ on termen; cilia pure white; the under side ochreous white, the costal area slightly irrorated with fuscous, a slight discoidal lunule and diffused subterminal band.

Hab. SIKHIM, Tungu, vii. 03. 1 ♂, type. *Exp.* 28 millim.

The mid and hind legs are missing, but the small reniform hairy eyes and the close resemblance in pattern to *A. potanini* Alph. from ?W. China, and *diodonta* Püng. Iris, xix. p. 80 (1906) from Lob-nor, makes it practically certain that it belongs to the genus *Anartomorpha* Alph. (1892) = *Ala* Staud. (1882) nec Lock. Crust. (1877) = *Trichanarta* Hmps. (1896).

*CHLORIDEA TRANSLUCENS Feld. Reis. Nov. pl. 108. f. 49 (1874); Moths Ind. ii. p. 176.

TIBET, Gyantze, vi. 04 (*H. J. Walton*). 1 ♂.

*CHLORIDEA NANNA, sp. n. (Plate XXXVI. fig. 1.)

♂. Head and thorax ochreous white mixed with fuscous and sometimes tinged with rufous; palpi at base, pectus, and legs white, the fore tarsi banded with fuscous; abdomen ochreous dorsally suffused and irrorated with fuscous black. Fore wing pale ochreous, sometimes tinged with rufous, the basal area suffused with grey and irrorated with fuscous; an indistinct antemedial line, oblique from costa to vein 1, then bent inwards to inner margin; a medial fuscous or rufous band, diffused on outer side, incurved from costa to median nervure, where it is strongly angled outwards, then again incurved; reniform blackish, rather diffused and with grey lunule in centre; postmedial line brown, slightly bent outwards below costa, excurved to vein 4, then incurved, the postmedial area from just beyond it fuscous or rufous, its outer edge forming the subterminal line, slightly angled outwards at vein 7, excurved at middle, then incurved; a terminal series of dark points. Hind wing ochreous white; the basal area suffused with black, leaving a pale streak below median nervure; a large black discoidal lunule; terminal area broadly black, its inner edge curved inwards between veins 4 and 1 and leaving some ochreous on termen between veins 3 and 1; cilia ochreous white. Under side of both wings ochreous white, with large black discoidal spots and black postmedial line excurved at middle and with dark suffusion beyond it, slight on fore wing, broad on hind wing.

Hab. TIBET, Khamba Jong, vii. 03. 2 ♂, type. *Exp.* 28 millim. Allied to *C. dipsacea*.

*ISOCHLORA METAPHLEA, sp. n. (Plate XXXVI. fig. 2.)

♂. Head and thorax emerald-green; palpi and sides of frons purplish red; antennæ fulvous; pectus and legs greyish ochreous, the front of pectus and fore and mid legs in front purplish red; abdomen pale ochreous, the ventral surface suffused with purplish red, the anal tuft fulvous. Fore wing emerald-green, the costal edge white; cilia white at tips. Hind wing ochreous white uniformly suffused with pale brown; cilia yellowish white. The under side of fore wing pale purplish red, the termen greenish; hind wing brownish white, the costal area tinged with purplish red.

Hab. SIKHIM (*Walton*), 1904. 2 ♂, type. *Exp.* 42 millim.

*EUXOA CONFUSA Alph. Hor. Soc. Ent. Ross. xvii. p. 61, pl. 2. f. 47 (1882); Staud. Cat. Lep. pal. p. 136.

SIKHIM (*Walton*), 1904. 1 ♀.

*EUXOA BASIGRAMMA Staud. Berl. ent. Zeit. 1870, p. 111; id. Cat. Lep. pal. p. 150.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♀.

*EUXOA OBERTHURI Leech, Trans. Ent. Soc. 1900, p. 30; Hmps. Cat. Lep. Phal. B.M. iv. p. 310, pl. 67. f. 1.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♂.

*METALEPSIS ALETES, sp. n. (Plate XXXVI. fig. 6.)

♂. Antennæ ciliated.

Head and thorax pale rufous with a few black hairs; patagia with a white fascia edged on each side by black; pectus, legs, and abdomen brownish grey, the anal tuft ochreous. Fore wing pale rufous, the veins streaked with white and defined on each side by grey; a slight black streak below base of costa; a black streak below base of cell and another above basal half of inner margin; two black streaks in cell, the upper interrupted beyond middle, the lower not reaching lower angle; an obliquely curved post-medial series of wedge-shaped black streaks in the interspaces from above vein 7 to above 1, the streak above vein 5 displaced inwards and the streak above vein 1 longer; a terminal series of wedge-shaped black streaks in the interspaces. Hind wing pale brownish grey.

Hab. SIKHIM (*Walton*), 1904. 1 ♂, type. *Exp.* 30 millim.

The antennæ are missing, but the base of the shaft of one is sufficient to show they are ciliated. This *Leucania*-like Agrotid is like nothing known to me from the Old World; it, however, closely resembles a species of the same genus with pectinated antennæ from Tierra del Fuego and several species in allied genera from the Higher Andes.

*EPISILIA VITTATA Staud. Iris, viii. p. 314, pl. 5. f. 15 (1895); id. Cat. Lep. pal. p. 137.

TIBET, Khamba Jong, vii. 03, 1 ♂; 8 miles S. of Khamba Jong (*Walton*), 1 ♂ with the orbicular stigma absent.

**EPISILIA ASTIGMATA*, sp. n. (Plate XXXVI. figs. 4 ♂, 5 ♀.)

♂. Head and thorax brown suffused with fuscous, the hairs tipped with grey; tarsi with slight pale rings; abdomen ochreous brown, with fuscous-brown lateral stripes. Fore wing dull rufous, the basal, inner, and terminal areas suffused with fuscous, the costal edge and veins fuscous; subbasal line represented by a slight black striga from costa; antemedial line oblique, very minutely dentate, slightly angled inwards on vein 1; orbicular absent; reniform represented by a dark line on discocellulars; postmedial line single, black, bent outwards below costa, then minutely dentate and produced to short streaks on the veins, obliquely incurved below vein 4, the area from just beyond it suffused with fuscous and with slight pale points on costa; subterminal line absent; a terminal series of slight black lunules; cilia fuscous, with fine whitish line at base. Hind wing pale brownish grey, the terminal area slightly darker; cilia pale brown, with a whitish line at base; the under side whitish, the costal area tinged with brown, a faint discoidal spot and postmedial series of minute dark streaks on veins 8 to 6.

♀. Fore wing much blacker, showing a faint rufous tinge on medial area in cell only, irrorated with a few white scales.

Hab. TIBET, Gyantze (*Walton*), vi. 04. 1 ♂, 1 ♀, type. *Exp.* 34-38 millim.

Remotely allied to *E. subplumbea* Staud.

**LYCOPHOTIA POLIOCHROA*, sp. n. (Plate XXXVI. figs. 16 ♂, 17 ♀.)

♂. Antennæ strongly serrate and fasciculate.

Head and thorax grey-white mixed with some brown and fuscous; abdomen ochreous white. Fore wing grey and white, tinged with ochreous and slightly irrorated with brown; subbasal line represented by black striæ from costa and cell; antemedial line single, black defined by whitish on inner side, interrupted at the veins, erect from costa to vein 1 and angled outwards above inner margin; claviform moderate, defined by black; orbicular and reniform defined by rather diffused black, the former with its inner edge produced inwards as a streak to antemedial line; traces of a diffused medial line touching orbicular and claviform; postmedial line single, black slightly defined by whitish on outer side, bent outwards below costa, then dentate and produced to short streaks on the veins, confluent with outer edge of reniform, oblique below vein 4; faint traces of a whitish subterminal line slightly defined by fuscous on inner side, excurved at vein 7 and middle; a terminal series of slight black lunules; cilia ochreous white, with two slight dark lines through them. Hind wing white tinged with pale brown, the cilia pure white; the under side white, with slight discoidal spot and indistinct postmedial line from costa to vein 4.

♀. Wings aborted, small; the fore wing elongate, narrow, the

termen rounded; the hind wing triangular. Fore wing with the lines browner, the antemedial line excurved below cell and above inner margin; claviform absent; orbicular reduced to a point, the reniform a slight lunule well separated from postmedial line; the subterminal line more distinct and dentate. Hind wing whiter.

Hab. TIBET, Khamba Jong, vii. 03. 1 ♂, type. SIKHIM, Teesta Valley, Lhanak Valley, vii. 03. 1 ♀. *Exp.*, ♂ 36, ♀ 12 millim.

There is no proof that these are sexes of one species, but the structure is identical, and the general colour, scaling, and pattern the same. In *Episilia argillacea* Alph. from Tibet, of which the ♀ has aborted wings, the fore wing is very produced and acute at apex and the hind wing rounded.

HADENINÆ.

*BARATHRA BRASSICÆ Linn. Syst. Nat. i. p. 516 (1758); Moths Ind. ii. p. 202.

TIBET, Gyantze (*Walton*), vi. 04. 3 ♂, 1 ♀.

*TRICHOCLEA ALBICOLON Sepp, Ins. ii. pl. 1. ff. 1-9 (1786); Staud. Cat. Lep. pal. p. 156.

TIBET, Khamba Jong, vii. 03. 1 ♀.

*MANOBIA XENA Staud. Iris, viii. p. 317, pl. 6. f. 8 (1875); id. Cat. Lep. pal. p. 161.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♀.

CUCULLIANÆ.

*BLEPHARIDIA PASPA Pung. Iris, xiii. p. 123 (1900); Staud. Cat. Lep. pal. p. 255.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♂.

ACRONYCTINÆ.

*EUPLEXIA LATERITIA Hüfn. Berl. Mag. iii. p. 306 (1766); Staud. Cat. Lep. pal. p. 173.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♂, 5 ♀.

CATOCALINÆ.

NYCTIPAO GLAUCOPIS Wlk. xiv. 1306 (1857); Moths Ind. ii. p. 461.

SIKHIM, Chengtong, vi. 03. 1 ♀.

PLUSIANÆ.

*OMORPHINA AURANTIACA Alph. Hor. Soc. Ent. Ross. xxvi. p. 452 (1892); id. Rom. Mém. ix. p. 41, pl. 1. f. 2; Staud. Cat. Lep. pal. p. 220.

SIKHIM (*Walton*), 1904. 2 ♂, 1 ♀.

NOCTUINÆ.

SYNA PUNCTOSA Wlk. xxxiii. 939 (1865); Moths Ind. ii. p. 447.
SIKHIM, Raitdong, vi. 03. 1 ♂.

ERASTRAINÆ.

**KERALA MULTIPUNCTATA* Moore, Lep. Atk. p. 93, pl. 4. f. 4
(1882); Moths Ind. ii. p. 62.

SIKHIM, Tungu, vii. 03. 1 ♀.

HYPENINÆ.

DICHROMIA TRIPLICALIS Wlk. xvi. 16 (1858); Moths Ind. iii.
p. 73.

SIKHIM, Raitdong, vi. 03. 1 ♀.

LYMANTRIADÆ.

PANTANA BICOLOR Wlk. iv. 787 (1855); Moths Ind. i. p. 444.

SIKHIM, Raitdong, vi. 03. 1 ♂.

MARDARA CALIGRAMMA Wlk. xxxii. 402 (1865); Moths Ind. i.
p. 455.

SIKHIM, Gantok, vi. 03. 1 ♀.

HYPSIDÆ.

ARGINA ARGUS Koll. Hüg. Kaschm. iv. p. 467, pl. 21. f. 3 (1844);
Moths Ind. ii. p. 51.

SIKHIM, Raitdong, vi. 03. 1 ♀.

SPHINGIDÆ.

HERSE CONVULVULI Linn. Syst. Nat. i. p. 798 (1758); Moths
Ind. i. p. 103.

SIKHIM, Gantok, vi. 03. 1 ♂.

MARUMBA DYRAS Wlk. viii. 250 (1856); Moths Ind. i. p. 69.

SIKHIM, Gantok, vi. 03. 1 ♂, 1 ♀.

GEOMETRIDÆ.

BOARMIANÆ.

ANONYCHIA GRISEA Butl. P. Z. S. 1883, p. 172; Moths Ind. iii.
p. 178.

SIKHIM, Gantok, vi. 03. 1 ♂, 1 ♀.

**CROCALIS OBLIQUARIA* Moore, P. Z. S. 1867, p. 622; Moths
Ind. iii. p. 232.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♂.

DALIMA SCHISTACEARIA Mooré, P. Z. S. 1867, p. 615; Moths
Ind. iii. p. 239.

SIKHIM, Gantok, vi. 03. 1 ♂, 1 ♀.

*GNOPHUS EOLARIA Guén. Phal. i. p. 294 (1857); Moths Ind. iii. p. 253.

TIBET, Gyantze (*Walton*), vi. 04. 1 ♂.

*BOARMIA SELENARIA Hübn. Samml. Eur. Schmett., Geom. f. 163 (1827); Moths Ind. iii. p. 264.

SIKHIM, Gantok, vi. 03. 1 ♀.

BOARMIA DUPLEXA, Moore, Lep. Atk. p. 293 (1888); Moths Ind. iii. p. 258.

SIKHIM, Raitdong, vi. 03. 1 ♂.

OBEIDIA MILLEPUNCTATA, Warr. P. Z. S. 1893, p. 389; Moths Ind. iii. p. 310.

SIKHIM, Chengtong, vi. 03, 3 ♂; Gantok, vi. 03, 7 ♂.

LARENTIANÆ.

*CIDARIA SILACEATA Schiff. Wien. Verz. p. 113 (1776); Moths Ind. iii. p. 357.

SIKHIM, Gantok, vi. 03. 1 ♂.

*LARENTIA ALBIGIRATA Koll. Hügel's Kaschmir, iv. p. 419 (1844); Moths Ind. iii. p. 367.

TIBET, Khamba Jong, vii. 03. 1 ♂.

*VENUSIA CONISARIA Hmps. J. Bomb. Soc. xiv. p. 647 (1903).

SIKHIM, Tungu, vii. 03. 1 ♂.

ACIDALIANÆ.

ERYTHROLOPHUS HYRIARIA Wlk. xxxv. 1617 (1866); Moths Ind. iii. p. 453.

SIKHIM, Gantok, vi. 03. 1 ♀.

TIMANDRA CORRESPONDENS Hmps. Moths Ind. iii. p. 459 (1895).

SIKHIM, Gantok, vi. 03. 1 ♀.

BOMBYCIDÆ.

ANDRACA BIPUNCTATA Wlk. xxxii. 582 (1865); Moths Ind. i. p. 40.

SIKHIM, Gantok, vi. 03. 1 ♀.

LIMACODIDÆ.

CERATONEMA ALBIFUSA Hmps. Moths Ind. i. p. 394 (1892).

SIKHIM, Tungu, vii. 03. 1 ♂.

ARÆOGYIA PHEOPASTA, sp. n. (Plate XXXVI, fig. 22.)

Fore wing with veins 7, 8, 9, 10 stalked; fore and mid tibæ,

the 1st joint of fore tarsi, and the first two joints of fore and hind tarsi fringed with long scales.

♂. Head and thorax grey irrorated with dark brown, the tips of scales on the legs black; abdomen ochreous tinged with rufous. Fore wing ochreous thickly irrorated with dark brown, leaving an indistinct oblique ochreous line from lower angle of cell to inner margin, an elliptical spot between bases of veins 5, 4, some ochreous on costa towards apex and on termen from vein 5 to tornus; cilia fuscous, with an ochreous line at base. Hind wing uniform silky brown; cilia ochreous at base, brown at tips.

Hab. SIKHIM, Darjiling (*Atkinson*), 1 ♂, type; Gantok, vi. 03, 1 ♂ in bad condition. *Exp.* 22 millim.

ZYGÆNIDÆ.

CHALCOSIANÆ.

CAMPYLOTES HISTRIONICA Westw. Royle's Ill. Himal. p. liii, pl. 10. f. 1 (1840); Moths Ind. i. p. 274.

SIK HIM, Raitdong, vi. 03. 1 ♀.

PHILOPATOR BASIMACULA Moore, P. Z. S. 1865, p. 800, pl. 42. f. 6; Moths Ind. i. p. 282.

SIK HIM, Raitdong, vi. 03. 1 ♀.

ZYGÆNINÆ.

PLATYZYGÆNA MÖLLERI Elwes, P. Z. S. 1890, p. 385, pl. 32. f. 13; Moths Ind. i. p. 243.

SIK HIM, Chengtong, vi. 03. 1 ♀.

ARTONA CONFUSA Butl. Journ. Linn. Soc., Zool. xii. p. 357 (1876); Moths Ind. i. p. 236.

SIK HIM, Raitdong, vi. 03. 1 ♀.

PHAUDINÆ.

PHAUDA FLAMMANS Wlk. i. 257 (1854); Moths Ind. i. p. 287.

SIK HIM, Raitdong, vi. 05. 1 ♀.

DREPANIDÆ.

EUCHERA RECTIFICATA Wlk. xxiv. 1142 (1862); Moths Ind. i. p. 328.

SIK HIM, Gantok, vi. 03. 1 ♂.

THYRIDIDÆ.

CAMADENA VESPERTILIONIS Moore, Lep. Atk. p. 214, pl. 7. f. 13 & pl. 8. f. 7 (1888); Moths Ind. i. p. 367.

SIK HIM, Raitdong, vi. 03. 1 ♂.

CAMADENA POLYSTACTA, sp. n. (Plate XXXVI. fig. 7.)

♂. Head and thorax dark brown suffused with greyish; abdomen red-brown suffused with dark greyish brown. Fore wing red-brown thickly striated with dark brown, on terminal area forming numerous annulate spots; the costal and inner areas suffused with dark brown to the medial band; two indistinct, somewhat irregular dark antemedial lines; a broad oblique dark medial band before the indistinct postmedial line, which is bent outwards below costa, excurved to vein 5, then oblique; an indistinct subterminal line excurved from costa to vein 5, then oblique. Hind wing red-brown thickly striated with dark brown, on terminal half forming numerous annulate spots; a small black discoidal spot and slight medial line excurved between veins 5 and 2; the termen strongly excurved at middle.

Hab. SIKHIM, Gantok, vi. 03. 1 ♂, type. *Exp.* 32 millim.

PYRALIDÆ.

GALLERIANÆ.

MEGARTHRIA VELUTINA Hmps. J. Bomb. Soc. xii. p. 304 (1901); id. Rom. Mém. viii. pl. 53. f. 12.

SIKHIM, Gantok, vi. 03. 1 ♂.

CRAMBINÆ.

*CRAMBUS PERLELLUS Scop. Ent. Carn. no. 620 (1763); Staud. Cat. Lep. pal. p. 4.

TIBET, Lhasa (*Walton*), viii. 04. 1 ♂.

*CRAMBUS BRACHYRHABDA, sp. n. (Plate XXXVI. fig. 18.)

♂. Head, thorax, and abdomen black-brown. Fore wing fuscous brown with a cupreous tinge; a white fascia on median nervure emitting very short streaks on veins 2, 3, 4; cilia brown at base, brownish grey at tips. Hind wing fuscous brown; cilia brown at base, brownish grey at tips.

Hab. SIKHIM (*Walton*), 1904. 1 ♂, type. *Exp.* 16 millim.

Allied to *C. furcatellus* Zett., which is redder with the white streaks beyond lower angle of cell of fore wing much more produced.

ESCHATA CHRYSARGYRIA Wlk. xxxiii. 634 (1865); Moths Ind. iv. p. 29.

SIKHIM, Raitdong, vi. 03. 1 ♀.

PYRAUSTINÆ.

*PHLYCTÆNODES STICTICALIS Linn. Faun. Suec. no. 1354 (1761); Moths Ind. iv. p. 407.

TIBET, Gyantze, vi. 04, 11 ♂, 4 ♀; Lhasa (*Walton*), viii. 04, 5 ♂, 3 ♀.

*PHLYCTÆNODES XUTHUSALIS, sp. n. (Plate XXXVI. fig. 19.)

Head, thorax, and abdomen yellow irrorated with brown; palpi

brown at sides, white below. Fore wing yellow; the costal area suffused with brown to beyond middle; the inner area suffused with brown to the blackish streak in basal half of submedian fold, then to vein 2, below which it ends in a dark point near tornus; a very elongate oblique wedge-shaped brown mark in end of cell; an oblique irregularly quadrate discoidal blackish spot with a slight dark streak beyond it usually present; an oblique band formed of confluent brown streaks in the interspaces from apex to vein 2, where it joins the brown suffusion on inner area, the streaks longer and paler below vein 5; a fine blackish terminal line; cilia brownish at base. Hind wing orange, the costal area rather paler, the inner area faintly tinged with brown; an indistinct diffused brown subterminal band; a fine blackish terminal line and brown line at base of cilia except towards tornus.

Hab. TIBET, Khamba Jong, vii. 03, 12 ♂, 3 ♀, type; Gyantze (*Walton*), vi. 04, 1 ♀. *Exp.*, ♂ 30-34, ♀ 26 millim.

Allied to *P. rhabdalis* Hmps. from Thianshan.

*EVERGESTIS PEROBLIQUALIS, sp. n. (Plate XXXVI. fig. 20.)

♂. Head and thorax greyish mixed with dark olive-brown; frons with lateral white lines; abdomen pale olive-brown with slight segmental pale lines. Fore wing grey tinged with olive-brown and thickly irrorated with dark brown; a slight dark discoidal bar; a very oblique black line slightly defined on inner side by flesh-white from median nervure near end of cell to vein 1; a very oblique black line defined on inner side by a band of flesh-white from apex to middle of vein 1; an oblique flesh-white postmedial line from vein 4 to vein 1 and a subterminal narrow flesh-white band between veins 7 and 1; cilia whitish with three slight brown lines through them. Hind wing fuscous brown, the apical area rather darker; a diffused fuscous subterminal line; a fine dark terminal line; cilia yellowish white with a brown line near base; the under side brownish grey, the costal area tinged with brown, the subterminal line indistinct, fine, waved.

Hab. TIBET, Gyantze (*Walton*), vi. 04, 1 ♂, type. *Exp.* 38 millim.

Remotely allied to *E. umbrosalis* F. R.

SESIADÆ.

*TROCHILIUM LASICERA, sp. n. (Plate XXXVI. fig. 21.)

Proboscis absent; palpi with the 2nd joint fringed with very long hair in front and reaching above vertex of head, the 3rd joint long; antennæ of male with fascicles of very long hair.

Head and thorax black, with some white hair; palpi ochreous with some black hair and scales, white behind; frons white; legs mostly white, with some ochreous hair and black scales; abdomen black, with ochreous and white segmental bands except on 1st segment, the band on 3rd segment slight, the ventral surface with the bands broad, the anal tuft ochreous with subdorsal black

streaks. Fore wing with the costal area black-brown, with ochreous streak on costa to beyond middle and slight streaks in the interspaces; the median nervure and veins 4, 5 black-brown; the inner area ochreous white; the cell and a slight streak below it before middle and streaks beyond it above veins 3 to 6 hyaline; discoidal spot black-brown with ochreous outer edge; a terminal black-brown line with ochreous suffusion on its inner side; cilia pale brown. Hind wing hyaline with some black at base, the veins and margins black; cilia pale brown, yellowish white towards tornus.

Hab. TIBET, Gyantze (*Walton*), vi. 04. 5 ♂, 3 ♀, type. *Exp.* 20-26 millim.

TINEINA.

By J. HARTLEY DURRANT, F.E.S.

CECOPHORIDÆ.

365. ETHMIA Hb.

= *PSECADIA* Hb.; Stgr.-Rbl. Cat.

3145:1. ETHMIA ASSAMENSIS Btl.

= *hockingella* Wlsm.

Hyponomeuta assamensis Btl. Tr. Ent. Soc. Lond. 1879. 6-7 (1879)¹.

Psecadia hockingella Wlsm. Pr. Zool. Soc. Lond. 1880. 90-1, pl. xii. 8-9 (1880)².

Azinis assamensis Wrn. Pr. Zool. Soc. Lond. 1888. 338 (1888)³.

Psecadia hockingella Swinh. & Cotes, Cat. Moths Ind. 718, No. 4912 (1889)⁴.

Azinis assamensis Swinh. & Cotes Cat. Moths Ind. 719, No. 4918 (1889)⁵.

Hab. CASHMERE (*ex Coll. Ragonot*). PUNJAB—Dharmasala, Larva "Poonah" (probably = *Ehretia serrata*) IV-V, excl. VI²; Kulu⁴; Kala Pani, IV³. SIKHIM—Gantok, 24-26 VI. 1903 (Tibet Exped. 1905: 172); 7000 ft., VI. 1894 (*Pilcher*); 5000 ft., IX. 1895 (*Pilcher*). BHOTAN—IX. 1894 (*Dudgeon*). ASSAM—Cachar¹; Golaghat (Naga Hills, *Doherty* 1890).

HYPONOMEUTIDÆ.

292. PLUTELLA Schrk.

2448:1. PLUTELLA VIATICA, sp. n., Dnt.

Antennæ ochreous, becoming blackish from two-thirds. *Palpi* ochreous, the triangular tuft on the median joint almost fuscous externally; terminal joint suffused with dark fuscous, except on its upper edge and towards the tip.

Head ochreous. *Thorax* whitish. *Forewings* dirty creamy

whitish with fuscous markings (the specimens are not in good condition and they will be more recognisably described as fuscous with a sinuate creamy-white dorsal stripe); the paler colour, which is most noticeable on the dorsum, leaves the base at about one-third the wing-width descending obliquely to the fold, it is thence slightly sinuate upwards, thence descending it ascends triangularly, and again obscurely, thence occupying the terminal area of the wing (and perhaps irrorating the subcostal portion); there is a strong short black streak from the base to above the flexus, and along the dorsum are some irregular dark spots; above the pale dorsal portion of the wing the fuscous colouring becomes more concentrated, appearing as a length-streak from the base; originating from the costa are several transverse dark markings, the most distinct being a cloudy spot at about two-thirds, below which is a cloudy patch at the end of the cell; there is a dark (somewhat triangular) spot at the apex and others along the costa and termen; cilia greyish ochreous, with a cinereous dividing line near their base. *Ecp. al.* 23 mm. *Hindwings* plumbeous; cilia greyish fuscous, with a dark dividing-line near their base. *Abdomen* cinereous. *Legs* pale cinereous, tarsi blackish, with narrow whitish bands above.

Type ♂.

Hab. TIBET, Gyantse, 13,000 ft., vi. 1904 (*H. J. Walton*, Tibet Expedition 1905: 172). Two specimens.

Intermediate between *senilella* Zett. and *annulatella* Crt.; in size and coloration more nearly resembling the former, but in pattern more like the latter, from which it differs in the pale dorsal marking being less abruptly (less angularly) bent upward and being divided by a black length-streak from the base—these would appear to be good diagnostic characters, but the poor condition of the specimens makes the matter uncertain.

TORTRICIDÆ.

249. ENARMONIA Hb.

1990: 1. ENARMONIA VEXILLA, sp. n., Drnt.

Antennæ (broken) fuscous. *Palpi* whitish cinereous. *Head* and *Thorax* cinereous. *Forewings* appearing greyish, but actually chalky-white with fuscous markings and irrorations; a basal patch terminated at about one-third by a darker sooty marginal line, which leaving the costa obliquely outward becomes concave and thence projects strongly along the fold, receding obliquely backward to the dorsum—this basal patch is slightly darker than the rest of the wing and contains some darker transverse markings; before two-thirds a somewhat similar dark fascia includes a chalky, transversely irrorated, band; beyond this the wing is whiter in appearance, and on the costa are three distinct fuscous triangular spots separated by the white ground-colour and succeeded by a patch of a more creamy colour; from the last dark marking

descends slightly inwardly a transverse narrow dark fascia, becoming forked at the tornus; beyond this fascia the terminal area of the wing is fuscous with a white transverse dorsal patch divided by a dark line; cilia whitish tipped with blackish, with a blackish line near their base, followed by two obscure lines which coalesce and vanish at the position where a white subapical spot interrupts the dark tips of the cilia (in *really* fine specimens it would seem that the extreme tips of the cilia would be white). *Exp. al.* 15 mm. *Hindwings* appearing dark cinereous (but actually blackish tessellated with whitish); cilia cinereous, with a dark dividing-line near their base. *Abdomen* cinereous. *Legs* whitish, the tarsi with blackish bands externally.

Type ♀.

Hab. TIBET, Gyantze, 13,000 ft., VI. 1904 (*H. J. Walton*, Tibet Expedition 1905: 172). Unique.

227. TORTRIX L.

TORTRIX sp.

Hab. SIKHIM—Teesta Vy., Tungu, 13,000–14,000 ft., I–15. VII. 1903 (Tibet Exped. 1905: 172).

A broken and worn specimen in unrecognisable condition.

1607. TORTRIX ARGENTANA Cl.

argentana Cl. + *plumbeana* [B.-Haas, Stgr. List 42. 24 (1899) *LN*].

Hab. SIBERIA (*Stgr.*). KASHMIR—Deosai Plains, 13,000 ft., VIII. 1887 (*Leech*). SIKHIM—1904 (*H. J. Walton*, Tibet Exped. 1905: 172); Khamba Jong, 15,000–16,000 ft., 15–30. VII. 1903 (Tibet Exped. 1905: 172).

Two specimens belonging to the Siberian and Central Asian form distributed by Staudinger as var. *plumbeana*. As this melanic form is quite recognisable, it will be well to refer to it under this varietal name, describing it briefly as plumbeous irrorated with white, the white scales tending to be more distinctly noticeable between the veins, along the fold and on the cell, but in most specimens no such attempt at white markings is to be observed; the hind wings are cinereous or plumbeous.

EXPLANATION OF PLATE XXXVI.

- | | |
|---|---|
| 1. <i>Chloridea nanna</i> ♂, p. 487. | 12. <i>Lycæna semiargus</i> var. <i>annulata</i> ♂, p. 484. |
| 2. <i>Isochlora metaphæa</i> ♂, p. 488. | 13. <i>Colias berylla</i> ♂, p. 480. |
| 3. <i>Anartomorpha flavescens</i> ♂, p. 486. | 14. <i>Callerebia waltoni</i> ♂, p. 482. |
| 4. <i>Episilia astigmata</i> ♂, p. 489. | 15. <i>Callerebia waltoni</i> ♀, p. 482. |
| 5. <i>Episilia astigmata</i> ♀, p. 489. | 16. <i>Lycophotia poliochroa</i> ♂, p. 489. |
| 6. <i>Metalepsis aletes</i> ♂, p. 488. | 17. <i>Lycophotia poliochroa</i> ♀, p. 489. |
| 7. <i>Camadenia polystacta</i> ♂, p. 494. | 18. <i>Crambus brachyrhabda</i> ♂, p. 494. |
| 8. <i>Colias dubia</i> ♂, p. 481. | 19. <i>Phlyctenodes rufusalis</i> ♂, p. 494. |
| 9. <i>Colias dubia</i> ♀, p. 481. | 20. <i>Evergestis peroblivalis</i> ♂, p. 495. |
| 10. <i>Lycæna younghusbandi</i> ♂, p. 484. | 21. <i>Trochilium lasiocera</i> ♂, p. 495. |
| 11. <i>Lycæna semiargus</i> var. <i>annulata</i> , ♀, p. 484. | 22. <i>Aræogyia phæapasta</i> ♂, p. 492. |

4. Contributions to the Knowledge of the Vascular and Respiratory Systems in the Ophidia, and to the Anatomy of the Genera *Boa* and *Corallus*. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received March 7, 1906.]

(Text-figures 86-93.)

The facts of structure which I lay before the Society, in continuation of other memoirs* dealing with the Ophidia, may be conveniently considered under the following headings, viz. :—

- (1) On certain Arteries and Veins in the Genera *Erythrolamprus* and *Coluber*, p. 499.
- (2) Some Notes upon the Anatomy of *Boa diviviloqua* and *B. constrictor*, p. 507.
- (3) Notes upon the Boine genus *Corallus*, p. 516.
- (4) On the Modifications of Structure in the Lungs of certain Ophidia, p. 519.

- (1) *On certain Arteries and Veins in the Genera Erythrolamprus and Coluber.*

Inasmuch as the arrangement of the arteries and veins is known in so few genera of Ophidia, it is clearly useful to collect the facts, even if they appear to have for the time being no bearing upon the classification and relations of the group. I therefore direct attention in the following pages to a few new facts concerning the vascular system of *Erythrolamprus aesculapii* and *Coluber corais*, especially of the former species, which was very successfully injected in both the arterial and venous systems. I may observe that with the exception of *Tropidonotus natrix*, investigated by many anatomists, and most recently by Hochstetter †, no Colubrine snake has received so much attention as I give to *Erythrolamprus* in the following account of some of the principal features in the arrangement of its arteries and veins.

Intercostal Arteries.—The arrangement of these arteries in *Erythrolamprus* (see text-fig. 86, p. 501) recalls in some particulars the intercostal arteries of *Python*, and in others the intercostal arteries of Colubrine Snakes generally ‡. The anterior region of the aorta down to about the middle of the liver, or rather beyond that point, gives off very numerous intercostals which

* "Contributions to our Knowledge of the Circulatory System in the Ophidia," P. Z. S. 1904, vol. i. "On the Trachea, Lungs, &c., of the Hamadryad," P. Z. S. 1903, vol. ii. "Notes upon the Anatomy of certain Snakes of the Family Boidæ," P. Z. S. 1904, vol. ii. "Visceral Anatomy of *Hydrus* and *Platyurus*," *ibid.* "Contributions to the Anatomy of Ophidia," P. Z. S. 1906, vol. i.

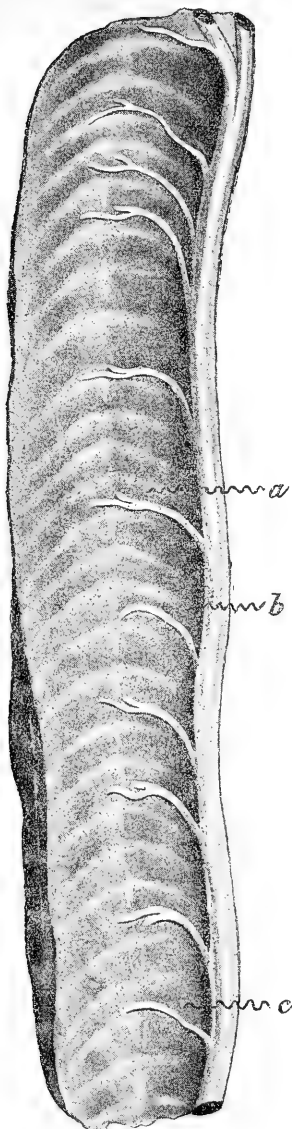
† Morph. Jahrb. xix. 1893.

‡ P. Z. S. 1904, vol. i. p. 335, fig. 67.

bifurcate as in *Python*, &c., and thus supply both sides of the vertebral column. Interspersed among these are a few arteries which, as in Colubrines generally, plunge into the dorsal parietes on one side or the other of the middle line. There is in these arteries no question of a bifurcation. In this anterior section of the body from the junction of the two aortæ I counted 16 bifurcated intercostals, and only three which were single arteries throughout supplying only one side of the body. It must be pointed out, however, that there is not here, as there is in *Python*, an artery to each intercostal space. There are interspaces of several vertebræ between consecutive arteries. Rarely there are arteries following each other immediately. For a considerable region of the body, beginning towards the end of the liver, the intercostals are mostly single trunks, and therefore entering the body-wall to the right or to the left of the dorsal median line as the case may be. Further back the arteries again become prevalently double. It is clear therefore that there are some grounds for comparing the intercostal arteries of this genus with the *Pythons* on the one hand and with the *Colubrines* on the other. The irregularity of those arteries in the *Colubrines* generally (though it must be remembered that after all our knowledge is at present very deficient) is shown in *Erythrolamprus*, and coupled with this the bifurcation in the middle line before entering the body-wall of some of those arteries, which is a *Pythonine* characteristic. We may perhaps also see in this latter character a point of likeness to the *Viperidæ*. In these *Snakes* there is up to the present no exception to the rule that the intercostal arteries arise irregularly, but enter the middle line of the dorsal parietes instead of to the right or to the left as in the *Colubrines*. The division of these vessels therefore takes place within the thickness of the parietes, instead of outside as in *Python* and its allies. It seems therefore that, starting from the conditions observable in the *Boidæ*—and there is now much evidence for the reasonableness of the assumption that this family lies nearest to the base of the *Ophidian* series—we can trace the modifications of the intercostal arteries in at any rate two directions. The usual *Colubrine* arrangement may be derived, as I have already suggested*, by an obliteration, now on one side and now on the other, of one of each of the paired intercostals, the usual gaps being already indicated among the *Boids* by the secondary longitudinal intercostal trunks which are connected only at intervals with the aorta. The second path of development is completed in the *Vipers*, where in one way the *Boid* arrangement may be looked upon as more obviously preserved. It appears to me that *Erythrolamprus* may be looked upon as a stage in this metamorphosis. The *Boid* character has been largely retained and the *Colubrine* character correspondingly feebly developed. The disappearance of the latter and a slight change (already referred to) in the former would give the *Viperine* character. It is note-

* P. Z. S. 1904, vol. ii. p. 108.

Text-fig. 86.



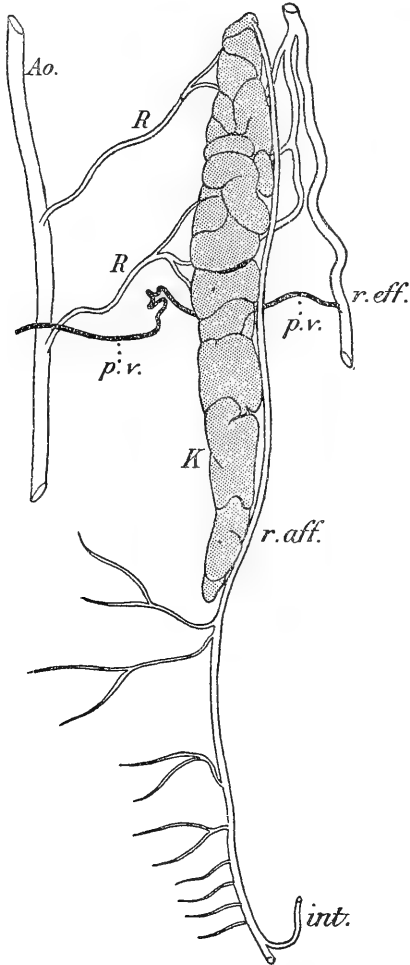
A portion of body-wall of *Erythrolamprus esculapii*, to show arrangement of intercostal arteries.

- a.* An intercostal bifurcating to supply both sides of mid-dorsal line;
- b.* An intercostal supplying only left side;
- c.* An intercostal supplying only right side.

worthy that the opinion has been expressed that the Viperidæ are nearer to the Opisthoglyphs than to other Colubrines.

Renal Arteries.—Coupled with the usual inequality of size of

Text-fig. 87.



Right kidney and adjacent blood-vessels of *Erythrolamprus aesculapii*.

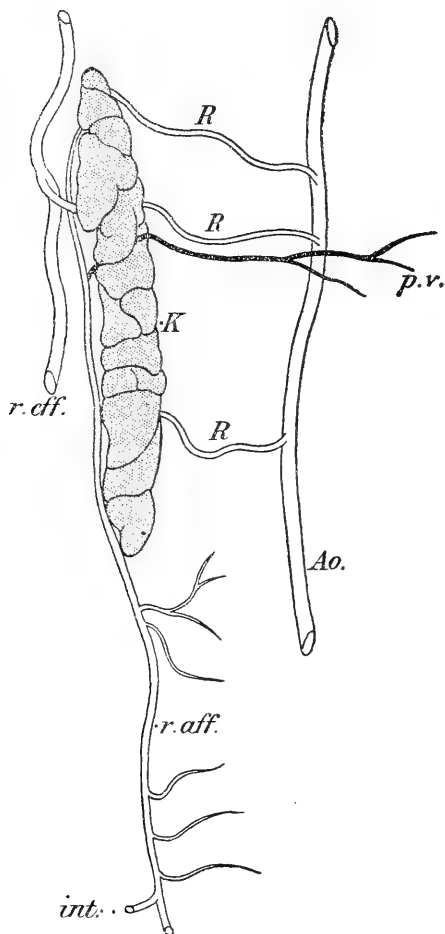
Ao. Aorta; *int.* Rectal branch of renal afferent vein; *K.* Kidney; *p.v.* Parietal vein; *R.* Renal arteries; *r.aff.* Afferent renal vein; *r.eff.* Efferent renal vein.

the kidneys in Serpents and their asymmetry in position, there is frequently, though not always (the Boidæ furnish exceptions),

an inequality in the number of renal arteries supplying each kidney. I find two renal arteries only in the case of the right kidney, and three in the case of the left.

The *vertebral artery* also varies in the Ophidia. In the present

Text-fig. 88.



Left kidney and adjacent blood-vessels of *Erythrolamprus aesculapii*.

Lettering as in text-fig. 87.

species it ceases to run superficially, perforating the musculature about 4 inches behind the snout. The branches of the vertebral are almost segmentally disposed one to each vertebra. Each

enters a distinct foramen larger than itself, formed in the tendons exactly in the middle line. Before entering this foramen it gives off a slender branch to the œsophagus. The intercostal artery can then be plainly seen to divide into two.

Erythrolamprus has only one *gastric artery* proper. This arises from the aorta about on a level with the posterior end of the liver*. The following superior mesenteric artery arises from the aorta about on a level with the gall-bladder. It sends off, of course, a gastric branch. The number of gastric arteries varies much among Snakes†, and it is therefore of importance to record the fact, though its systematic value is not yet apparent.

The *azygos vein* of *Erythrolamprus* is in some ways remarkable as compared with that of other serpents. For it is particularly short though its branches are of considerable calibre. There are, in fact, only three branches, supplying as many intercostal spaces, which unite to form the single azygos trunk. This lies on the right side of the body, and of course joins the anterior vertebral vein before the latter enters the heart. This is apparently shorter than the azygos of any snake yet described. The azygos of *Coronella getula* is just larger—four interspaces.

In *Coluber corais* the single azygos vein also lies on the right side of the body. It is, however, a little more extensive though perhaps slighter. It supplies six intercostal spaces. It is to be noticed that in both these Colubrines the azygos vein is of very limited extent as compared with the Pythonine and Boine Snakes, speaking generally, for *Eunectes* is an exception. This fact is in correspondence with the generally limited development of superficial parietal veins in non-Boine Snakes as compared with the Boiæ. Even in *Eryx*, though a genus containing small-sized species, the azygos is, as I have pointed out‡, comparatively long. I may take this opportunity of pointing out that in *Python regius*—a small Python—the azygos extends over about 15 vertebræ, to 2 inches or so behind the heart.

The vena cava inferior of *Coluber corais* shows an interesting vestige of the umbilical vein. Near to the anterior end of the liver the vena cava has a short diverticulum, which seems hardly to be pervious, lying to the left side and extending obliquely backwards. I take it that this seam is the equivalent of the thick branch of the same vein in the same position which I have described in *Python sebæ* §, and which I then regarded, and still regard, as a last remaining fragment of the embryonic umbilical. It is clearly even more rudimentary in the present species.

* I take this opportunity of noting that in *Erythrolamprus æsculapii* there is a detached fragment of the liver lying upon the post-caval vein about an inch behind the extremity of the liver. This is quite analogous to the division of the pancreas and of the spleen which is to be seen in other Snakes. It is also to be compared to the extremely thin posterior end of the liver in *Corallus* (*vide infra*, p. 518). In these cases the gland appears to be in course of reduction in length. It is possible that this is connected with a shortening of the body generally which has conspicuously taken place in certain Vipers.

† Beddard, "Circulatory System in Ophidia," P. Z. S. 1904, vol. i. p. 331.

‡ P. Z. S. 1904, vol. ii. p. 119.

§ P. Z. S. 1906, vol. i. p. 28.

It is to be noted that there is no development of longitudinal trunks running along the vertebral column in the liver-region which give off branches to the portal vein. There are a number of the branches to the portal; but each of these emerges separately from the parietes or is formed of the junction of two or three. There is no extensive fusion such as occurs in the Boine Snakes generally. I do not think that this absence of a longitudinal trunk is due to the emptiness of the blood-vessels. It seems to me to be an anatomical fact.

The *vena renalis advehens* (text-figs. 87, 88, pp. 502, 503), as is known to be the case in other Snakes, communicates directly with the mesenteric vein underlying the gut*. Between this point and the right kidney the renal vein receives about eight branches from the parietes. In the case of the left kidney, which is nearer to the cloaca than the right, there are only five of these branches. At the anterior end of the kidney the vein distinctly ends, though at the very extremity. There is no continuation forwards such as occurs so generally (? universally) among the Boidæ and occasionally (*Zamenis gemonensis*) among the Colubrinæ. Each kidney also receives a special branch from the dorsal parietes, which is not mentioned by Hochstetter in *Tropidonotus*. This arises from the parietes at about the middle of the kidney and from several intercostal spaces on the left side of the body, but from one only on the right. In both cases these veins closely accompany the second renal artery (reckoning from the anterior end of the kidney). Their course, however, is rather different on the two sides of the body. The vein of the left side (text-fig. 88) perforates the kidney, or rather runs between the lobules of that organ; it ultimately joins the renal afferent vein. It is remarkable that the corresponding vein of the right side of the body is different in its relation to the veins of the kidney. It was thoroughly injected, and therefore quite easy to follow. The vein is seen to have no connection whatever with the renal afferent vein of the right kidney, but it opens without doubt into the renal efferent vein (see text-fig. 87) at a point roughly opposite to its point of emergence from the parietes. This anatomical relationship is obviously very unexpected, and it is quite possible that we have here an abnormal state of affairs.

The *venous system* of the *kidneys* in *Coluber corais* differs in some details from that of other genera. The afferent renals, some way before they reach the kidneys, give off two important branches. One of these is to the dorsal parietes, and is a vein which is very general among the Ophidia. The other forms with its fellow of the opposite caudal, which it meets at an angle of 180 degrees, what is practically the commencement of the inferior mesenteric vein running along the dorsal surface of the intestine.

* In *Tropidonotus* and *Coluber æsculapii*, according to Hochstetter (Morph. Jahrb. xix. p. 489), who thus confirms Schlemm and Jourdain as regards the former. I have found this vein in *Coluber corais*, in *Zamenis gemonensis*, and *Ancistrodon piscivorus*.

That this vein originates from the afferent renal has been shown by Hochstetter and myself in other Snakes*. The afferent renal runs along the margin of the kidney and only dies away at the very end anteriorly. It is distinctly not continued forwards as in the Pythonidæ, or if so by the minutest of twigs. In the case of the right kidney, the renal afferent receives affluents from the dorsal parietes along its course upon the kidney. The existence of affluents occupying this position seems in the present state of our knowledge to be a distinctive feature of the Colubrine Snakes as opposed to the Boidæ †.

These affluents are two in number. The first is near to the posterior end of the kidney, and is formed by the junction of two intercostal veins. The second is at the end of the first third of the kidney, and seems to arise from only one intercostal space. These veins join the main trunk of the afferent renal; they do not plunge independently into the kidney-substance, as they apparently do in *Erythrolamprus*. I could find no corresponding veins upon the opposite side of the dorsal middle line supplying the left kidney. The efferent renals do not retain their independence until they are free of the region occupied by the kidneys. The two vessels join at the anterior end of the left kidney, which is situated, as in other Snakes, behind the larger right kidney. The anterior part of the conjoined renal efferents, which is of course the vena cava inferior, received twigs from the right kidney. It is to be noted that in both cases the branches flowing from the kidneys into the venæ renales efferentes have a free course of some millimetres after emerging from the kidney-tissue.

Hepatic Portal System.—The portal vein receives very few affluents from the parietes before it reaches the liver. Directly after reaching the liver the portal trunk shows a spiral twisting, such as is figured by Hochstetter ‡ in the case of the portal vein of *Lacerta*, just before entering the liver. As in other Snakes, the portal runs to the extreme anterior end of the liver. The affluents of the vein are, as usual, dorsal and ventral. The dorsal affluents are mainly in the region of the liver. In fact I could find only one dorsal parietal vein before the liver is reached. This vein, which springs from three intercostal spaces, joins the portal in the region of the gall-bladder, and corresponds in position with the first mesenteric artery. It is apparently general in Snakes for a vein to exist in this region. In the course of the liver, the portal receives seven or eight twigs from the dorsal parietes, which all arise from the left side of the vertebral column. These are roughly at equal distances. The one nearest the posterior end of the liver, situated at about the beginning of the posterior third of the liver, arises by three roots from the parietes,

* Hochstetter, *Morph. Jahrb.* xix., and *supra* p. 505 footnote.

† See *infra*, p. 509. But in *Eunectes* (*P. Z. S.* 1906, vol. i. p. 21) we may find an exception. It seemed to me that in this snake an affluent vein entered the kidney as in *Ophisaurus* (*P. Z. S.* 1905, vol. ii. p. 477).

‡ *Morph. Jahrb.* xix. pl. xvi. fig. 14.

At the anterior end of the liver is another equally stout dorsal parieto-hepatic, which also arises by three or four twigs from the parietes. Between these two are smaller affluents which spring from two roots. In every case, these vessels are joined by a branch or branches from the stomach before entering the portal vein. At the extreme anterior end of the liver the portal vein, greatly diminished in calibre, is continuous with a slender vein which runs along the dorsal side of the œsophagus; this vein was traced forward to the front end of the heart, and apparently extends rather further, but I am unable to be exact as to its relationships here. It has, I think, a branch from the parietes very far forward, in which case it conforms in its construction to the other veins from the parietes. It is noted that these dorsal parieto-hepatic veins are not in any way connected together to form a continuous longitudinal vein running along the parietes in the region of the liver or near to it. In the *Boidæ* there is constantly such a development of longitudinal veins in the hepatic region. It is possible to compare the anterior vein, which enters the portal vein in a straight line with it at the extremity of the liver, to a somewhat similar vein which in *Varanus* enters the anterior tip of the left lobe of the liver*.

There are also the usual branches of the epigastric vein concerned with the circulation of the liver. The most anterior of these are two which enter, close together, the œsophageal vein already referred to as joining the portal at the anterior extremity of the liver. Along the course of the liver there are also two branches from the epigastric, each of which arises from that vein by two or three roots. Finally, at the end of the liver a strong branch joins the epigastric and portal just before the latter reaches the liver. There are some further connections between the epigastric and the portal and anterior abdominal posteriorly; but I have not mapped them accurately. The occurrence of a marked anterior and posterior communication between the epigastric vein and the vessels of the liver appears to be general in the *Ophidia*. It should be noted that the epigastric branches entering the liver at its middle plunge into the liver-substance, and are not directly connected with the portal vein.

(2) *Some Notes upon the Anatomy of Boa diviniloqua and B. constrictor* †.

I have had the opportunity of dissecting two specimens of the former Snake which have recently died in the Menagerie. I am therefore able to make known a few anatomical facts which have not hitherto received much attention. So far as I am aware, this particular species has not been studied up to the present. Some other species have been examined with regard to particular points,

* Beddard, P. Z. S. 1906, vol. ii.

† For a few notes on anatomy see Hering, Württemb. naturw. Jahreshfte, xvi. 1860, p. 103.

and I shall take occasion to refer in the course of the following notes to what is already known relating to the organs and systems which I have myself examined in *Boa diviniiloqua*. My own notes chiefly refer to the vascular and respiratory systems.

Anterior Abdominal Veins.—These veins in the present species of *Boa* retain their distinctness until within an inch of the gall-bladder. Posteriorly each arises, as Gadow has figured*, from the divided caudal.

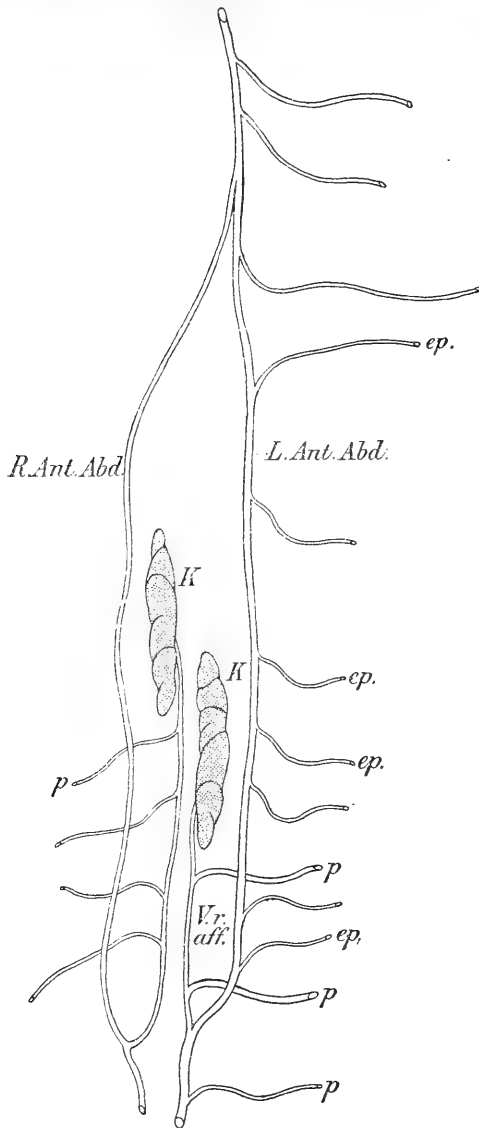
The exact arrangement in *Boa diviniiloqua* is shown by dissection to be this:—Each half of the divided caudal vein again divides into two trunks considerably behind the kidneys. This occurs at a slightly different level on the two sides of the body. On the left side, the division took place, in a male individual measuring 52 inches from the tip of the snout to the cloaca, at a point $3\frac{1}{2}$ inches from the cloaca and $6\frac{1}{2}$ inches from the posterior end of the left kidney. On the other side of the body, the point of separation was a trifle further forward in correspondence with the anterior shifting of the right kidney. Only the left side is figured in the work referred to below, but the junction of both anterior abdominals with the corresponding renal afferent is mentioned in the text. The figure* of *Pelophilus madagascariensis* shows a difference from what I have found in *Boa diviniiloqua*. In the latter species, immediately after the separation of the renal trunk from the caudal vein, the renal branch receives an important affluent from the parietals. This is found on both sides of the body. I ascertained with care the exact point of entrance of this vein, since there are apparently differences among the Boidæ. By Gadow the vein is represented as debouching into the caudal before it has divided into the renal afferent and anterior abdominal. In *Eunectes* and *Eryx* I have described and figured or described the vein as opening exactly at the point of divergence of the afferent renal and anterior abdominal †, or as in the present species. In the example of *Boa constrictor* which I dissected the details (text-fig. 89) are somewhat different. The two anterior abdominals retain their separateness until within $4\frac{1}{4}$ inches of the gall-bladder. As the snake measured 70 inches from the snout to the cloacal orifice, the proportions are very much the same as those given above. The origins of the two posteriorly from the caudals are quite symmetrical; they are exactly opposite to each other. And this is in spite of the fact that the kidneys are unsymmetrical as in *Boa diviniiloqua*. In fact the kidneys are more unsymmetrical. The left kidney, which is $5\frac{3}{4}$ inches in length, is 12 inches from the cloacal orifice. The right kidney is smaller, $4\frac{1}{2}$ inches, and only overlaps the left kidney for the space of $1\frac{1}{4}$ inches. There is a greater overlap in *Boa diviniiloqua*.

Renal Veins.—The afferent renal veins, after parting from the roots of the anterior abdominal, receive affluents from the parietes.

* In Bronn's 'Thierreich,' Bd. vi. pl. cxxxv. fig. 2 v.a.s., v.a.d.

† "Notes upon the Anatomy of certain Snakes of the Family Boidæ," P. Z. S. 1904, vol. ii. p. 113, text-figs. 21, 22.

Text-fig. 89.

Anterior abdominal and renal afferent veins of *Boa constrictor*.

ep. Epigastric veins; *K.* Kidneys; *L.Ant.Abd.* Left anterior abdominal vein;
p. Parietal veins; *R.Ant.Abd.* Right anterior abdominal vein; *V.r.aff.*
 Renal afferent vein.

In *Boa constrictor* the left vein had only two of these: I counted four joining the right renal afferent. I did not count these veins in *Boa diviniloqua*. In the latter species (of which one example was in a particularly good condition for observing the point) the renal afferent, as in other Boidæ*, extends beyond the kidney and forms a delicate vein running up to the testis. This is doubtless the posterior cardinal.

Epigastric Vein.—I did not note the number of branches which connect in *Boa diviniloqua* the anterior abdominal with the epigastric vein. In *Boa constrictor* I was able to observe that all these branches connect the epigastric vein with the left larger anterior abdominal. I could find no branches running between the smaller right anterior abdominal and the median single epigastric vein. This vein appeared to be concerned only with the fat-body. Several branches, however, join the anterior abdominal and the epigastric after the former has become a single vessel by the union of the right and left halves. Posteriorly to this point there were in all about eight transverse vessels uniting the left anterior abdominal and the epigastric. The epigastric, I may take this opportunity of remarking, is one of the most constant veins in the Ophidia in its position, form, and relations with other veins. It appears to be nearly always single. In the case of *Lioheterodon madagascariensis*, however, a specimen which I dissected showed an epigastric vein constantly alternating between the single and double condition, like the dorsal vessel in certain Earthworms.

As is so usual in the Ophidia, a considerable parietal vein flows into the afferent renal shortly before the latter reaches the kidney. At the anterior end of each kidney there is another such vein; and a careful dissection of the same shows that it does not open into the kidney-substance or into the efferent renal, but into the very slender forward prolongation of the afferent renal. This vein, the posterior cardinal, is traceable, as already mentioned, to a little way in front of the testis. In the neighbourhood of each testis the vein receives the

Suprarenal Portal Veins.—Of these veins (text-fig. 90, p. 511) I counted three separate trunks on the left side; two of these reached the cardinal in the region of the corresponding testis; the third vein lay further back, it emerged from the parietes, and joined the cardinal some little way behind the left testis. On the right side of the body there were only two of these parieto-suprarenal veins. They reached the posterior cardinal of their side of the body in the region of the corresponding testis.

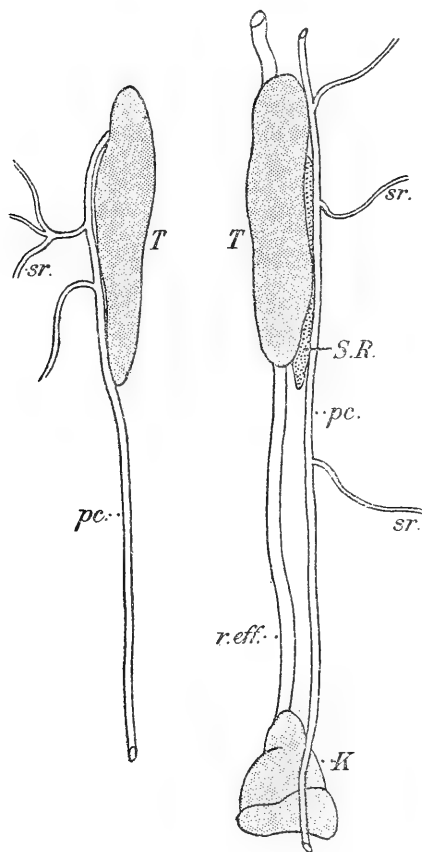
In describing certain points in the anatomy of the Anaconda†, I recorded the presence of an extensive vein running along the body-wall on both sides of and near to the spinal column in the region of the kidney. This vessel connects the affluents of the

* Cf. Beddard, "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 28.

† P. Z. S. 1906, vol. i. p. 23, text-figs. 6, 7.

afferent renal before it reaches the kidney with its affluents after it has left the kidney in front. I have not referred to any similar vein in *Boa*, and I have not found one. The existence or non-existence of this vein does not, however, seem to be of any systematic importance. I find, in fact, that it may either exist

Text-fig. 90.

Posterior cardinal and suprarenal veins of *Boa divinitoqua*.

K. Left kidney; *pc.* Post-cardinal vein (continuation forward of renal afferent vein); *S.R.* Left suprarenal body; *sr.* Suprarenal portal veins; *r. eff.* Efferent renal vein of left side; *T.* Testes.

or not in the Pythonine division of the Boidæ. In both *Python molurus* and *P. sebae* I have found this vein to be very extensively developed both in the region of the kidney and behind it, and furthermore on both sides of the body. It seemed to me to be

slightly better developed on the right side than on the left in *P. molurus*. This vein ran nearly to the cloaca. It is connected by numerous branches with the renal afferent up to the point where the latter reaches the kidney; but after that point there are no more branches to the renal afferent until the latter leaves the kidney anteriorly. Here the vessel is connected with the anterrenal prolongation of the renal afferent by one branch, or rather ends in it, for the lateral dorsal is not itself prolonged beyond the kidney, although numerous intercostal veins arise separately in front of the kidney and join the post-cardinal, as I regard this forward prolongation of the afferent renal. The absence of any intercostals running from the parietes in the region of the kidney across that gland to the renal afferent vein, such as are met with in *Erythrolamprus* and *Coluber**, may prove to be a distinguishing feature of the Boine Snakes.

Python regius may be an exception. In an injected example of that snake, the renal afferent vein was seen to receive from the parietes a branch just behind the kidney and one a little way in front. Just behind the latter, and therefore arising from the parietes just in the kidney-region, was a vessel of which I could not detect the ending. It may, however, very well have reached the post-cardinal in front of the kidney. In this species there is no continuous lateral vein in the kidney-region. And as the specimen was well injected in this region, I am confident of this difference from *P. molurus*.

Azygos Vein.—The azygos vein in *Boa diviniroqua* is in many respects much like that of other Snakes—that is to say, it is not very extensive, extending down the body not much beyond the beginning of the liver. It gives off branches of two kinds, both of which are not always developed in Snakes, or are, at least, not always visible in examples which I have dissected. These branches are firstly those which flow from the body close to the median ventral line, on the right side of the vertebral column of course, *i. e.* on that side which the azygos lies upon. Besides these there is a series of veins which run so superficially to the lateral parietes as to lie actually above the surface of the body-wall. They are supported by membranes, and are not in close connection with the parietes. Two of these veins arise from the main azygos trunk before the latter reaches the level of the parietes. The main trunk of the azygos divides into two branches soon after the region of the heart. An outer branch runs back for some distance before again approaching the median line and giving branches to the intervertebral spaces. These branches generally are fewer than the intercostal spaces, and they must therefore divide within the parietes.

The azygos, then, of this species supplies two regions of the body. It draws blood from the parietes in the immediate neighbourhood of the dorsal median line, and also from the body-wall

* See p. 502 (text-fig. 87) and p. 503 (text-fig. 88).

more laterally. In *Boa constrictor* the same area is drawn from, but there is more specialisation in the veins.

There are, in fact, two longitudinal trunks, one of which is lateral in position and the other close to the medial dorsal line. These arise by separate origins from the jugular. The branch of the azygos which draws blood from the immediate neighbourhood of the vertebral column does not form a long vessel running freely in the body-cavity. It divides directly after its opening near the heart into three equally sized branches, which run straight to the body-wall and plunge into the parietes between two successive vertebræ. This specialisation of the azygos into a proximal and a more distal trunk is an approach to the conditions observable in the Crocodilia, and is an advance upon the structure which has been as yet recorded among most of the Ophidia. In *Python sebæ*, however, there is a similar division of the azygos into two branches concerned with different regions of the dorsal parietes*.

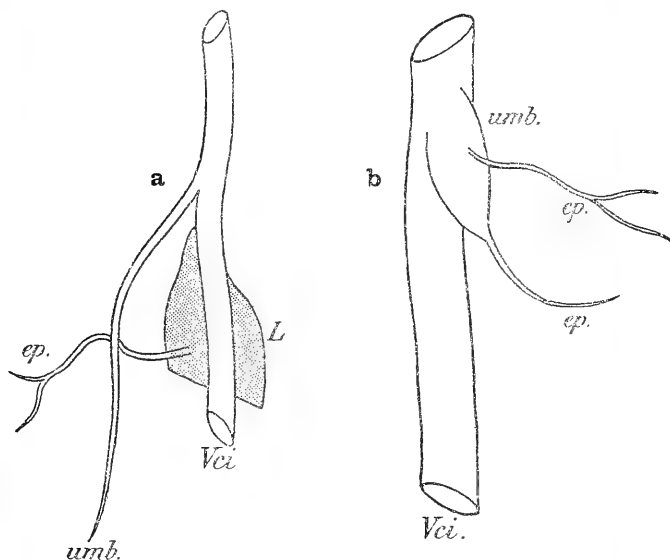
A specimen of *Python sebæ* which I have dissected since writing the account of the azygos of that snake referred to below affords confirmation of that account (which is of importance in view of getting at the normal arrangement of the veins in these animals) and enables me to add a few details. In the individual to which I now refer, a female, the azygos shows the same division into a more dorsal and a more lateral branch. The trunk is bifid behind the point where the third intercostal is given off from the undivided trunk. The more lateral branch only supplies three intercostal spaces. After this point the main trunk gives off eleven branches to as many rib-spaces, the last two of which are very slender. There is then a gap, but the very next rib is accompanied by a vein which is the first of a continuous series of fourteen intercostals arising from the right side of the median line which communicate with the hepatic portal system. So large a development of intercostal veins on the *right* side is not common in Snakes. On the left side, in this specimen as in other snakes, there is a strong development of the longitudinal parietal vessel.

Remains of Umbilical Vein.—In the case of *Boa diviniroqua* the male and female examples which I dissected showed traces of the umbilical vein (text-fig. 91, p. 514). I do not think that there were any noticeable differences in the several examples. But I made more complete notes in one case than in the other. In the larger female specimen the vena cava, immediately after emerging from the liver, was joined by a slender vein expanding somewhat at its debouchment into the vena cava. The extreme anterior end of the liver occupied the angle formed by the confluence of the two veins. Traced backwards, this affluent of the vena cava continued to be full of blood for some little distance; but soon it seemed to be impervious, and to be a mere ligamentous

* See Beddard, "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, p. 30.

thread lying on the ventral surface of the body-wall. It did not extend for a great distance, but was visible for four inches or so down the body. It did not join any of the veins putting the epigastric into communication with the portal system within the liver. It was quite clear from dissection that such of these veins as occurred in its neighbourhood crossed it without forming a junction with it. These various facts leave little doubt in my mind that this vein is the persistent umbilical, which is longer than in *Python*, and more like that of *Eunectes* for this reason.

Text-fig. 91.

Umbilical veins of (a) *Boa* and (b) *Python regius*.

ep. Epigastric veins; L. Liver; umb. Umbilical vein; Vci. Post-caval vein.

The umbilical vein in *Boa constrictor* offers some interesting variations from the condition found in *Boa divinihoqua*, though I do not assert for the present that they are actually specific variations. In the example which I dissected, the vein was longer than in the last species, and also vascular for a greater extent, thus resembling the Anaconda. Its relations to the postcaval vein were, however, quite as in *Boa divinihoqua*. The vein is as usual attached to the ventral surface of the liver, and it extended down to about the middle of that organ. A careful examination of the vein showed that it gave off, or rather received, a number of subsidiary trunks of very small calibre. These branches run over the liver, but they do not appear to form any part of the portal system. They are, in fact, so far as I could make out, distributed

entirely to the peritoneal sac in which the liver lies. They ramify over the walls of this sac, and do not plunge beneath it to enter the substance of the liver. This recalls the branches of the umbilical vein of Birds, many of which ramify in the umbilical ligament which bears the vein. It may be that these veins are also present in *Boa diviniloqua*; indeed, one would assume that they were present but they were not visible.

With regard to the *Arterial System*, I call attention here to two points only. Firstly, in both *Boa diviniloqua* and *B. constrictor* each kidney is supplied by a single renal artery, which enters the kidney at the anterior end. These additional instances increase the probability that the Boidæ in general are to be characterised by this anatomical fact. Though it has to be admitted that the number of Boine genera at present examined from this point of view is not large, only one exception has been met with, viz. *Eryx jaculus*, in which snake there are sometimes, but not always, two renal arteries to each kidney.

I may take this opportunity of increasing the list of Boidæ known to possess only a single renal artery to each kidney. I have recently had the opportunity of dissecting an example of *Python molurus* measuring over 9 feet in length. In this snake the right kidney measured eight and a quarter inches in length, and the left kidney was nearly as long. In spite of this length, each kidney had only one renal artery.

In *Python regius*, which is a smaller species but still of considerable size, there was no doubt about the fact that each kidney had only a single artery.

In an example of *Enygrus carinatus** the left kidney at any rate had but one renal artery. I did not examine the right.

The second point concerns the *intercostal arteries*, which resemble those of *Eunectes* and *Eryx*† and *Python spilotes*‡, and not those of *Python sebae* and *Corallus*. Each pair of arteries, in fact, does not issue directly from the aorta; but several pairs are given off from a common trunk which runs longitudinally for varying distances in different cases. These trunks arise at varying intervals from the aorta.

Lungs.—In *Boa diviniloqua* there are two lungs which are, of course, unequal in size, though both are vascular. The trachea in the neck-region has incomplete rings, which are united posteriorly by a tract of membrane. There is, however, no trace, that I could discover, of a tracheal lung. The lungs, both of them, end in a very distinct line at the point of opening into them of the bronchi. The vascular and red membrane ceases abruptly.

A point in which the genus *Boa* differs from *Python* is in

* I owe the opportunity of examining this snake to Dr. C. G. Seligmann. I may take this opportunity of remarking that the kidneys are very small, as in *Eryx*, measuring respectively 16 and 17 mm. The right kidney lay 72 mm. from the cloaca. The snake measured 19½ inches from the tip of the snout to the cloaca.

† Beddard, "Anatomy of Boidæ," P. Z. S. 1904, vol. ii. p. 108.

‡ Beddard, P. Z. S. 1904, vol. i. p. 362. This species has been placed in a separate genus.

the bronchus in each case being continued far into the interior of the lung as a gutter, which is, however, so narrow as not to be functionally a gutter at all; it is for the greater part merely a flat band composed of tracheal, or rather bronchial semi-rings. Relatively to the length of the two lungs, the bronchial rings extend perhaps nearly as far towards the posterior extremity of the lung in both cases. In the larger lung the bronchial semi-rings reach down a long way, nearly to the anangious part of that sac. They die away rather gradually, becoming narrower at the end of the series. It is also important to notice that the two bronchi do not diverge as they do in *Python*. In *Boa* the shorter bronchus does not arise by a perforation of the tracheal rings; but the aperture is seen to lie in a thickened area on one side of the bronchial rings appertaining to the right bronchus.

The lungs of *Boa constrictor* present certain differences from those of *B. diviniroqua*. Milne-Edwards has mentioned the tracheal gutter in this species. The larger lung is vascular up to about the end of the first third of the liver. The bronchial gutter runs nearly as far as this point and ends rather abruptly; its rings do not decrease much in breadth towards their termination; they do not fine off to a point. The smaller lung is vascular to a point about one inch beyond the commencement of the liver. It extends altogether about halfway down the liver. There is no trace of a bronchus belonging to this lung. It presents the appearance at its orifice of communication of being merely a lobe of the larger lung. It is clear that there is no orifice in the tracheal gutter such as is obvious in various Snakes which are provided with a second lung. But on a careful examination it may be seen that the edge of the tracheal gutter is slightly bitten out, as it were, for a space of a few lines where the smaller lung arises. There is no question of a bronchial gutter continued along this lung.

(3) *Notes upon the Boine genus Corallus.*

This snake is placed by systematists among the Snakes of the Boine division of the Boidæ*. A dissection of the Madagascar species *Corallus madagascariensis* enables me to record certain anatomical facts which bear upon the question of its systematic placing, and which will also serve as a contribution to our knowledge of the anatomy of this division of Serpents.

The example of this serpent which I dissected was not in a very favourable condition for unravelling the details of the circulatory system, for the veins, and, naturally, the arteries, were largely empty of blood, an anæmic condition which is not infrequent in reptiles that die in the Society's Gardens. Nevertheless, I have been able to ascertain a few facts about the veins which are of importance from the systematic standpoint.

The first vein which I endeavoured to find was the *umbilical*.

* Boulenger, Catalogue of Snakes in the British Museum, vol. i. p. 99.

It will be remembered that in *Python**, contrary to what is found in *Eunectes*†, and even, though to a less extent, in *Boa*‡, the umbilical vein is represented in the adult by a rudiment only. Nevertheless this rudiment was quite obvious in the several examples in which I sought for, and succeeded in finding, it. I am therefore inclined to regard my inability to find the least trace of such a rudiment in *Corallus* as evidence that the vein has completely disappeared in that snake. This state of affairs is, however, more like that of *Python* than of the two Boine genera *Eunectes* and *Boa*. The vein running from the front end of the liver to the pericardium showed no indications whatever of a branch.

Although in this particular the evidence afforded is rather in favour of the placing of *Corallus* in the Pythonine subdivision, it has less value in that it is a negative character.

The *intercostal arteries* offer a positive character pointing in the same direction. In *Boa*, *Eunectes*, and *Eryx*§ the intercostal arteries are apt to arise at widely separated intervals from the aorta, a single branch thus arising running backwards or forwards or both for a considerable distance, and giving off a regular series of branches to the right and left of the dorsal middle line of the body. In *Python*, on the other hand, as the researches of Jacquart|| and my own observations have shown, the intercostals arise regularly from the main trunk of the aorta. Each artery springs separately from the aorta and divides below into two, one for each side of the body. In *Eryx*, &c. each artery may leave the aorta separately from the point of its origin. There is but a slight development at most of secondary longitudinal intercostal trunks. Now it is important to record the fact that in these characteristic features *Corallus* is on the side of *Python*, and departs equally from the conditions observable in the Boas.

I do not venture upon any further details concerning the circulatory organs for the reasons already stated.

The position of the viscera in the Ophidia is of importance to note as a means of comparison between various genera and even various species.

In the present serpent, which measured 55 inches including the short tail, the *liver* begins fairly close to the heart, its anterior end being only $2\frac{1}{2}$ inches from the apex of the heart. The liver itself presents peculiarities worth noting. It is very long, measuring $12\frac{1}{2}$ inches altogether. Of these the last 4 inches belong to a backward extension of one of the two lobes. It is very usual for this lobe to extend back beyond the other lobe among Ophidia, and the proportions vary somewhat in different cases. I have not, however, as yet had the opportunity of dissecting a snake in

* Beddard, "Contribution to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 28. I may take this opportunity of recording the fact that *Python molurus* and *P. regius* agree with *P. sebæ* in the retention of a similar rudiment.

† Beddard, *loc. cit.* p. 18.

‡ *Supra*, p. 514.

§ Beddard, *loc. cit.* p. 33, and P. Z. S. 1904, vol. ii. p. 109, text-fig. 19.

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which the posterior tail-like extremity of the right lobe is so lengthy in proportion as it is in *Corallus madagascariensis*. Not only is it very long, but it is also very thin, ending posteriorly in the tiniest filament of liver-tissue. There is no doubt, however, that the extreme end is liver-tissue, and that I have not confounded with this unusual extension a portion of the vena cava, with which, possibly, in a badly preserved specimen one might have confounded it. The liver almost, if indeed not actually, touches the spleen behind, and comes very near to the gall-bladder, which organ is, as a rule, separated by a considerable space from its posterior termination. The spleen is smallish and dark red in colour and uneven in form, being lobulated, the lobules, however, showing no tendency to become separate from each other. It lies, as will be gathered, just in front of the gall-bladder. The pancreas is firmly fixed at the junction of the slender pyloric part of the stomach with the wider small intestine and lies on both sides of the gut. The ducts arising from the gall-bladder form a plexus upon it.

Both *lungs* of *Corallus* are functional; but there is the usual disparity of size between them. The difference of size, however, is greater than in *Python*. Both lungs possess a headward extension in the form of a short pyramidal cæcum directed forwards. The tissue of the larger lung is continued headwards as the membranous interval between the tracheal rings dorsally. There is, however, no trace whatever of any invasion of this membrane by lung-tissue. It is merely membranous. The bronchus belonging to the larger lung is continued for a long way down it, very much further than in any species of *Python* which I have had the opportunity of examining. This tracheal or bronchial extension reaches, in fact, some little way down the liver. Its exact place of ending is rather difficult to define. Towards the end it narrows rather rapidly, but is thereafter continued further as a fibrous band. A similar fibrous band exists in the Python, *P. spilotes*; but it begins much earlier in the lung. The extension of the bronchus is reminiscent of the lung of *Boa divinitoqua* rather than of any Python with which I am acquainted. In the smaller left lung the bronchus is also continued, but extends only for two or three rings. The origin of the left bronchus appears as a perforation in the right bronchus; it is exactly in the middle of the rings of the latter, not to one side for example. It is to be noted that the extension of the bronchus down the right lung differs from a similar extension in *Coluber* and some other Snakes by reason of the fact that the rings are flattened out. There is no such occlusion of the rings dorsally to form a practically closed tube as we meet with in the genus *Coluber*. The fibrous band which seems to continue the bronchus down the lung is probably really to be looked upon as morphologically the posterior end of the cartilaginous series of bronchial semirings. The present species, when compared with *Python*, offers evidence that this is

actually the case. For the shorter the tract of bronchial semi-rings within the lung, the longer the seam running down that organ. The lungs of *Corallus* therefore conform to the usual Boid pattern. They lean more towards the Boine than the Pythonine structure, but offer differences of detail from those of other genera which have been examined. These facts therefore clearly justify the generic independence of *Corallus*, coupled with its inclusion within the Boine section of the Boidæ.

The only other organs which I have especially noted are the *kidneys*, and this by reason of the fact that they offer characters of systematic value in discriminating certain Ophidia. In *Corallus*, as in the Boidæ generally, the renal glands lie at a considerable distance from the cloaca. I did not make an absolute measurement, since at the time I only noted that they appeared to occupy much the same position as do those of *Eryx*, &c. Furthermore, the kidneys are very small relatively speaking. The two of them measure about an inch and three-quarters, and there is not a great deal of difference between that of each side of the body. The smallness of the kidneys is exactly the same as in the cases of *Eryx* and *Enygrus*; and, as in those two genera, the kidneys of *Corallus* are deeply separated into lobes, more so than can be noted in some Snakes. Finally, the present genus agrees with other Boidæ in the fact that each kidney is served by a single renal artery. This latter appears to be one of the most decisive characters of the Boidæ, and, so far as present observations enable a statement, is only found in *Ilysia* outside that family; *Ilysia* has also other Boine characters*.

(4) *On the Modifications of Structure in the Lungs of certain Ophidia.*

The most recent general paper dealing with the lungs in the Ophidia is by the late Prof. Cope †, who refers in that communication to some of the previous work upon the subject, mainly to be found in Siebold & Stannius' well-known text-book. It is now known, both from Prof. Cope's work and from the memoirs of others, that the chief variations in structure which the lungs in this group show are:—(1) the existence in most Boidæ of two functional lungs, a right and left, of which the right is the larger; (2) that other Snakes have only one functional lung, which Butler ‡ has proved to be the right in every case; (3) that the rudimentary left lung may be altogether absent; and (4) that the lung-substance may exist from the very commencement of the trachea forming the so-called "tracheal lung," which itself shows considerable variations in its condition in different Serpents.

To the facts collected together by these authors I have been

* Beddard, P. Z. S. 1906, vol. i. p. 31.

† "On the Lungs of the Ophidia," Proc. Amer. Phil. Soc. xxxiii. p. 217.

‡ "On the Complete or Partial Suppression of . . . the Left Lung in Snakes, &c.," P. Z. S. 1895, p. 691.

able to add the description of the lung in the Hamadryad*, which shows a new form of tracheal lung or rather air-sac, and an account of the lung in the two sea-snakes *Platyurus colubrinus* and *Hydrus platyurus*†, extending the observations of Cantor upon one of these, and I have lately brought forward some evidence in favour of regarding the existence of the tracheal lung as typical for the Squamata‡. I have now to direct attention to further facts collected during the last few months which fill in several lacunæ in our knowledge of the respiratory system in the Ophidia, and permit of some more general statements than could be made by previous observers, who had examined comparatively few species and genera. I am able considerably to extend the knowledge of the occurrence of the tracheal lung, and thus to put upon a firmer basis my view that this part of the lung is not a secondary development, but that its presence is a primary condition of the lung in those reptiles, and probably in the allied Lacertilia. In the following pages I direct attention to the structure of the lungs in a few Colubrine Snakes. I have already referred to the lungs of certain Boidæ §.

The lungs of *Coluber corais* are in several respects remarkable. In this serpent the tracheal lung is developed to a very great extent, but as an air-sac. The trachea ceases to be a closed tube almost immediately after its origin; half way between the free and the attached ends of the mandibles the trachea opens out into a gutter. It is not a question here of a narrow membranous interval dorsally between the free ends of the tracheal rings. These extremities are connected by a wide thin-walled sac several times the diameter of the trachea itself. Towards the heart this tracheal lung becomes slightly honeycombed in structure and vascularised; but it is a very small tract that can possibly serve as an organ of respiration. The lung proper begins at the heart; there is no change at this point either in the calibre of the tracheal lung, which is continuous with the thoracic lung, or in the form of the tracheal gutter. The latter ceases almost immediately after the commencement of the thoracic lung. An aperture leads into the rudimentary left lung. This lung although small is evidently functional; its walls have the usual honeycomb structure and are red with blood capillaries.

Moreover, the cartilaginous semirings of the trachea are continued for a short distance into the second and smaller lung. The large and principal lung retains its vascularity down to just after the beginning of the liver. After this point it is merely a thin-walled air-sac like the tracheal lung. Its length is unusual, at least if it be compared, for instance, with the lungs of the Python. It is traceable nearly to the cloaca posteriorly. It must therefore form a very efficient swim-bladder or enable the snake to puff itself

* "On the Trachea, Lungs, &c. of the Hamadryad," P. Z. S. 1903, vol. ii. p. 319.

† "On the Visceral Anatomy of Pelagic Serpents," *ibid.* 1904, vol. ii. p. 147.

‡ "Contributions to the Anatomy of the Ophidia," *ibid.* 1906, vol. i. p. 41.

§ *Supra*, p. 515.

up, when adopting a threatening demeanour, to an unusual extent. It will be observed that the tracheal lung of *Coluber corais* is planned on the model of that of the Viperidæ. But instead of being vascular as in those Snakes, it is just the part of the lung which is non-vascular, the vascularity commencing with the thoracic lung. In the Vipers it is the tracheal lung which is vascular and the thoracic lung which is not so.

I am fortunately able to compare the state of affairs in this species *Coluber corais* with that of other species of the genus *Coluber*. These will now be dealt with.

In *Coluber longissimus* (= *C. cesulapii*) there is also a tracheal lung, which is, however, different in detail from that of *C. corais*. The lung-tissue is, as usual, continuous with the dorsal membranous interval between the tips of the incomplete tracheal rings. This interval is narrow as in Serpents, with no tracheal lung; but for some distance, an inch or so, in front of the heart it has the honeycombed structure of the lung proper. This fades away gradually anteriorly into the ordinary membranous appearance of this part of the respiratory apparatus in those Ophidia which possess no tracheal lung. It does not seem to be vascular except perhaps just at its commencement below, and has not the pink colour characteristic of the functional lung. There is a rudimentary second lung which is vascular as in *Coluber corais*, and the existence of which has been duly noted by G. W. Butler*.

Coluber obsoletus (= *alleghaviensis*).— In a spirit-preserved example of this *Coluber* there are also traces of the tracheal lung invading the membrane for some little distance in front of the heart. There is also in this species a very distinct headwardly directed cæcum of the lung, as in other species of *Coluber*. There is also present the second though rudimentary lung, which is, however, cellular in structure and not a mere thin-walled sac. The orifice into the second lung is exactly on a level with the apex of the heart. The orifice has the form of a perforation of the tracheal gutter. It does not lie in the lung-substance beside it. The tracheal gutter is in this species fairly extensive. It can be traced easily to a point lying about half an inch behind the commencement of the liver, that is about 4 inches behind the apex of the heart. Its termination coincides with the end of the vascular region of the lung. The total length of the Snake itself from mouth to vent is 47 inches.

Coluber leopardinus, though a small Snake like *Coluber longissimus*, has vestiges of the tracheal lung more like those of the large *Coluber corais*. It resembles that species, in fact, by reason of the great width of the anangious membrane which divides the tracheal rings at their tips anteriorly. The honeycomb structure of the lung extends for a shorter distance than in *Coluber longissimus* in front of the heart, and in this region the width of the "lung" is less than anteriorly. Close to the apex of the heart—a little in

* P. Z. S. 1895, p. 705.

front of it—the thoracic lung is marked off from the tracheal by a short forwardly extending pouch of the former which lies dorsally, and therefore, as seen in dissection, beneath the lower end of the tracheal lung. Such a forward process of the thoracic lung is common in Snakes, but I have not found it in *Coluber longissimus*. It has in *C. leopardinus* obviously nothing to do with the tracheal lung.

There is a second honeycombed and vascular rudimentary lung.

In *Coluber melanoleucus** there is a type of lung differing in many respects from that of the three species of *Coluber* already, or to be, dealt with. The trachea is continued down the lung for a very great distance. It is from high up in the neck an open gutter and runs as such to a point about half way down, or not far from the posterior end of, the liver. The trachea does not cease at the end of the vascular region of the lung, but extends some way beyond the point at which the lung ceases to be vascular. When a transverse section is made of the lung behind the heart, the appearances presented suggest at first that the trachea is quite independent of the lung. The elasticity of the cartilaginous rings keeps the trachea closed, and produces the impression of a closed tube running within the lung. It is not, however, closed but freely communicates along its whole length with the cavity of the lung. The lung-tissue does not extend forwards beyond the region of the heart; this species has therefore no tracheal lung. The honeycombed structure ceases in a very abrupt fashion along a line which is rather oblique. I found a pocket running forwards such as is met with in *Coluber longissimus* and is not uncommon among Snakes. There is a considerable distance in the neck-region between the separated extremities of the tracheal semirings. But the membrane which divides them is not swollen out into such a thin-walled sac as occurs in *Coluber corais*. It is rather thick, and nowhere could I find any traces of a honeycombed structure, which, considering the abrupt way in which the lung ends at the heart, would hardly be expected. Furthermore, there does not seem to be in this serpent any rudimentary left lung at all. If it be present, which I doubt, it is so small as to have escaped my observation.

It is clear that *Coluber melanoleucus* presents more differences from the three species of *Coluber* that have been described than any of them do from each other. The absence of a rudiment of the left lung †, the enormous extension down the lung of the trachea, and finally the abrupt ending of the lung-tissue in the region of the heart, are the salient points of difference. I am much inclined to doubt whether the inclusion of this species in the same genus with the three species already referred to is, anatomically considered, a sound procedure. But I hope later to offer some observations upon the systematic arrangement of certain Ophidia.

* I dissected two examples.

† Even if this has been overlooked considerable differences remain. Cope, however, was unable to find it like myself.

Coluber catenifer agrees in most respects with *Coluber melanoleucus*, and these species, together with two or three others, have been placed in a genus apart, viz. **Pityophis*. The trachea in the same way extends a long way down the lung, further, indeed, than in *Coluber melanoleucus*. I traced the tracheal gutter some way behind the liver, in fact to a point about two inches behind that organ and close to the gall-bladder. In this region of the body the lung has ceased to be vascular. As in the last species, the lung-tissue is sharply marked off anteriorly and there is an anterior diverticulum of the lung. Nor could I find the orifice of a second lung. Transverse sections of the lung in the vascular part of that organ showed precisely the same features as have been indicated in describing *Coluber melanoleucus*. The structure of the trachea and lung, in fact, of the present species shows a slightly exaggerated replica of the structure of the same parts in *Coluber melanoleucus*.

Coluber catenifer var. *sayi*.—I have examined a snake which is thus labelled, but I am not aware by whom it was identified. It forms part of a small collection of Snakes in spirit belonging to the Society. In Boulenger's 'Catalogue of Snakes in the British Museum,' "*Coluber catenifer* var. *sayi*" is placed under *Coluber melanoleucus*, which is distinguished from *C. catenifer*. In the example referred to here, I find absolutely no difference from the lungs of *Coluber catenifer* as described above. So alike are they that I find no occasion for a description †.

* Of the 45 species of *Coluber* described by Boulenger (Catalogue of Snakes in the British Museum, vol. ii. 1894, pp. 29 *et seq.*) the two above mentioned are the only species in which only one labial scale forms a part of the margin of the eye and there are two suboculars. In four other species which have been assigned to the genus *Pityophis* both of these characters do not occur. The presence of a subocular segmented off from the preocular is common and occurs, I may take this opportunity of remarking, in an example of *Coluber longissimus* which I have examined, on one side of the head with indications of approaching separation on the other. This point is not mentioned by Boulenger in his definition of the species and is therefore, I presume, not usual. I am able therefore here to correlate a peculiarity of internal structure with an external modification, viz. in the scaling of the head. But without a more exhaustive survey of the structure of the species of *Coluber*, it would be unwise to attempt generic rearrangements.

† It is clear therefore that the question of the species requires some consideration. I extract from Boulenger's description in the Catalogue (p. 68) the following features as *distinctive* of the two, viz.:—

C. catenifer. Rostral as broad as deep or slightly deeper. Anterior chin-shields longer than the posterior. Subcaudal scales more than 65.

C. melanoleucus. Rostral much deeper than broad. Parietals usually broken up behind. Anterior chin-shields much longer than the posterior. Subcaudals less than 65. Some or all of labials with black sutures.

The other characters used either overlap or are not diagnostic so far as these two species are concerned.

In one specimen of *C. catenifer* and two of *C. melanoleucus* belonging to the Society I distinguish the above-mentioned characters with the exception of the black edges of the labial, which occur in both species. In the latter the subcaudal scales were 48 and 57 pairs respectively; in the single specimen of *C. catenifer* 71 pairs. In this specimen, the prefrontals were not broken up, as is the case, according to Cope (P. U. S. Nat. Mus. 1892), with *C. wilkesii*; there was a subocular below the preocular and one subocular below the two postoculars. In the two specimens of *C. melanoleucus* there was no subocular in front and one below the two postoculars. In all other respects, save colour, these several individuals agreed with Boulenger's description. Yet Baird & Girard (Cat. N. Amer. Reptiles in Mus. Smiths. Inst.

Coluber guttatus has a lung which is slightly different in various ways from the species already described. The tracheal gutter extends a good way down the lung, in fact a little way beyond the point where it ceases to be vascular. This point is 5 inches from the apex of the heart, and rather more than 2 inches after the commencement of the liver. The lung-tissue does not cease abruptly anteriorly, but dies away gradually some little way in front of the heart. Here and further forward the membrane lying between the extremities of the tracheal semirings is of considerable breadth. At about on a level with the apex of the heart there is an aperture in the lung-tissue which leads into a forwardly directed diverticulum of the lung. I could find a minute though decided trace of a second lung arising from the tracheal gutter on a level with the apex of the heart.

The lung in *Erythrolamprus aesculapii* is single, there being only a rudiment of the second lung. This rudiment, however, is distinctly vascular and cellular in appearance, and a branch from the pulmonary artery serves it. It is not, however, more than about $\frac{3}{4}$ of an inch in length, and communicates with the trachea not by a separate bronchus, but by a round hole in the trachea before the latter ends in the interior of the perfect lung. The complete lung extends headwards beyond the point where the trachea enters it, as in various Snakes and Lizards. This section of the lung has a kind of independence, for it possesses a restricted lumen which is not broadly continuous with that of the lung

1853, pp. 65 & 69) distinguish "*Pityophis*" *catenifer* and "*P.*" *melanoleucus* by, *inter alia*, the numerous dorsal blotches of the former and the fewer and larger of the latter. Boulenger does not use this difference, and for the good reason (so far as his own views are concerned) that he regards as a synonym of *C. melanoleucus* "*Churchillia*" or "*Pityophis*" *bellona* of Baird & Girard (*loc. cit.* p. 66), which has, like *C. catenifer*, numerous smallish dorsal blotches, but has the narrow rostral and other characters of *C. melanoleucus*. The specimen of *Coluber* described above as "*Coluber catenifer* var. *sayi*" is quite obviously Baird & Girard's *Pityophis bellona*. It has the additional frontal shield mentioned and figured by those authors. In other respects, save colour, it agrees in all the characters that I have just mentioned with my two examples of *C. melanoleucus*; the subcaudal scales are 55 pairs. The colour is paler than that of my example of *C. catenifer*, but the pattern is the same. These facts seem to me to support the view (held by Cope and others) that *Coluber sayi* is a distinct species. And I have further evidence pointing the same way. The arrangement of the tracheal gutter is like that of *Coluber catenifer*, not of *C. melanoleucus*.

In *Coluber melanoleucus* (measuring 41 inches from snout to cloaca) the liver, $7\frac{3}{4}$ inches long, commences 4 inches away from the apex of the heart. A second specimen showed the same proportion. In an example of *Coluber catenifer* ($36\frac{1}{2}$ inches from snout to cloaca) the liver ($7\frac{1}{2}$ inches long) commences 2 inches from the apex of the heart. Finally, in "*Coluber catenifer* var. *sayi*," measuring 32 inches from snout to cloaca, the liver ($6\frac{3}{4}$ inches long) begins 2 inches from apex of heart. To resume—the snake called *Coluber sayi* by Schlegel and *Churchillia bellona* by Baird & Girard is not to be confused with either *C. melanoleucus* or *C. catenifer*. While the scaling of the head agrees with that of *C. melanoleucus*, the colour plan is that of *C. catenifer*. Certain visceral characters also agree with those of *C. catenifer* rather than *C. melanoleucus*. We must therefore either fuse all these varieties into one species or distinguish three. The latter course seems to be the more reasonable. But it obviously remains to be determined what are the limits of the species, so far as external characters are concerned.

itself, but certain of the alveoli (about two I think) of the latter are deeper than the rest and communicate with the pulmonary appendage. In a transverse section of the latter it is seen to be for the most part solid, with a cavity at either side. It seems to be a prolongation of the outer edge of the lung proper, which is thicker in its wall than the rest of the lung. There is no special communication of the headward extension of the lung with the trachea. The lung ceases to be vascular some way down the liver, and ends altogether a few inches before the termination posteriorly of the liver.

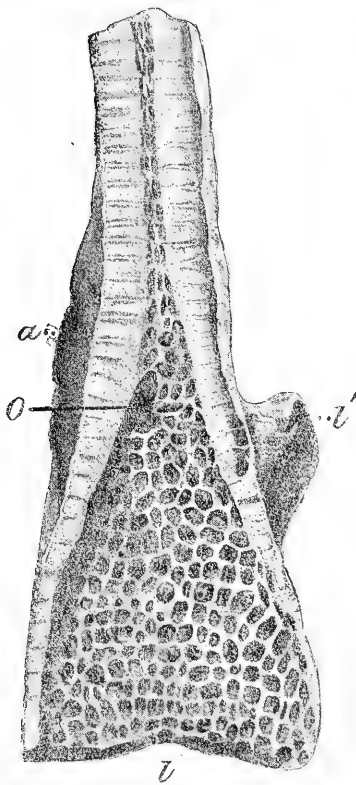
When the trachea of *Erythrolamprus* (text-fig. 93, p. 526) is cut open, it is seen that, as in many (probably in all) Snakes, the tube is not completely encircled with the cartilaginous hoops. There is a median dorsal area which is occupied by soft tissue. This area of soft tissue is continuous with the lung-tissue, and, more than that, it is not merely a fibrous membrane but is divided into hexagonal cells. It presents, in fact, the honeycombed appearance of the lung though less marked. This is obviously a tracheal lung, recorded in this Serpent here for the first time, so far as I am aware. The tracheal lung of *Erythrolamprus* is, however, of small dimensions. The cells are ranged not more than two or three deep. The lung therefore does not project dorsally from the trachea as in the better-developed forms of tracheal lung. It is not, in fact, wider than in many forms where there is no development of pulmonary tissue in this region, but merely a fibrous connecting-band between the tracheal semirings. The tracheal lung, however, inextensive as it is, seems to function as a lung, for it is vascular and of the same red colour as the functional lung below. It has, moreover, a special branch of the pulmonary artery supplying it. The pulmonary artery of this Snake is single (text-fig. 93). It reaches the lung at the apex of the anterior lobe, and passes obliquely back, lying ultimately to the outside of the lung outside of the vena cava inferior, which covers in the natural position of the viscera the pulmonary vein. The artery before it quite reaches the lung gives off a branch which at once divides into two. The lower of these branches supplies the anterior lobe of the lung. The upper branch turns back, and runs up the trachea along the pulmonary surface of that tube. It corresponds therefore to the anterior branch of the pulmonary artery in *Bitis**, and to the tracheal branch of the pulmonary artery in certain Lizards †. The pulmonary artery can be traced nearly to the end of the lung; it is to be seen in the posterior anangious region of that viscus. At regular intervals it gives off branches running across the lung. In the anangious region these branches are slender; it is an interesting fact that they end by anastomosing with the intercostals above. The nutritive blood of the lung is therefore not separated from the respiratory blood.

* Beddard, "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 36.

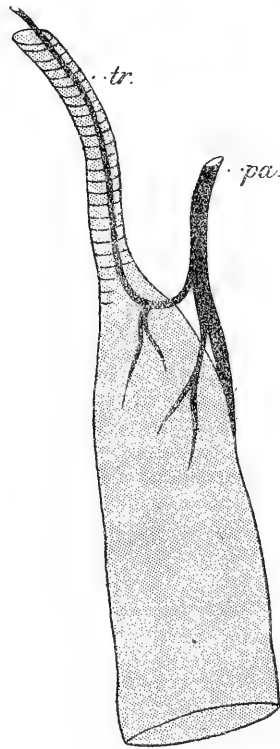
† *Id. ibid.* p. 44.

It is correctly stated by Duvernoy* that "on voit dans un long espace des traces de la trachée intrapulmonaire dans le poumon unique † de l'*Erythrolamprus aesculapii*." There is not, however, a distinct gutter such as occurs in so many Snakes

Text-fig. 92.



Text-fig. 93.



Text-fig. 92.—Commencement of lung of *Erythrolamprus aesculapii* cut open.
a. Forward extension of lung along trachea; *l.* Lung; *l'*. Rudimentary second lung, the orifice into which is shown in the tracheal semirings; *o.* Orifice of headward extension of lung (*a*) into main lung. The tracheal lung is shown in front of (above) *o.*

Text-fig. 93.—Lung of *Erythrolamprus aesculapii*.

pa. Pulmonary artery; *tr.* Trachea, along which runs special branch of pulmonary artery.

referred to in the present communication. It is a stout, though narrow flat band, showing no incurving of its sides to form a

* *Leçons d'Anatomie Comparée de Georges Cuvier*, red. par G. L. Duvernoy, ed. 2, vol. vii. (Paris, 1840) p. 138.

† This particular statement is inaccurate.

gutter, which extends beyond the commencement of the liver. This band seems to me to present a stage which I have not yet met with in any other Snake, lying between the more usual tracheal gutter and the rudimentary seam, which in a few Snakes (e. g., *Python sebae* and, which is more to the point at the present moment, *Tarbophis*) seems to be all that is left to represent the continuation backwards of the trachea within the lung.

Tarbophis obtusus closely resembles *Erythrolamprus aesculapii* in the structure of its respiratory organs, and both Snakes are placed by Boulenger in the same subfamily of Opisthoglypha. It has a very distinct tracheal lung. This tracheal lung, however, as in *Erythrolamprus*, is of very modest dimensions. Although it presents the characteristic honeycombed structure only, two or three of the cells intervene between the free ends of the tracheal semirings. The tracheal lung is, in fact, very narrow. The trachea is continued for a short distance into the lung proper, and shortly before its termination gives off a bronchus to the rudimentary left lung. From the point where the tracheal semirings apparently terminate in the interior of the lung a fibrous seam is continued onwards, which recalls at once a very similar seam or ridge in the lungs of the Lacertilian genus *Teius** as well as of *Python sebae*, and of *Erythrolamprus* just described.

In *Leptodira hotamboeia*, which belongs, like *Erythrolamprus* and *Tarbophis*, to the Dipsadomorphine family of the Opisthoglypha, the lungs are not widely different from those of *Tarbophis*. The advantage of examining a recently dead specimen is chiefly seen in the ease with which the vascular can be marked off from the anangious region of the lung. The minute portion of the lung which in this Snake (and others) serves as an efficient breathing-organ, contrasts with the large extent of the functional lung in such a snake as *Bitis arietans*. There are about 10 inches of vascular lung in the Puff-Adder and about 1½ inches in *Leptodira hotamboeia*. Nor is this enormous difference to be explained by relative bulk. *Leptodira* possesses a rudimentary left lung which in spite of its small size is red, and thus entirely vascular. I have had to remark in other cases upon the vascularity of the rudimentary lung in Snakes. Assuming that the point where the rudimentary lung arises marks the line of division between the thoracic and tracheal lungs, *Leptodira* may be said to possess a functional tracheal lung. As there is no headward extension of the larger lung, it is not possible to fix the boundary of the thoracic and tracheal lung otherwise. There is, however, an extension of lung-tissue further forward than the very short tract lying in front of the bifurcation of the trachea which is vascular. The tracheal lung is very wide. The membranous interval between the dorsal ends of the tracheal semirings is very much wider than the diameter of the trachea itself. This Snake, therefore, in the

* Milano, Zool. Jahrb. Abth. f. Anat. vii.

relations of the tracheal to the thoracic lung, bears the same relation to *Tarbophis* as does *Coluber corais* to e. g. *Coluber melanoleucus*. Finally, I have to point out that the bronchus does not extend very far down the functional lung. The bronchial gutter, which is quite flattened out and not gutter-like as it is in *Coluber**, reaches back to a point not more than half an inch behind the apex of the heart.

In a fresh example of *Boodon lineatus* the conditions of the lung were very plainly visible on opening the body. The limits between the vascular and the anangious regions of the respiratory organ were easily mapped. The trachea was seen to be provided dorsally with a tracheal lung, the cells of which were especially plain and presented the appearance, before the trachea was split up, of bubbles of air lying between the ends of the tracheal rings. At a level with the commencement of the ventricle, this tracheal ring took on a red hue, this part being vascular. The vascularity of the lung was seen to continue down about an inch along the liver, before the middle of which it ceased to be visible. The bronchus is not, in this species, continued far down the lung. It ceases, in fact, at the very commencement of the thoracic lung. A careful examination failed to reveal any trace of a second rudimentary lung. There was no perforation of the open bronchus at the end of the heart. Neither is there any forward extension of the functional lung headwards. The lung of this Snake is therefore primitive in that it has retained considerable traces of the tracheal lung, but modified in the entire absence of a second lung and of a forward extension of the lung headwards. A second specimen showed identical characters.

Sepedon haemachates.—In view of its relationship to the Hamadryad, I have been particularly anxious to examine this Snake, which, however, shows only slight resemblances to the peculiar precardiac diverticula of the windpipe in *Ophiophagus*†. The single lung—I have been unable to find a rudimentary lung‡—commences to be vascular in the region of the heart and continues to be so a little distance down the liver. The lung-tissue does not, however, abruptly end or begin anteriorly; it commences gradually at about on a level with the auricles of the heart, this portion being the equivalent of the tracheal lung of other species, though not vascular. In front of this again the ends of the tracheal rings are separated by a very wide membranous interval, fully as wide as the true thoracic lung, and forming an air-sac continuous with the lung which extends up to the head. The arrangement is, in fact, like that of *Coluber corais* described above. The tracheal gutter does not extend far into the thoracic lung and is continued a little way further by a fibrous band.

The new facts which have been here detailed seem to afford

* See p. 522.

† P. Z. S. 1903, vol. ii. p. 332.

‡ Milne-Edwards (Phys. et Anat. Comp. ii. 1857, p. 308 footnote) states that there is one.

additional evidence for the position which I ventured to take up in a recent communication to the Society*. I there expressed the view that the tracheal lung typically exists in the Ophidia, and that those cases where no traces are to be found are to be looked upon as a reduction from a former state of affairs where the tracheal lung was fully developed and functional. It seems unlikely that the reverse is the case, and that the various genera in which undoubted remains of a tracheal lung are now to be found have independently acquired that structure. If such instances were limited in number to a very few, that view might with greater reason be adopted. As it is, it appears, from what we know of comparative anatomy, to be not at all likely that a complex series of modifications, resulting in the change of structure and vascularisation of a membrane uniting the separate edges of the tracheal semirings, should independently and so constantly occur as the facts would then demand.

The new instances which I have been able to bring forward in the present communication thus furnish additional arguments for the correctness of my way of looking upon the matter, as I think. It is interesting to note the ways in which the tracheal lung has disappeared. In two Snakes so remote in the system as are *Coluber corais* and *Sepeidon haemachates* we have a practically identical disposition of the lung. In both, the precardiac portion of the lung is a very wide sac along which the trachea runs as a gutter, and at the lowest extreme of which only is there any development of lung-tissue. There is no question here of a tracheal sac separate from the ensuing lung. Both organs are evidently continuous. Nor is there a fixed line of demarcation between the two regions; the one fades into the other. On the hypothesis of a reduction, the structure of both of these genera can be derived from such a condition as is preserved in the Viperidæ; or, if the introduction of a family, generally regarded as much modified, be objected to (though it does not follow that the Vipers are not archaic in one particular structure), then the Boid *Ungalia* may be adduced, so far as I can judge from Prof. Cope's statements.

In *Coluber longissimus* and *Erythrolamprus æsculapii*, two Snakes equally as remote from each other as are the two examples just treated of, the modification is evidently taking place along slightly different lines. In these Serpents the lung has apparently shrunk in diameter before commencing to atrophy as a lung, but the process of lung disappearance has taken place from before backwards. The initial stage of this series of modifications is offered by such a type as *Chersydrus granulatus*, in which the tracheal lung, according to Cope's figure †, is of considerably less calibre than the tracheal lung of a Viper. These are the two principal lines along which the degeneration of the tracheal lung has taken place: *i. e.*, firstly the disappearance of the lung-tissue,

* "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 41.

† *Loc. cit.* pl. xiii.

and then the restriction of the membrane left; *or*, firstly the reduction in diameter of the lung and then the disappearance of the lung-tissue. That degeneration of this kind should occur in more than one way is not surprising. It may be obviously matched by parallel instances.

It is well known that among the Boidæ, for example, the lung, or lungs, extend, like those of Lizards, beyond (*i. e.* headwards of) the point of entrance of the bronchus into the lung. I have mentioned several instances in the present communication. This recess is enormously exaggerated in *Heterodon platyrhinos*, as Prof. Cope (as well as others) has pointed out, and I can confirm him from the examination of several individuals. It is in this pocket of the lung that Prof. Cope seeks the origin of the tracheal lung, if I rightly interpret the following passage, *viz.* (*loc. cit.* p. 218):—"The dorsal lung may present proximally alongside of the trachea an auricle or pocket, and this is so developed in the genus *Heterodon* as to reach to the head, without communication with the trachea, other than that furnished by the normal portion of the lung. In the Solenoglypha, without exception, this extension of the dorsal lung is present, and extends to the head, and its lumen is continuous with the trachea throughout its length. The same structure exists," &c. In the above-given account of various species of Ophidia, it will be seen that I have found the pocket in question to coexist with the rudiments of a tracheal lung independent of it.

I cannot therefore accept Prof. Cope's view of the origin of the tracheal lung, and I put forward my own suggestions in its place. His attempt to classify Serpents by the character of the lungs will possibly form the groundwork of a more successful scheme. At present the facts are not sufficient for the elaboration of a complete arrangement of those Reptiles. Cope is probably justified in some of the details of the scheme, for example in the separation of the genus *Ungalia* from other Boas and Pythons. It is clear, however, that he is not necessarily right in separating Leptognathinæ from Scytalinæ, for though the former doubtless possess a tracheal lung, I have shown that *Erythrolamprus* has considerable traces of one. In details I have myself pointed out that the characters of the lungs offer useful facts of assistance in classification. This is shown, for instance, among the species of the genus *Coluber*, and the minute points of likeness between *Erythrolamprus* and another Opisthoglyph genus, *viz.* *Tarbophis*, are noteworthy. The presence or absence of the rudimentary lung is obviously not so useful a character.

The usefulness of the lung-structure in settling details of classification is also well shown in the case of *Lioheterodon*. This genus was confused by earlier systematists with the American *Heterodon*. Boulenger has shown*, utilising a structural peculiarity in the dorsal vertebræ first made use of by Prof. Cope,

* B. M. Cat. Snakes, vol. i. 1893, p. 171.

that *Lioheterodon* and *Heterodon* are distinct. The lung confirms Boulenger's view of the separateness of these genera. I have already referred to the long headward extension of the lung in *Heterodon*, which nearly reaches the head. In *Lioheterodon madagascariensis* this diverticulum of lung is only $\frac{3}{4}$ of an inch in length, and is anangious at its free extremity. Moreover, in *Heterodon*, the interannular membrane is very narrow; in *Lioheterodon* on the other hand, as I have already partly indicated in another communication upon the Ophidia*, the membrane in question is much wider than are the tracheal semirings. Near to the heart are two folds across the membrane which result in the formation of a pouch. This is not unsuggestive of the pouches in the Hamadryad Snake †. In any case the differences in lung-structure between the two genera will be obvious.

§ *Résumé of Principal Facts.*

From the foregoing account of new facts in the structure of the Ophidia I may select the following as embodying the principal results:—

(1) The umbilical vein largely persists in *Boa*, as in *Eunectes*, as a functional vessel. In *Python* there are less conspicuous traces of it; but it is distinctly recognisable in *P. molurus* and *P. regius* as well as in *P. sebae*. No blood-holding diverticulum of the post-caval has been yet met with in Colubrine Snakes, the only vestige of the embryonic umbilical being a membranous seam on the liver of *Coluber corais*.

(2) The additional facts recorded in the present communication support the probability that a forward prolongation of the renal afferent vein to the region of the gonads, which is to be regarded as part of a persistent post-cardinal, is characteristic of the Boidæ and at least not characteristic (though rudiments may occur) of the Colubrine Snakes. So far the Boidæ lie at a lower level than other Snakes.

(3) In some, but not in all, Boidæ the parietal tributaries of the renal afferent vein are connected at their emergence from the body-wall by a continuous longitudinal trunk which extends from behind to in front of the kidney. In the region of the kidney this longitudinal vessel gives off no branches to the kidney itself. In the Colubrine Snakes, on the contrary, there is no such longitudinal dorsal parietal vessel; but intercostal veins may emerge from the parietes in the region of the kidney to cross it and enter the afferent renal vein. But there is no direct connection of these intercostals with the capillary network of the kidney such as has been found to occur in the snake-like Lizards *Ophisaurus* and *Amphisbæna*.

(4) The generality of the occurrence in the Boidæ of but a

* P. Z. S. 1906, vol. i. p. 12.

† Beddard, P. Z. S. 1903, vol. ii. p. 319.

single renal artery to each kidney, a fact quite independent of the size of the kidney, is confirmed by several fresh examples.

(5) More evidence is adduced to show that among the Boine Snakes the relations of the anterior abdominal vein to the afferent renal veins are those of the Lacertilia; and it has been pointed out that (in *Boa constrictor*) these veins may be symmetrical in their origins in spite of the asymmetry of the kidneys. This is, of course, a further point of likeness to (presumably) primitive conditions.

(6) In considering the relations of the more or less double anterior abdominal vein of the Boidæ to the same vein or veins in other Sauropsida, it is (or may be) important to note that, at any rate occasionally (*Boa constrictor*), the left trunk is associated by transverse connections with the epigastric vein, and the right trunk only with the fat-body, and not at all with the epigastric vein.

(7) Attention is directed to the intercostal arteries of *Erythronomprus*, which appears to offer an intermediate condition between the Boid Snakes and the Viperidæ. To others it has appeared that the Viperine Snakes are to be derived from the Opisthoglyphous Colubrinæ.

(8) The structure of the genus *Corallus* on the whole confirms the current view that it is to be referred to the Boine section of the Boidæ.

(9) The existence of rudiments, apparently functional, of the tracheal lung are more numerous in the Ophidia than would be inferred from a consultation of the literature of the subject. Such traces have been described above in a number of species where they have not been hitherto recorded.

(10) The prevalence of at least traces of a tracheal lung in so many and often not nearly related families is an argument for considering that its existence is a retention—that it has not been acquired separately in the several genera or families where it occurs, but has rather been lost in those genera, &c., where there is now no tracheal lung.

(11) The view of Prof. Cope that the tracheal lung is a further extension of the Lizard-like pocket extending beyond the entrance of the bronchus, which is found in the functional lung or lungs of many Snakes, cannot be correct, since this pocket coexists with remains of the tracheal lung in some forms.

(12) The structure of the lungs offers facts of detailed classificatory value; but the wide prevalence of the tracheal lung or remains of it does not tend to support the scheme of classification set out by Prof. Cope in its entirety.

May 15, 1906.

DR. J. ROSE BRADFORD, F.R.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie during the month of April 1906:—

The number of registered additions to the Society's Menagerie during the month of April was 171. Of these 71 were acquired by presentation and 6 by purchase, 80 were received on deposit, 4 in exchange, and 10 were born in the Gardens. The number of departures during the same period, by death and removals, was 150.

Among the additions special attention may be called to:—

A Samango Guenon (*Cercopithecus samango*) from South Africa, deposited on April 25th.

A Pallas's Cat (*Felis manul*) from Tibet, deposited on April 3rd, new to the collection.

Fourteen Desert Jerboa Rats (*Notomys cervinus*) from Australia, deposited on April 20, new to the collection.

A Canadian Porcupine (*Erithizon dorsatus*) from North America, presented by Mr. Munro Walker on April 11th.

Mr. F. E. Beddard, F.R.S., exhibited a nearly full-time fœtus of the Red-fronted Lemur (*Lemur rufifrons*), and called attention to the carpal vibrissæ, which were extremely conspicuous, though the rest of the ventral surface of the arm was devoid of hair.

Mr. Beddard also exhibited, on behalf of Dr. C. G. Seligmann, a cock of mixed breed which had been caponised for commercial purposes whilst young. The bird, which had been under observation for over a year, at no time showed any evidence of sexual attraction for or towards either sex. On dissection, there was no trace of testicular tissue. The head was hen-like, but the bird possessed well-marked and rather stout but short spurs, whilst the tail, which contained sickle-feathers, was "over-furnished."

Mr. R. I. Pocock, F.Z.S., Superintendent of the Gardens, exhibited and made remarks upon a specimen of a Leaf-insect (*Phyllium*) from the Seychelles, which had been brought to the Gardens by Mr. E. G. B. Meade-Waldo, F.Z.S.

Mr. Henry Munt, F.Z.S., exhibited, on behalf of Mr. Bussell, a skin of the Spotted-necked Otter (*Lutra maculicollis*) obtained at Fort Johnston, Uganda. The skull and carcase had been extracted through the mouth, thus leaving the skin intact.

The following papers were read:—

1. Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunningham, 1904-1905. Report on the *Hydrachnida*. By J. N. HALBERT, Dublin Museum*.

[Received March 9, 1906.]

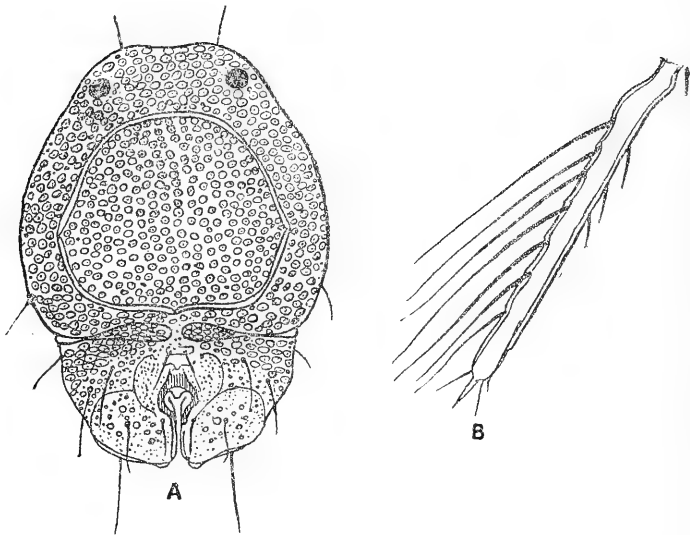
(Text-figure 94.)

The Water Mites collected by Dr. W. A. Cunningham were taken in Lake Nyasa and are referable to two species, which have been described by Dr. F. Koenike in his papers on the Hydrachnida of Madagascar and East Africa.

ENCENTRIDOPHORUS SPINIFER (Koen.).

Two of the three specimens of Hydrachnida collected at Nyasa are to be referred to this species. Dr. Koenike includes it in the

Text-fig. 94.



A. Dorsal view of *Arrhenurus plenipalpis*, Koen. (legs and palps not drawn).

B. End segment of fourth pair of legs of *Encentridophorus spinifer* (Koen.).

genus *Atax* (1); but Piersig makes a new genus *Encentridophorus* for its reception (2), chiefly on account of the peculiar spine which replaces the claws on the end segment of the fourth pair of legs

* Communicated by Dr. W. T. CALMAN, F.Z.S.

(text-fig. 9 B), and the absence of a large chitinous disc-bearing plate on each side of the genital field. The genital discs are imbedded in the soft skin of the body.

The colouring of the Nyasa specimens is pale green with brownish blotches on the dorsal surface, the central caecal area is yellow, and the legs and palps green.

Localities. Zanzibar (*Stuhlmann*); Dromira Bay, Lake Nyasa, June 19, 1904, among algæ &c. (*Cunnington*).

ARRHENURUS PLENIPALPIS Koen.

A male *Arrhenurus* found in the same locality as the preceding species seems to be referable to *A. plenipalpis* Koen. On comparison, however, with the description and figures of this species some rather puzzling differences are apparent, notably the presence in the Nyasa specimen of a chitinous petiolus-like organ. This structure is situated in the middle line of the body and projects in the posterior indentation of the body appendage in the form of a short bluntly-pointed process (text-fig. 94 A). This, however, is a sexual characteristic, which in the *Micrurus* section of the genus may possibly be prominent only in some specimens or under certain conditions. The forked chitinous organ in the centre of the appendage, which Dr. Koenike calls the "Hautgebilde," seems to differ somewhat in outline, but I suspect that this may be due to the preservation of the specimens or to slight differences in the drawing. Otherwise the Nyasa mite agrees closely with the description of *A. plenipalpis* (3), and a full description of the Nyasa specimen is unnecessary. Although Dr. Koenike describes the present species in the letterpress of his paper (3) under the name of *A. plenipalpis*, and makes reference to plate xxi. figures 36-40, yet in the explanation of the plates these particular figures are referred to as representing a new species, *pertusus* (page 427). No explanation is given for this change of name. The species is included in Dr. Piersig's recent work on the Hydrachnida (4) as *A. plenipalpis*.

Localities. Madagascar; Nossi-Bé; German East Africa (*Quilimane*); Dromira Bay, Lake Nyasa (*Cunnington*).

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4. PIERSIG, R.—"Hydrachnida und Halacarida." Das Tierreich, 1901. 13. Lieferung.

2. On Mammals from Northern Australia presented to the National Museum by Sir Wm. Ingram, Bt., and the Hon. John Forrest. By OLDFIELD THOMAS, F.R.S., F.Z.S.*

[Received April 2, 1906.]

(Plate XXXVII.†)

The Northern Territory of South Australia has a Mammalian fauna of a very peculiar type; and one that is far from being worked out, in spite of the labours of Dr. Elsey, Mr. Gould's collectors, and others in early days, and of Dahl, Tunney, and others more recently. Similarly the centre of the continent is badly represented in the National Collection, although Prof. W. B. Spencer, of Melbourne, who first went there with the Horn Expedition, has laid the foundation of a proper knowledge of it.

Now, thanks to the liberality of Sir William Ingram, Bart., and of the Hon. John Forrest, of Brisbane, a zoological collector has been put to work at Alexandria, a station intermediate in position between the two areas above referred to, and therefore in a district possessing a very special interest to the student of Australian zoology.

Alexandria is situated about lat. 19° S., long. 137° E., about 200 miles inland from the S.W. coast of the Gulf of Carpentaria, and lies in an area draining inwards to the Polygonum swamp. The watershed-boundaries would, however, appear to be low, and unlikely to act as barriers to the dispersal of species, so that in this region the question of drainage is not likely to be of great zoological importance. Collections have also been made near Alroy, about 100 miles to the west of Alexandria. Perhaps later the exploration may be extended still further west to the ranges along the Trans-continental Telegraph-line.

Mr. W. Stalker, the collector employed, has naturally found immense difficulties in the way of collecting in this desert region, owing to the long-continued drought, no rains of any value having fallen for several years, and the fauna being therefore at its lowest ebb.

For this reason the collection of which I here give a list is a most creditable one for the time in which it was obtained, and as rain has since fallen in the district we may hope that Mr. Stalker will now be enabled to capture many further forms of interest that have hitherto escaped him.

The present collection contains examples of 16 species, of which five are new. The most interesting of these is the peculiar little flat-headed Marsupial mouse which I have named *Phascogale*

* [The complete accounts of the new species described in this communication appear here; the names and preliminary diagnoses of two of the species were published in the 'Abstract,' and these are distinguished by the names being underlined.—EDITOR.]

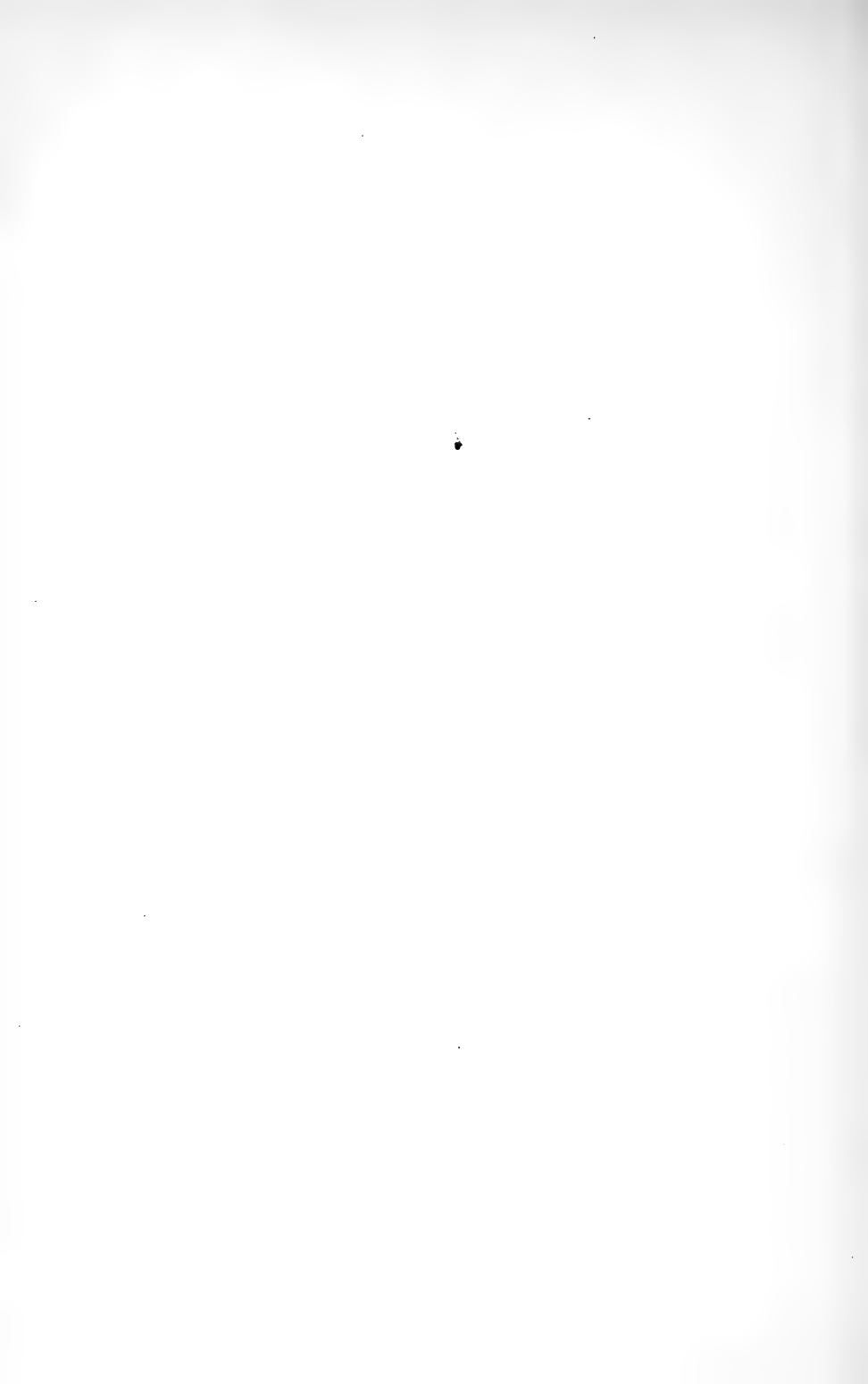
† For explanation of the Plate, see p. 543.



H Goodchild, del. et lith.

lith, imp

1. MUS FORRESTI. 2. PHASCOGALE INGRAMI



ingrami, after Sir William Ingram, though a new species of *Mus* (*M. forresti*) has such peculiarities of dentition that their study has resulted in a recent rearrangement of the murine genera of Australia.

1. NYCTOPHILUS GEOFFROYI Leach.

♂. Alexandria.

Forearm 35 mm.

2. CHALINOLOBUS GOULDI Gray.

♂. 122, 127. ♀. 125, 128. Bluff Hole, Alexandria, 21-24 May, 1905.

3. SCOTEINUS GREYI Gould.

Ten specimens. Alexandria.

4. NYCTINOMUS PLICATUS COLONICUS, subsp. n.

♂. Alexandria. B.M. No. 6.3.9.16. *Type*.

Similar in all essential particulars to the true Indian *plicatus*, but rather larger in body and limb dimensions, and markedly larger in the skull, the cranial crests, sagittal and lambdoid, very well developed.

Dimensions of the type, measured on the spirit-specimen:—

Forearm 50 mm.

Head and body 67 mm.; tail 42; ear 22; third finger, metacarpal 50, 1st phalanx 21, 2nd phalanx 22; lower leg 18.

Skull—greatest length to occipital crest 23; basal length 17.7; zygomatic breadth 13.5; mastoid breadth 12; palate length 8.7; front of upper canine to back of m^3 8; front of lower canine to back of m_3 9.

Hab. and *Type* as above.

A South-Australian specimen of *N. plicatus* received from Prof. Leche in 1890 also belongs to this larger race. On the other hand, examples from New Guinea and the Fiji Islands correspond in size with Javan and Indian specimens.

5. CANIS DINGO Blum.

Skin and two skulls. Alexandria.

6. MUS VILLOSISSIMUS Waite.

M. longipilis Gould *nec* Waterh.

♂. 86, 87, 89, 101, 106, 108, 139, 140, 142. ♀. 114, 137, 141, 143. Alexandria.

♂. 145, 186, 187. ♀. 147, 148, 184, 185. S.W. of Alroy.

This species is so common at the station as to be a serious pest.

The type locality of Gould's *M. longipilis* was the Victoria River, about 400 miles to the west of Alexandria, but in the same faunal area.

7. *MUS FORRESTI* Thos. (Plate XXXVII. fig. 1.)

Abstr. P. Z. S. No. 32, p. 6, May 22, 1906.

♀. 92, 101, 104, 117, 118, 119. Alexandria.

"Caught on dry grassy plain. Native name 'Keragenga.'
Mammæ 4."—*W. S.*

Size medium, intermediate between "rat" and "mouse." Fur of medium length; hairs of back 9–10 mm. long, fairly coarse, but not spinous. General colour above pale "drab-grey," paling to a creamy drab on the sides. Some specimens are, however, more buffy in tone. Under surface pure sharply defined white throughout, the hairs white to their bases. Ears rather short, their proectote pale brown, not darker than the general colour of the head; a tuft of creamy-drab hairs at their anterior base. Upper surface of hands and feet pure white. Tail well-haired, greyish white, little darker along the upper side.

Skull rather lightly built, with a slender muzzle. Interorbital region narrow, parallel-sided, its centre concave upwards, its edges rounded anteriorly, squared behind, but without ridges. Palatal foramina long, reaching backward to the anterior fourth of m^1 , unusually narrow, especially posteriorly, their edges rounded. Palate extending in middle line some way behind m^3 , the interpterygoid fossæ commencing further forward than the mesopterygoid one between them; the former very broad, the latter narrow. Bullæ comparatively little swollen.

Incisors slender, even in old specimens. Molars of rather unusual structure as compared with typical *Mus (rattus, &c.)*, but there is a great deal of variation among the Australian Muridæ in this respect, and the characters of *M. forresti* are led up to by other described species—e. g., *M. nanus* and *M. gouldii*. M^1 with a very strongly marked cingular ledge at its antero-internal corner, practically forming a small supplementary anterior lamina; the normal anterior and second laminae very strongly slanted backwards internally, their outer cusps hardly perceptible. M^2 with the large antero-internal cusp ("6" of Winge) about equal to the postero-external ("5"), the normal main lamina between them strongly tilted, as in m^1 , and with its inner and median cusps subequal, the outer practically absent; a minute antero-external supplementary cusp present. Lower teeth unusually brachyodont; m_1 and m_2 each with a small median supplementary cusp behind.

Dimensions of the type:—

Head and body 104 mm.; tail 72; hind foot 19; ear 15.

Skull—greatest length 25; basilar length 21; zygomatic breadth 13.5; nasals, length 8.5; interorbital breadth 3.6; palatilar length 13; diastema 7.6; palatal foramina 5.5×1.4 ; length of upper molar series 4.4.

Hab. Alexandria.

Type. Old female. B.M. No. 6.3.9.39. Original number 118. Collected 10 May, 1905.

This striking species may be readily distinguished from all others by its intermediate size, pale colour, pure white belly, peculiarly narrowed palatal foramina, and the unusual dental characters above described. *Mus fieldi* Waite, in other respects apparently near it, has a very much longer tail. I have named it in honour of the Hon. John Forrest, who has shared with Sir William Ingram the expense of supporting a collector at Alexandria station.

8. *MUS HERMANNBURGENSIS* Waite.

♂. 126, 131. ♀. 124, 130. Bluff Hole, Alexandria, May 1905.

♂. 160, 161, 162, 163, 164, 165, 166, 169, 179, 182. ♀. 167, 168, 170, 180, 181, 183. 35 miles S.W. of Alroy, Alexandria. Alt. 800'.

"These Mice make large burrows in the hard stony ridges, piling up the excavated stones on the surface. The entrance is about 15 or 20 feet from the pile of stones, and is a small hole surrounded by a ring of stones."—*W. S.*

Many of the dental peculiarities of *M. forresti* are present in this species, notably the strong development of the antero-internal cingular cusp of m^1 , and the slanting position of the inner part of the laminae of the same tooth. There is, however, an unusual amount of variability in the development of the different cusps, especially in the degree to which the outer cusp of the upper molars is separated from the main middle one. The palatal foramina are not specially narrowed behind.

No skins of this interesting species had been previously sent to Europe.

9. *NOTOMYS MITCHELLI* Og.

♂. 153, 154, 157, 158, 172, 177, 178. ♀. 149, 150, 151, 152, 156, 171, 173, 176; and one in spirit. S.W. of Alroy, Alexandria.

Mammæ 0—2=4.

The range of *N. mitchelli* seems to extend through the western part of New South Wales and Queensland. The British Museum contains examples collected by Sir Thomas Mitchell in Central New South Wales, while the type, now in the Sydney Museum, was obtained near the junction of the Murrumbidgee with the Murray.

My reasons for applying the name *Notomys* to the Jerboa-footed members of the *Conilurus* group have been explained elsewhere*.

All these specimens have an indication of a glandular organ on the throat, but whether it is such a "pouch" as that on which Mr. Waite founded the genus *Ascopharynx*, the condition of the specimen does not enable me to state.

* Ann. & Mag. N. H. (7) xvii. p. 81 (1906).

10. *MACROPUS RUFUS* Desm.

♀ (young). Alexandria.

11. *TRICHOSURUS VULPECULA ARNHEMENSIS* Coll.

♀. 123, 133. Alexandria.

12. *DASYURUS HALLUCATUS* Gould.

♀. 138. Alexandria, 800'.

"Trapped near water. Lives in lakes under and in rocks."—
W. S.

13. *PHASCOGALE MIMULUS*, sp. n.

♀. Skinned from spirit. Alexandria. (B.M. No. 6.3.9.75.)

A small species with a red patch behind each ear. No lower secator*.

Size small, the general bulk far less than in *Ph. macdonnellensis*, with which alone comparison is needed. Fur short and fine; hairs of back only about 5 mm. in length, as compared with 8 mm. in the allied species. General colour above rather browner than "smoke-grey," rather greyer than "broccoli-brown," but some slight alteration may have occurred during the few months the specimen has been in spirit. Under surface dull cream-buff, probably whiter originally, the hairs dark slaty for three-fourths their length. Head clearer grey than back, a light line edging the eyes above and below. Ears of medium length, their fine hairs rufous brown. Behind each ear a large and prominent patch of light rufous hairs, contrasting strongly with the general colour. Upper surface of hands and feet dull whitish; soles with the main pads arranged as in *Ph. macdonnellensis*, but the general surface less granulated and the foot itself markedly narrower, measuring in the type only 3.4 mm. in breadth as compared with 5.2. Tail nearly the length of the head and body, slightly rufous at base, thinly haired, not tufted or crested, dull rufous brown above, rather paler below.

Skull considerably smaller than that of *Ph. macdonnellensis*, but of the same general proportions. Nasals rather shorter and broader. Bullæ conspicuously smaller.

Teeth as in the allied species, with the remarkable exception that the last premolariform tooth, the "secator" (p^4 of the Catalogue of Marsupials), while similarly absent in the lower jaw, is in the upper well developed, two-rooted, barely smaller than the tooth in front of it, and slightly larger than p^1 . In *Ph. macdonnellensis* this tooth is minute and single-rooted above in the usual correlation to its total absence below.

* The secator is the changing premolar, " p^4 " of the Catalogue of Marsupials, but probably more correctly homologised with the tritus, or p^3 of other mammals: cf. Ann. & Mag. N. H. (7) xvi. p. 425 (footnote) (1905). In that footnote the words "or more probably mp^3 " should be deleted.

Dimensions of the type, measured in spirit:—

Head and body 76 mm.; tail 74; hind foot 13·5; ear 16.

Skull—greatest length 24·7; basal length 22; zygomatic breadth 14·6; nasals 9; interorbital breadth 5·3; height of crown above basion 5·6; palate length 13; breadth at outer corners of penultimate molar 8·8; antero-posterior length of bullæ 5·8 (6·8 in *Ph. macdonnellensis*); combined length of three anterior molariform teeth 5·2.

Hab. and *Type* as above.

This species shows affinity to the Central-Australian *Ph. macdonnellensis* by its absent lower secator and its rufous ear-patches, but is distinguished by its smaller size, shorter fur, greyer colour, smaller bullæ, and by the increased development of its upper secator, a development quite anomalous in the case of a species without a lower one. In *Ph. macdonnellensis* Prof. W. B. Spencer records that in every one of 13 specimens examined this tooth is either absent or very minute, so that the presence of a well-developed double-rooted upper secator clearly indicates specific distinction.

14. PHASCOGALE INGRAMI Thos. (Plate XXXVII. fig. 2.)

Abstr. P. Z. S. No. 32, p. 6, May 22, 1906.

♂. 110, 111. ♀. 109, 113. Buchanan, Alexandria, 600'.

♂. 120. Bluff Hole, Alexandria, 600'.

A remarkably small species, with minute teeth and flattened skull.

Size very small, slightly smaller even than in *Ph. minutissima*. Fur soft, close, and fine; hairs of back about 4 mm. in length. General colour above not unlike that of the paler wild-living forms of *Mus musculus*, something between Ridgway's "wood-brown" and "broccoli-brown," the hairs slaty grey with pale tips. A younger specimen is clearer grey, without the drabby tone. Under surface paler, with a yellowish tinge, not sharply defined, the hairs slaty at base except on the chin. Crown like back. Cheeks and chin whitish. A whitish-buffy line just over each eye. Ears of medium length, their fine hairs buffy whitish. Upper surface of hands and feet whitish. Tail of medium length, uniformly short-haired, about as in *Mus musculus*, not pencilled, pale brownish white, scarcely lighter below.

Skull remarkable for its extraordinary flattening, a flattening only equalled in 4 other mammals*, three being bats, the height in profile view from the base of the skull in front of the bullæ to the crown only 3·3 mm., as compared with 4·7 mm. in a skull, otherwise little larger, of *Ph. minutissima*. Zygomata evenly convex outwards. Nasals well expanded in their posterior half. Interorbital region flat, its edges without ridges. Occipital crests almost obsolete. Anterior palatine foramina reaching to the level

* *Graphiurus platyops*, *Tylonycteris pachypus*, *Mimotillus moloneyi*, and *Platymops macmillani*.

of the front of the canines. Posterior palate practically without vacuities. Anterior portion of bullæ considerably larger than posterior.

Teeth with the same relative proportions to each other as in *Ph. minutissima*, but conspicuously smaller throughout, both absolutely and in proportion to the size of the skull. Upper secator (last premolar, the "p⁴" of the Catalogue of Marsupials) about twice the size of the subequal anterior and median premolars. Lower secator about half the size of the anterior premolar, which is in turn about half the size of the median one.

Dimensions of the type, measured in the flesh:—

Head and body 80 mm.; tail 60; hind foot 10; ear 9.

Skull—greatest median length 18; basal length 17; zygomatic breadth 9·7; nasals 6·6 × 3; interorbital breadth 3·8; breadth of brain-case 8·5; palate length 8·7; length of upper tooth-row 8; combined length of three anterior molariform teeth 3·1; length of lower tooth-row 7·2.

A female skull is smaller, 16 mm. in greatest length.

Hab. Alexandria, central part of Northern South Australia. Alt. 600'.

Type. Male. B.M. No. 6.3.9.77. Original number 111. Collected 30 April, 1905. Three specimens.

This remarkable little species looks externally like a more pallid representative of *Ph. minutissima*, but the peculiar characters of its skull and teeth show that it is really a quite distinct animal. I have much pleasure in naming it after Sir William Ingram, to whose initiative and generosity the Museum is indebted for the sending of a collector to this most interesting locality.

15. SMINTHOPSIS LARAFINTA Spencer.

♂. 101, 102, 112, 116. ♀. 93, 100, 119, 144. Alexandria, 600'.

♂. 146. S.W. of Alroy, Alexandria.

"Native name 'Baraga.' Caught among dead timber on plain."—*W.S.*

This is a very beautiful drab-grey species, with a contrasted dark line running down the muzzle, and with the centre of the sole naked as far back as a point equidistant between the heel and the tip of the hallux. It was first obtained at Charlotte Waters, Central Australia, during the Horn Expedition, and was described by Prof. Spencer, who unfortunately, working only from spirit-specimens, did not mention the dark facial line, which is, however, clearly marked in a metatype in the Museum collection.

S. nitela Collett*, of which we have a co-type, would appear to be the same animal, Dr. Collett having been misled by the absence of all reference to the facial line in the original description, and the metatype in the Museum having only been received

* P. Z. S. 1897, p. 334.

after his description was published. Dr. Collett's examples were from the Daly River, so that Alexandria is to a certain extent intermediate between the two localities.

16. *SMINTHOPSIS STALKERI*, sp. n.

♂. 174, 175. S.W. of Alroy, 800'.

A small species coloured like *S. larapinta*, but with more hairy soles and shorter tail.

Size rather less than in *S. larapinta*, but neither of the two specimens is more than just adult. Fur soft and fine, about 6 mm. long on the back. General colour above more buffy than in *S. larapinta*, the light rings on the hairs dull cream-buff, their fine tips dark brown. Under surface creamy white, the extreme bases of the hairs slaty. Head like back, a dark line on the forehead between the eyes, not so distinct or so long as in *S. larapinta*. Ears of medium length, quite unlike the long ears of *S. hirtipes*, pale grey throughout. Upper surface of hands and feet white. Palms and soles intermediate in their characters between those of the hairy-footed *S. hirtipes* and of the ordinary naked-footed species; the palms apparently with low granulated cushions, but these cannot be accurately described on dried specimens, even when re-damped; the soles with a compound cushion at the end of the metatarsus, as in *S. hirtipes*, but this is naked and granulated as in other species, and has three minute non-lineated pads upon it; the centre of the foot is finely hairy to beyond the tip of the hallux, a few hairs even extending to the back of the large compound pad. Tail shorter than in *S. larapinta*, incrassated at base; finely hairy, greyish white above and below, the tip not darkened.

Skull and teeth very much as in *S. larapinta*, the muzzle rather shorter; bullæ much smaller than in *S. hirtipes*.

Dimensions of the type, measured in the flesh:—

Head and body 70 mm.; tail 65; hind foot 15; ear 17.

Skull—greatest length 23.2; basal length 21.4; zygomatic breadth 13; nasals 8; combined length of three anterior molariform teeth 4.7.

The other specimen has head and body 72 mm.; tail 70.

Type. Subadult male. B.M. No. 6.3.9.91. Original number 175. Collected 1 August, 1905.

This pretty species forms an interesting link between the hairy-soled *S. hirtipes* Thos., described from Charlotte Waters, and the ordinary naked-soled species of the genus. Its shorter tail and more buffy colour will also distinguish it from *S. larapinta*.

Prof. Spencer's *S. psammophilus* would appear to have a similar foot-structure, but is considerably larger.

EXPLANATION OF PLATE XXXVII.

Fig. 1. *Mus forresti*, p. 538.

2. *Phascogale ingrami*, p. 541.

3. On the Skull of a Young Specimen of the Ribbon-fish, *Regalecus*. By W. B. BENHAM, D.Sc., M.A., F.Z.S., Professor of Biology in the University of Otago, and W. J. DUNBAR.

[Received April 2, 1906.]

(Plates XXXVIII. & XXXIX.*)

I. INTRODUCTION.

Whether the small Ribbon-fish described by me (1) as *Regalecus parkeri* be a distinct species, or, as seems probable, merely a young stage of the Great Ribbon-fish, *R. glesne*, it seemed desirable to have the skull described and figured for comparison with the detailed account of the latter fish published by Professor Parker in the 'Transactions' of the Society †.

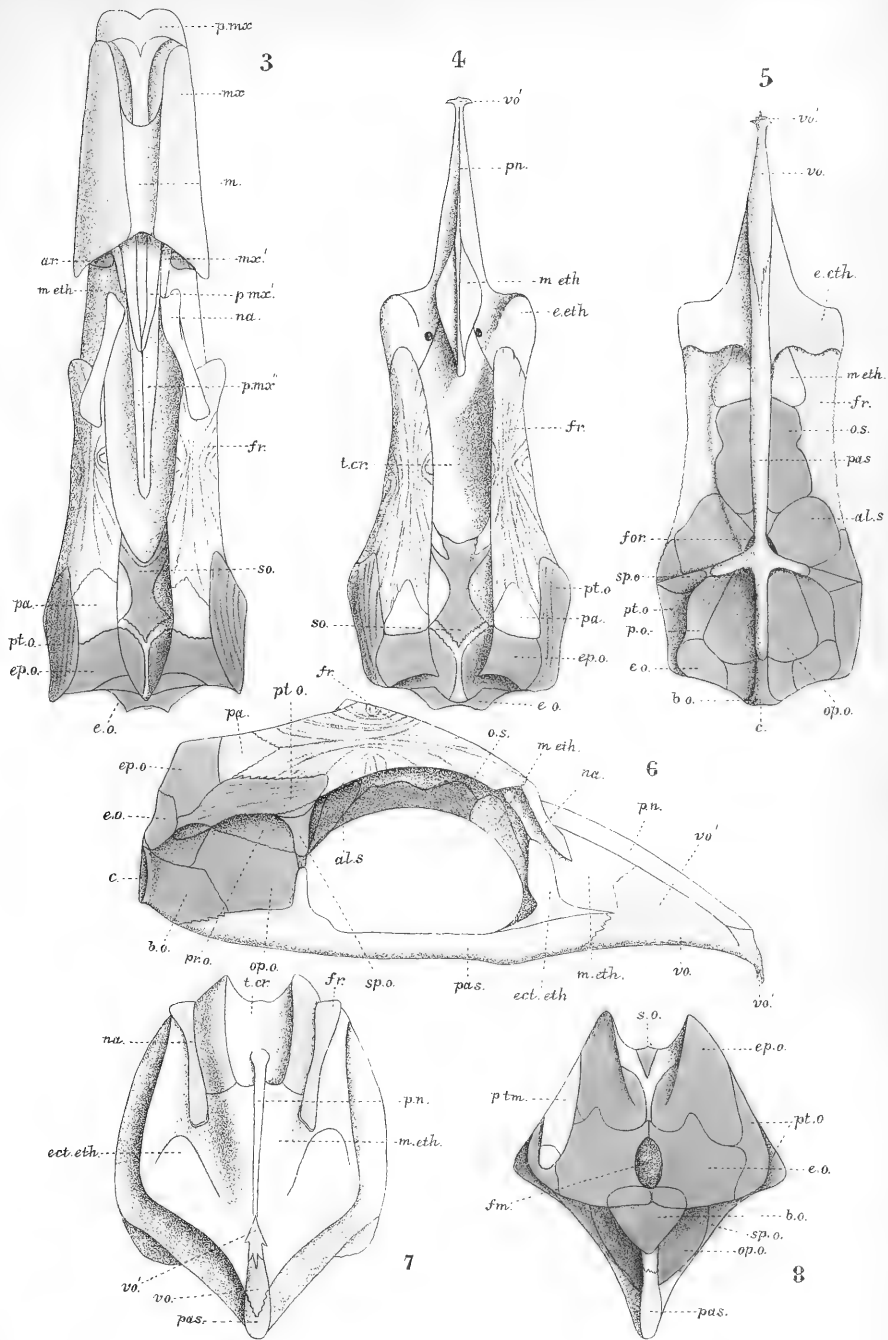
The correct name for the Ribbon-fishes of the New Zealand as of other coasts is somewhat doubtful. Specimens have been described and named by Von Haast (2) as *R. pacificus*, and by Parker (3 & 4) as *R. argenteus*, while Forbes (5) inclined to the opinion that the specimen which came into his hands was identical with *R. grillii* of Lindroth. This matter of the synonymy was treated at some length by Parker, and after a comparison of the measurements and of other external features given by various naturalists for different specimens studied here and in the Northern hemisphere he came to the conclusion (3) that the specimens obtained in the neighbourhood of Dunedin belonged to a new species, *R. argenteus*: and under this title he described the skeleton in the Society's 'Transactions' (9), but in an "Addendum" to his second article (4) (inserted at the commencement of the volume, immediately following the titlepage) he expressed a doubt as to whether, after all, he was justified in this step. He wrote: "Everything seems to lead to the conclusion that most of the supposed species of *Regalecus* are identical, and that the more recent specific names (including *argenteus*) will have to give way probably in favour of Ascanius' original name *glesne*."

To the same effect wrote Goode & Bean in 1895 in describing the Ribbon-fishes of the North Atlantic (6). On p. 481 of 'Oceanic Ichthyology' they write:—"It is not certain that there is more than one species of *Regalecus*, although various names have been suggested in connection with the comparatively few individuals which, during the past century and a half, have been captured in the North Atlantic." Consequently, they register these fishes under the name *R. glesne*.

If this be the case, we have an interesting instance of a practically cosmopolitan deep-water fish.

* For explanation of the Plates, see p. 556.

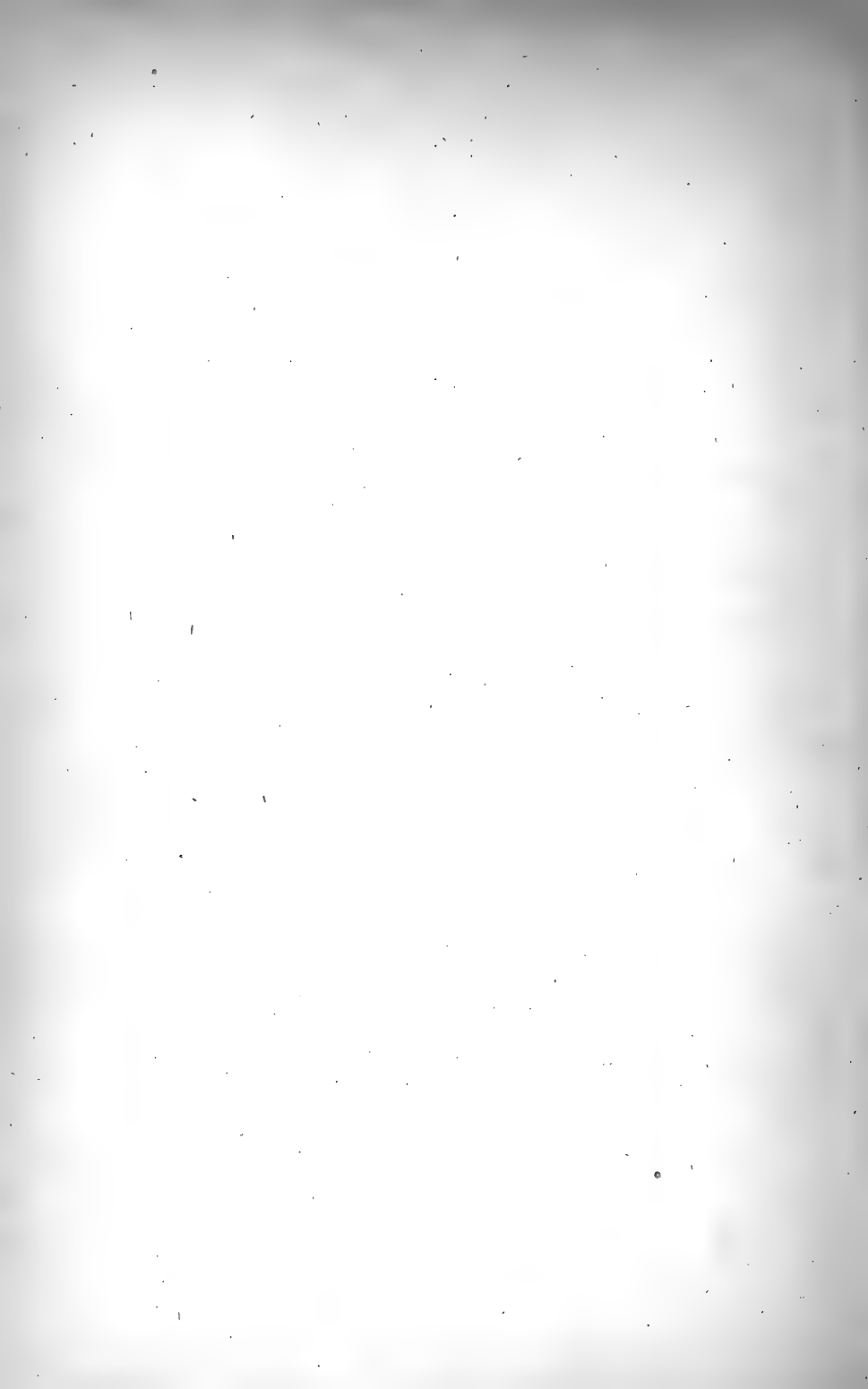
† For this purpose I handed the skull to my pupil W. J. Dunbar, who to my great regret was drowned just after the paper was completed in MS. I have retained his name as co-author, as he contributed the description and figures of this skull, and the notes comparing it with Parker's account.—W. B. BENHAM.



M P. Parker lith.

Parker & West imp.

SKULL OF YOUNG RIBBON FISH (REGALECUS.)



Parker (3) dealt so fully with the various accounts of the specimens captured on the coasts of New Zealand and Australia, that it is needless for me to repeat the record. But since he wrote his second article in 1888, additional specimens have been recorded and described by Forbes (5), by Drew (7), and by Clarke (8), the last being a quite perfect individual, with the pectoral fins still uninjured, and the article is illustrated by a good figure of the entire fish.

Finally, a couple of years ago, a large specimen was reported to me as having been thrown on shore near the entrance to the Otago Harbour, but while my informant was engaged in telephoning to the Museum, to arrange for its despatch to me, the usual fate, in the form of boys and stones and sticks, awaited the rarity: so that by the time my informant returned to the shore the fish was so damaged as to be valueless.

We thus have records of more than a dozen of these rare fishes having been obtained in these seas within the last 50 years; and the majority on the coast of the South Island. Of these all but one have been apparently nearly or quite full-grown, reaching a length of from 12 to 18 feet, Drew's specimen being only 7 feet $4\frac{1}{4}$ inches. Judging, however, from his other measurements, it appears probable that a part of the posterior end was missing: he says, "the fish ended abruptly with thick rounded end, and there were no spines at the caudal end." He does not state the height of this truncated extremity, and we are left in doubt as to how much is missing.

It is, however, to the markings on "*R. parkeri*" that I would draw attention. It will be remembered that one of the most striking differences in the external features of this specimen—apart from body-proportions—lies in its colour-markings.

Parker, Von Haast, Clarke, and others have described (and figured) the peculiar, irregularly vertical streaks of black or very dark-blue, irregular in form, size, and arrangement, but limited to the anterior region of the body.

Parker (4. p. 23) says:—"In addition [to these marks] the whole body was covered with oval or circular grey spots, covered, and thus toned down, by the silvery coating" (of the skin). "These very obscure spots are hardly visible in certain lights."

Clarke (8. p. 262) says of his specimen:—"As the fish gradually dried, numerous transverse markings developed themselves, more especially along the whole of the postanal division, and the round and greyish markings became more apparent."

Now, in "*R. parkeri*" the characteristic black, irregular streaks are entirely absent, but the silver ground-colour was traversed by "14 dark transverse bands set at fairly regular intervals from the back of the head to the end of the body. Each band extends over the entire depth of the body and is separated from its neighbour by a space about equal to its own length." "These colour-bands are not black, but extremely pale grey, and could only be recognised by reflection in certain lights, the grey

being due to minute pigment-cells below the silver" (Benham, *loc. cit.*). After being in formol for a couple of years these marks are still present, and more distinct than in the recently dead fish. Another feature in which *R. parkeri* differs from the specimens of *R. glesne* is in proportions of parts and in the greater number of dorsal fin-rays: for whereas, in most of specimens of the full-grown fish, these number from 200–260, as given for different individuals, there are 400–500 in the specimens of *R. parkeri*; but Forbes gives 422 as the total number in the full-grown individual described by him.

As the number of fin-rays in the dorsal fin has been utilised by ichthyologists as a specific character, this variation in the adults of what are regarded as one species is interesting.

For convenience of a comparison of "*R. parkeri*" with the adult forms, I here tabulate the series of measurements adopted by Parker and followed by Forbes and Clarke:—

The specimen A is the one described in the body of my article; B is that referred to in the footnote (1. p. 200), the skull of which is described below.

	A.	B.
Total length	3 ft. 9 in.	6 ft. 3 in.
Greatest height of body	0.75 inch	1.75 inch
Length of head (jaws retracted)	2.12 inches	3 inches
Preanal length (snout to anus)	13.25 "	22 "
Proportion of height to length	1 : 60	1 : 43
" length of head to total length	1 : 21.5	1 : 25
" preanal region to total length	1 : 3.3	1 : 3.4
" head-length to preanal length	1 : 6.36	1 : 7
" height to preanal length	1 : 17.5	1 : 12.5
Total number of dorsal fin-rays	(?) 397	450 to 500

In the adult fish the proportion	$\frac{\text{height}}{\text{length}}$	varies from	$\frac{1}{10}$	to	$\frac{1}{15.6}$
" " "	$\frac{\text{head-length}}{\text{total length}}$	" "	$\frac{1}{14}$	to	$\frac{1}{27.35}$
" " "	$\frac{\text{preanal length}}{\text{total length}}$	" "	$\frac{1}{2.5}$	to	$\frac{1}{33.6}$
" " "	$\frac{\text{head-length}}{\text{preanal length}}$	" "	$\frac{1}{6}$	to	$\frac{1}{7.9}$
" " "	$\frac{\text{height}}{\text{preanal length}}$	" "	$\frac{1}{4.3}$	to	$\frac{1}{5.2}$

It is remarkable that, in the case of the first three relations, the high numbers are found in the longest specimen, that described by Forbes, in which, too, the number of fin-rays is excessive.

Otherwise one might state that these denominators decrease as the fish increases in length.

The really important differences in these relations occur in those cases in which the greatest height is a factor—which is very much less in proportion to the length in the young than in the adult.

If, then, "*R. parkeri*" be the young of *R. glesne*, we have not only a great change taking place during growth, in the proportions of all the parts, especially the height-length relation, but a diminution in the total number of fin-rays in the dorsal fin, and the breaking up of transverse coloured bands into oval and circular spots, and also the appearance in the fore part of the body of much darker irregular streaks.

We know that somewhat similar changes do take place in fishes belonging to the family in which *Regalecus* is included. In *Trachypterus*, for example, such changes are illustrated in Günther's 'Study of Fishes,' p. 521, and apparently Lütken had already expressed the opinion that such growth-changes would occur in *Regalecus* (3, p. 294).

I was disappointed in finding so little about this subject in the recent volume on Fishes in the 'Cambridge Natural History'; but in the systematic portion Boulenger (p. 714) remarks: "The life-histories (of Tæniosomi) are still very imperfectly known, and great changes of form take place during growth;" but nothing further is said about the matter.

I have been unable, owing to the poverty of our libraries in New Zealand, to ascertain whether any, and if so what, work has been done on changes in the detailed structure of the skull during growth. The references to be found in Wiedersheim, or in Ziegler's 'Vergleich. Entwickl. d. nieder. Wirbelthiere,' refer only to embryonic changes, so far as I have been able to ascertain from abstracts in the 'Zoolog. Jahresbericht.'

The present contribution, together with my previous article on the external form of *R. parkeri*, is a step in this direction, if this fish be, in fact, the young of *R. glesne*.

II. DESCRIPTION OF THE SKULL.

(By W. J. DUNBAR.)

A. *The Bones of the Upper and Lower Jaw.*

The *Premaxilla* consists of two regions, namely, a thin plate lying at the side of the oral aperture (*pmx.*), the "alveolar portion" of Prof. Parker, and a long dorsally situated "nasal process" (*pmx.'*), which is connected with its fellow of the other side by a laterally compressed plate of cartilage (*pmx."*, Pl. XXXVIII. fig. 1 and Pl. XXXIX. fig. 3). This process extends back over the cranium on the dorsal surface, lying in a cartilage-lined "anterior dorsal" groove in which it can slide to and fro. In *R. glesne* the bone has relatively a much shorter nasal process, the two regions

being almost equal in length; whereas in the present species the nasal process is more than twice the length of the alveolar plate. Again, the longer axis of this plate is, in *R. glesne*, vertical and perpendicular to the nasal process, while in *R. parkeri* the longer axis of the plate is almost horizontal and parallel to the nasal process (Pl. XXXVIII. fig. 1).

The *Maxilla*, instead of being, as in a typical teleostean skull, a narrow rod of bone, is broad and subquadrate, marked on its outer surface by ridges—as in other dermal bones of *Regalecus*—which rise from a point near the dorsal posterior border (fig. 1). The maxilla overlaps the hinder part of the alveolar plate of the premaxilla, and can be distinctly seen through the silvery epidermis. On its inner side is a pronounced ridge, which is continued beyond the posterior margin of the bone as a peg-like process (*max.*') lying alongside the nasal process of the premaxilla (Pl. XXXVIII. fig. 1 and Pl. XXXIX. fig. 3). The antero-posterior length is somewhat greater than the vertical height, whereas in *R. glesne* the bone is long and narrow, and is at least twice as high dorso-ventrally as it is wide: in fact its relation to mouth is more like that commonly met with in Teleosteans.

The lower jaw (Pl. XXXVIII. figs. 1, 2) consists of the usual three bones, the Dentary, the Articulare, and the Angulare, enclosing Meckel's cartilage, which is distinctly visible through them. The region above Meckel's cartilage may be termed the supra-meckelian, and the part below that line the infra-meckelian region. In *R. glesne*, Prof. Parker describes the supra-meckelian part of the lower jaw as having "something the form of an equilateral triangle and the infra-meckelian of a right-angled triangle with altitude about one-fourth of its base, so that the whole jaw comes to be rather higher than long." In the present species the height of the lower jaw is very much greater than the length, and the proportions of the two regions are different from *R. glesne*. The supra-meckelian portion has the form of an isosceles right triangle with one limb of the dentary as hypotenuse. The infra-meckelian portion is an irregular four-sided figure whose height is one half its length; it is thus just twice as high proportionately as that of *Regalecus glesne* (Pl. XXXVIII. fig. 2).

The *Articulare* (*ar.*) is a thin plate of bone somewhat triangular in form. The posterior side is vertical and extends upwards as far as the peg of the maxilla. This posterior margin is much thickened. The lower margin is also slightly thickened, and extends horizontally below Meckel's cartilage, overlapping and concealing the angulare externally. The third side slopes downwards and forwards and meets the dentary along the edge.

The *Dentary* (*d.*) is a V-shaped bone placed with the angle forwards and bearing at the extremity one tooth which is not present in *R. glesne*. The two limbs meet one another at an angle of 90°, one being directed backwards and upwards to meet the articulare above, the other passing below Meckel's cartilage to meet the lower border of the articulare.

The *Angulare* (*ang.*) is a very small bone on the inner surface of the infra-meckelian part of the articulare. It does not meet the dentary as the *angulare* of *R. glesne* does.

B. *The Suspensorium and Hyoid Arch.*

The *Quadrate* has the usual triangular shape with a curved base directed backwards; the apex, which is directed forwards, not downwards as in ordinary fish-skulls, articulates with the articulare at the level of Meckel's cartilage.

The *Ectopterygoid* (Pl. XXXVIII. figs. 1 & 2) is a small triangular bone lying in a nearly vertical plane. At its lower end the bone is pointed and gradually widens to its upper border, where it meets the palatine. The posterior margin fits on to the anterior upper margin of the quadrate, and the dorsal border continues the curve of that bone (Pl. XXXIX. fig. 7). Relatively it is a short bone compared with that of *R. glesne*, in which it projects for a considerable distance—almost half its total length—beyond the quadrate.

Behind the *Ectopterygoid* lie the *Ento-* and the *Metapterygoid*, extending below the orbit and curving in towards the middle line. The entopterygoid stretches from the posterior border of the palatine, pterygoid, and quadrate anteriorly to the hyomandibular posteriorly; only the upper margin is ossified, a considerable amount of cartilage still existing along the lower border. The metapterygoid is a very small ossification of oblong shape lying below the hinder end of the entopterygoid. In *R. glesne* the latter is a somewhat quadrate bone about as high as it is long. In the present species the great length and relatively small vertical height of this bone form a marked contrast, as it extends beyond the metapterygoid nearly to the hyomandibular, whereas in *R. glesne* the bone does not reach the hinder end of the metapterygoid. The metapterygoid, too, is longer and narrower, relatively, than in *R. glesne*, and wholly underlies the entopterygoid.

Above the pterygoid lies the *Palatine*, a V-shaped bone with the sharp apex directed forwards. The two limbs embrace the end of the mesopterygoid. Although this bone in *R. glesne* is very irregular, there is little indication of this deep notch.

The *Hyomandibular* articulates with the cranium just behind the orbit and below the pterotic. At this end it is broad and thick, but narrows to a point as it passes downwards and forwards. This narrow portion lies on the inside of the pterygoid plate. The articular end is capped by cartilage, and under this is a convex articulation for the opercular bone.

At its anterior, pointed, end the hyomandibular is connected with the *Symplectic*, which extends to the quadrate, thus connecting it with the hyomandibular. In shape the symplectic is a long rod-like bone, slightly curved and much more elongated than that of *R. glesne*.

The *Interhyal*, connecting the hyomandibular with the rest of the hyoid arch, articulates with it almost at the same point as the symplectic does. It is a small bone tipped at both ends with cartilage.

The rest of the hyoid arch is much compressed laterally so as to form the "hyoidean cornu" of Prof. Parker, and is made up of four bones, the epi-cerato- and two hypo-hyals. Of these the *Epihyal*, a flat semicircular bone, articulates with the interhyal, forming the upper rounded end of the cornu. It lies posteriorly to the ceratohyal as in *R. glesne*.

The *Ceratohyal*, like that of *R. glesne*, is the largest of these bones, but relatively much longer and narrower than in that species. It intervenes between the epihyal and the two hypohyals, forming the posterior lower margin and but a small part of the dorsal margin of the arch.

The *Hypohyals*, of which there are two, take a greater share in the formation of the "hyoidean cornu" than in *R. glesne*, being together almost equal to the ceratohyal. The larger and upper one forms most of the anterior margin of the cornu, while the smaller and lower one (*h.hy.*') forms the rest of the anterior and the whole of the mesial margin where the hyoidean cornu is attached to the glossohyal. This lower one seems forked on the inner side, but this is due to the lower corner of the ceratohyal overlapping and concealing part of it. In fig. 2 the concealed part of the margin is indicated by a dotted line.

C. The Opercular Bones.

Of these there are four, and all are visible through the skin of uninjured fish.

The *Opercular* itself is a subcircular bone having a concave facet for articulation with the hyomandibular. It has three borders, all curved, one of which faces anteriorly, one dorsally, and the other postero-ventrally. Below the opercular is the *Subopercular*, a narrow plate of very delicate bone. In neither of these bones is there a marked difference from the corresponding bones in *R. glesne* (Pl. XXXIX. figs. 6 & 7).

The *Preopercular* is one of the largest bones in the skull, extending from the anterior border of the opercular to the anterior end of the quadrate, making a total length of one and three-quarter inches. Thus it forms a considerable part of the suborbital region of the face. Instead of the greatest length being in a vertical direction as is usual, it is here in a horizontal direction. The difference between the preopercular in the two species is very marked. In the present species the greater part of the bone is horizontal and suborbital, whereas in *R. glesne* the greater part is vertical and postorbital. Again, in the latter species the anterior and posterior margins are gently and regularly curved, but in *R. parkeri* the lower margin is straight for some distance and then curves suddenly upwards (Pl. XXXVIII. fig. 1).

The *Interopercular* is as much elongated as the preopercular; but is not so broad and also presents considerable difference from that of *R. glesne*. In the latter the posterior margin is curved sharply upwards and the dorsal edge is straight; but in *R. parkeri* the posterior end of the bone is scarcely turned up and the upper margin is excavated. The markings on this bone originate almost exactly in the centre, whereas in *R. glesne* they are described as originating "at the junction of the anterior and middle thirds."

D. *The Cranium.*

After the removal of the jaws and suspensorium, the form of the cranium, as seen from the side (Pl. XXXIX. fig. 6), is somewhat like that of a bird's skull. This appearance is due to its length, to the large orbit, and to the beak-like prenasal rostrum. On the dorsal surface are two median grooves, lying end to end, meeting above the centre of the orbit (Pl. XXXIX. fig. 4). The anterior dorsal groove has as its floor a plate of cartilage named the "tegmen cranii" by Parker, while its sides are formed by the frontals. In this groove the nasal process (*pnæ.*) of the premaxilla lies (Pl. XXXIX. fig. 3). The posterior groove has as its floor the supraccipital and as its sides the epiotics and parietals: it is scarcely existent in *R. glesne*. If the cranium of *R. parkeri* be compared with that of *R. glesne*, the most striking difference is the greater length and less vertical height in the present species. This excess of length is mainly due to the greater development of the preorbital region or "beak," which is nearly as long as the orbital region, whereas in *R. glesne* (Pl. XXXIX. fig. 7) it is less than half this proportion. The length of the cranium in the latter species is $1\frac{1}{2}$ times the greatest height, but the proportion of length to height in the present fish is 2:1. This difference in relative length is due partly to the greater development of the preorbital region, and in a small degree to the absence of the "subcranial crest" described by Parker, formed by parasphenoid, basi-occipital, and opisthotic.

The Occipital Region (Pl. XXXIX. figs. 4, 5, 6, 8).

The *Basi-occipital* forms the greater part of the occipital condyle (Pl. XXXIX. fig. 8), and is produced forwards and downwards as a median ridge which extends anteriorly to meet the end of the parasphenoid. In contrast to the condition in *R. glesne*, we may note that it is the most posteriorly placed bone in the skull (Pl. XXXIX. fig. 6). Dorsally and anteriorly it is bounded by the exoccipital and opisthotic, ventrally and anteriorly by the parasphenoid.

The *Exoccipitals* entirely bound the foramen magnum (Pl. XXXIX. fig. 8), each meeting its fellow below it, so that each takes a small share in the occipital condyle. The greater part of the exoccipital is a posterior vertical plate which extends upwards to meet the epiotic and outwards to meet the pterotic, while it sends

a process forwards to meet the great opisthotic (Pl. XXXIX. fig. 6).

The *Supraoccipital* is feebly ossified. Lying in the posterior dorsal groove and forming its floor, it is separated from the exoccipitals, however, by the epiotics—a very unusual condition (Pl. XXXIX. fig. 4). Anteriorly it reaches the meeting-place of the two dorsal grooves.

Otic Bones (Pl. XXXIX. figs. 4, 5, 6, 8).

Above the exoccipital lies the *Epiotic*, which is partly covered by the post-temporal. The position of the post-temporal is shown in Pl. XXXVIII. fig. 1 and Pl. XXXIX. fig. 8, but in the other figures it has been removed. The two epiotics nearly meet one another in the middle dorsal line, thereby excluding the occipital from the supraoccipital, which, as Prof. Parker pointed out, is a most unusual condition. The epiotic is a squarish bone as seen from above, raised into a prominent ridge along the dorsal surface, which forms the margin of the dorsal groove.

The *Pterotic* is a large well-ossified bone extending from the exoccipital to the posterior margin of the orbit. Dorsally it is bounded successively by the frontal, the parietal, and the epiotic bones, and ventrally it touches the sphenotic and prootic. The outer edge forms a prominent ridge under which the hyomandibular articulates. The pterotic is much grooved on its outer surface, the ridges being very delicate while the grooves are deep.

The *Sphenotic* is a more or less vertical bar at the posterior region of the orbit, forming the post-orbital process. The lower end slopes inwards and forwards to meet the upwardly-projecting process of the parasphenoid, and thus to form the post-orbital bar. Above, it touches the under surface of the pterotic and anteriorly the alisphenoid, while by a forward process it just reaches the frontal.

The *Prootic* lies below the ridge formed by the pterotic. It is bounded anteriorly by the sphenotic, ventrally by the opisthotic, and posteriorly by the exoccipital.

The *Opisthotic*, as seen in side view, is a large bone forming a plate above the parasphenoid and meets its fellow in the middle ventral line. Relatively it is a larger bone than that of *R. glesne*, and instead of the suture between it and the basioccipital being vertical, the opisthotic passes backward over the forward plate of the basioccipital to meet the exoccipital on the external surface of the skull (Pl. XXXIX. fig. 6). This external plate corresponds to Parker's "*oph.*"—the descending process. The other three processes which exist on the inner surface of the cranial wall are not figured. If the side view of the skull of *Regalecus* be compared with that of the Salmon, it will be seen that the opisthotic occupies the place of the prootic of the Salmon in its relation to the exoccipital and basioccipital; but Parker's dissection shows the true interpretation of the bone.

Bones in the Orbit.

In front of the sphenotic are two pairs of bones contributing to the roof of the orbit—the alisphenoids and orbito-sphenoids (Pl. XXXIX. figs. 5, 6).

The *Alisphenoid* is a flat bone not quite reaching to the outer edge of the orbit. Between and somewhat behind the two alisphenoids is a large triangular foramen which Parker discusses at length. He mentions that the only difficulty in the way of the interpretation that these bones are alisphenoids is, that there is no foramen for the fifth nerve behind them; but he points out that in many mammals the first division of the fifth nerve passes out altogether in front of the alisphenoid. In the Rabbit, too, the first two divisions of the fifth nerve pass out of the skull by the sphenotic fissure, which lies between the alisphenoid and the basisphenoid. This is relatively in the same position as the foramen in the skull of *R. parkeri*. In front of the alisphenoid is a large bone extending as far forward as the mesethmoid. This Parker identified as the *orbito-sphenoid*. There is no suture in the middle line, so that the two bones must be here fused. The orbito-sphenoid is not perforated by the second nerve, which must pass out through the foramen between the alisphenoids.

Cranial Roof.

The roof of the cranial cavity is formed by the frontal and the parietal bones along with the median plate of cartilage, the "tegmens cranii" (Pl. XXXIX. figs. 4, 6).

The *Frontal* is a large bone, relatively much larger than in *R. glesne*, extending as far forwards as the ectethmoid and backwards nearly to the posterior end of the supraoccipital. Thus they form the greater part of the upper surface of the skull and the lateral margin of the anterior dorsal groove for almost its whole extent. Further, each sends back a small process on the mesial side of the parietal, which thus only just reaches the margin of the posterior dorsal groove by a corner. The frontals do not, as is usual in Teleosts, meet in the middle line, as Parker pointed out for *R. glesne*, but are separated by the "tegmens cranii." Posteriorly, the frontal meets the parietal and pterotic, and sends a process back under the parietals which nearly meets the pterotic. On the under surface of the skull the frontal is seen to form a supraorbital plate (Pl. XXXIX. fig. 5).

The *Parietal* is a small bone, very different in form and size from that of *R. glesne*; it is long and narrow, extending forwards between the frontal and the "tegmens cranii," and forming a rounded prominence at the side of the supraoccipital. In the present species, although the boundaries of the bone were very difficult to determine owing to its thinness and friability, it seems to have a very different form. The internal backward process of the frontal almost cuts off the parietal from participation in forming the side of the dorsal groove, and far from forming a

prominence as it does in *R. glesne*, it barely reaches the groove (Pl. XXXIX. fig. 4).

Preorbital Region.

In front of the orbit is the prenasal "beak," a solid structure composed partly of bone and partly of cartilage. It is compressed from side to side, with a sharp dorsal and ventral edge. The greater part of the beak is formed by the mesethmoid, which is mainly cartilaginous, and by the ectethmoid cartilage. The *Mesethmoid* is, as its name implies, a median sheet extending from the orbit half way to the anterior extremity of the "beak," where it meets another vertical plate, a part of the vomer. Its posterior end is laterally broadened and appears on the roof of the orbit, of which it forms the anterior median wall.

The *Ectethmoid* cartilage is a thick mass of cartilage (without any ossification, such as occurs in *R. glesne*) extending outwards at right angles to and continuous with the mesethmoid, forming a rounded prominence, the anterior boundary of the orbit. The lower margin of the prenasal rostrum is formed by the *vomer*. This bone tapers from its middle to each end; the anterior end curves sharply down to form a median tooth, and on each side of this are two smaller lateral teeth*. Of this there is no mention in the description of *R. glesne*. The posterior end of the bone meets the parasphenoid. As mentioned above, the vomer sends a vertical plate upwards to meet the mesethmoid by its posterior margin. Above this vertical sheet is a strip of cartilage—the prenasal cartilage—extending back over the mesethmoid to the "tegmen cranii" and forming the dorsal edge of the "beak." Behind the vomer, the *Parasphenoid* forms at least two-thirds of the ventral margin of the skull. It is sword-shaped, the posterior region or "handle" having two lateral projections—the "guards"—near this end. These slope outwards and very slightly backwards and sharply upwards to meet the sphenotics. In *R. glesne* the parasphenoid is greatly extended backwards and upwards as a vertical plate underlying and extending behind the basioccipital. In the present species there is, however, no trace of such a plate, and the posterior end of the bone tapers to a point which lies well in front of the hinder end of the basioccipital.

Lying in front of the orbit, close under the skin, are the nasals and preorbitals (Pl. XXXVIII. fig. 1). The *Nasal* is a small rod-like bone which articulates with the anterior end of the frontal and, passing forwards and inwards, abuts loosely against the sides of the premaxilla. Under the nasal lie the *Preorbitals*, two on each side. These three bones readily separate from the skull and are shown only in figure 1.

* The fact that this young specimen is provided with teeth in both the upper and lower jaw is suggestive; for in some of the specimens of *R. glesne* that have been described they are present (*vide* Günther), in others absent (*vide* Parker).

Summary.

From these notes, it will be evident that nearly every bone in the skull of this small Ribbon-fish differs, to a greater or less extent, either in form or proportions, from the corresponding bone of the Great Ribbon-fish.

The specimen was undoubtedly a young one—a fact which is shown not only by the amount of cartilage in the skull, but also by the condition of the ovary, in which all the eggs were small. There are, therefore, two possible explanations of the differences: (1) that the fish was the young of a known species, probably *R. glesne*, which is the common species; or (2) that the fish belongs to a different species. If the specimen is the young of *R. glesne*, the changes which it must undergo before becoming adult must be far-reaching, especially in the skull. For example, the posterior part of the parasphenoid must grow backwards with great rapidity, while the rest of the bone continues its ordinary growth. In order that the parietal could assume the position occupied by that bone in *R. glesne*, it would have to grow enormously antero-posteriorly; but, before it could do so, the backwardly directed process of the frontal, which lies between the parietal and the posterior dorsal groove, would have to disappear. The maxilla, too, would have to change its shape entirely. Now the maxilla is a particularly well-ossified bone—one of the best ossified in the skull—and so least likely to undergo further developmental change. Such great changes as are here indicated would hardly have been expected after the animal had attained more than its half adult length.

Conclusion.

Taking all the facts into consideration, it seems more than probable that the so-called *R. parkeri* is but the young stage of *R. glesne*.

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EXPLANATION OF THE PLATES.

LIST OF ABBREVIATIONS.

<i>als.</i> , alisphenoid.	<i>mtp.</i> , metapterygoid.
<i>ang.</i> , angulare.	<i>na.</i> , nasal.
<i>ar.</i> , articulare.	<i>os.</i> , orbito-sphenoid.
<i>b.o.</i> , basi-occipital.	<i>op.</i> , opercular.
<i>br.r.</i> , branchiostegal rays.	<i>op.o.</i> , opisthotic.
<i>c.</i> , occipital condyle.	<i>pa.</i> , parietal.
<i>c.hy.</i> , ceratohyal.	<i>pl.</i> , palatine.
<i>d.</i> , dentary.	<i>pas.</i> , parasphenoid.
<i>ec.p.</i> , ectopterygoid.	<i>p.mx.</i> , premaxilla.
<i>ect.eth.</i> , ectethmoid cartilage.	<i>p.mx.'</i> , post-nasal process of premaxilla.
<i>en.p.</i> , endopterygoid.	<i>p.mx.ii</i> , post-nasal cartilage of premaxilla.
<i>ep.o.</i> , epiotic.	<i>pn.</i> , prenasal cartilage.
<i>e.o.</i> , exoccipital.	<i>pr.or.</i> , preorbital.
<i>e.hy.</i> , epihyal.	<i>p.op.</i> , preopercular.
<i>f.m.</i> , foramen magnum.	<i>pr.o.</i> , prootic.
<i>fr.</i> , frontal.	<i>p.tm.</i> , post-temporal.
<i>for.</i> , foramen between alisphenoids.	<i>pt.o.</i> , pterotic.
<i>g.hy.</i> , glosso-hyal.	<i>qu.</i> , quadrate.
<i>hy.c.</i> , hyoidean cornu.	<i>sy.</i> , symplectic.
<i>h.hy.</i> & <i>h.hy.'</i> , hypohyals.	<i>s.op.</i> , subopercular.
<i>hy.m.</i> , hyomandibular.	<i>s.o.</i> , supraoccipital.
<i>i.hy.</i> , interhyal.	<i>sp.o.</i> , sphenotic.
<i>i.op.</i> , interopercular.	<i>t.</i> , tooth on dentary.
<i>m.</i> , membrane connecting some of the bones of the upper jaw.	<i>t.cr.</i> , tegmen cranii.
<i>mck.</i> , Meckel's cartilage.	<i>u.hy.</i> , urohyal.
<i>mx.</i> , maxilla.	<i>vo.</i> , vomer.
<i>mx.'</i> , process of maxilla.	<i>vo.'</i> , vomerine tooth.
<i>m.eth.</i> , mesethmoid.	

PLATE XXXVIII.

The figures are drawn $\frac{1}{3}$ th their natural size.

- Fig. 1. The complete skull of *Regalecus*, with the jaws protruded. (The outlines of the otic bones are not indicated in this figure.)
 2. The suspensorium of the left side, seen from within.

PLATE XXXIX.

Fig. 3. Dorsal view of the complete skull of *Regalecus*.

4. Dorsal view of cranium, after removal of the upper jaw.
 5. Ventral view of cranium.
 6. Side view of cranium.
 7. Front view of cranium.
 8. Hind view of cranium.

4. On Worms of the Family *Gordiidæ* from Corea.

By Dr. VON LINSTOW*.

[Received May 1, 1906.]

(Text-figure 95.)

These worms were obtained by Mr. Malcolm P. Anderson, who has been sent out to the Far East by H.G. the Duke of Bedford to make collections of the Fauna. They consist of specimens of two new species.

* Communicated by F. JEFFREY BELL, F.Z.S.

GORDIUS PALLIDUS, sp. n. (Text-fig. 95 A.)

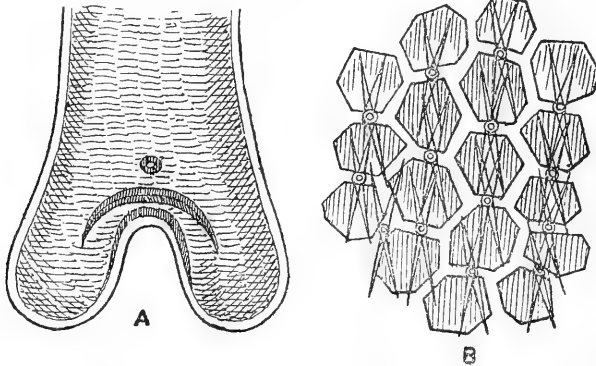
Locality. Freshwater pond in Korea. Three males.

Length, respectively, 265, 292, and 305 mm.

Breadth: at the anterior end, 0.59 mm.; in the middle, 0.75 mm.

Colour yellowish white. A broad, crescentic, cuticular fold on the ventral side at the posterior extremity, the inner sides of the posterior lappets and a ring around the cloacal opening yellow-brown.

Text-fig. 95.



A. *Gordius pallidus*. Posterior extremity of the male from the ventral aspect.
B. *Parachordades coreanus*. Cuticle.

The posterior end of the body is produced into two rounded lappets. The cuticle is traversed, at an angle of from 50° or 130° , by two bands separated by an interval of from 0.031 to 0.039 mm.; between these bands are two systems of fine lines, running in the same direction as the bands but too minute to measure.

PARACHORDADES COREANUS, sp. n. (Text-fig. 95 B.)

Locality. A freshwater stream, Korea. One female.

Length 322 mm.

Breadth: at the anterior end, 0.28 mm.; in the middle, 1.18 mm.; at the posterior end, 0.71 mm.

Colour dark brown; anterior end whitish, without a cervical band.

The rounded posterior extremity is sharply truncated. The cuticle exhibits five- to six-sided patches of from 0.026 to 0.031 mm. in size; between the patches there are glistening knobs each surrounded by a light-coloured ring, from which two lines pass outwards at a definite angle. The cuticle also exhibits two extremely delicate systems of lines parallel with those just described, and a third system running longitudinally.

5. Notes upon Menstruation, Gestation, and Parturition of some Monkeys that have lived in the Society's Gardens. By REGINALD I. POCK, F.L.S., Superintendent of the Gardens.

[Received May 15, 1906.]

The matter contained in the following pages is an amplification of notes upon the reproductive phenomena of certain Cercopithecoid Monkeys and Baboons that recently lived, or are still living, in the Society's Gardens, and upon the offspring of some species of *Macacus* (Macaques) that bred in the Menagerie in the early months of the present year (1906).

Through the kindness of Dr. E. Steegmann I am able to supplement and confirm my own observations on these questions by some new and interesting items of information concerning some of the Apes and Monkeys he has had of late years in his hands. Dr. Steegmann has most generously placed his notes at my disposal; and since they are extracted from a letter and form a connected whole, I have decided not to incorporate them with my own notes but to print them in full at the end of this paper.

MENSTRUATION IN MONKEYS AND BABOONS.

Menstrual Inflammation.

It is well known that the females of many Monkeys and Baboons when "on heat" exhibit extreme inflammation of the naked area surrounding the genital and anal orifices. The swelling, however, does not take place in all species of Cercopithecidæ. I have never detected it in any of the Guenon (*Cercopithecus*) nor in Macaques (*Macacus*) of the Common (*fascicularis* = *cynomolgus*), Bonnet (*sinicus*), Rhesus (*rhesus*), and Japanese (*fuscatus*) species. On the other hand, it is very conspicuous in Mangabeys (*Cercocebus*) of the Sooty (*fuliginosus*), White-crowned (*lunulatus*), and White-collared (*æthiopicus*) species; in all the Baboons (*Papio*) of which I have seen adult female examples, namely, the Chacma (*porcarius*), Guinea (*sphinx*), Green (*olivaceus*), Yellow (*cynocephalus*), and Hamadryas (*hamadryas*), and in the Pig-tailed Macaque (*Macacus nemestrinus*).

The present state of my knowledge on the subject may be summarised as follows:—

- a. A conspicuous subcaudal inflammatory swelling in the adult female when "on heat."

Cercocebus fuliginosus, *æthiopicus*, *lunulatus*.

Macacus nemestrinus and *M.* sp.?

Papio porcarius, *cynocephalus*, *sphinx*, *olivaceus*, *hamadryas*.

- a'. No such swelling in the female.

Cercopithecus—all the common menagerie species.

Macacus sinicus, *fascicularis*, *rhesus*, *fuscatus*.

Needless to add, this is hardly the classification to be expected on *à priori* grounds from the usually accepted views of the affinities of the species concerned. It seems to me to be probable that the swelling will be found to be characteristic of all the species of Mangabeys and Baboons; but in the case of the Macaques no generalisations can be drawn until further observations have been made. In 1904 I recollect seeing in the Berlin Gardens a female Macaque of a species whose name I have now forgotten, with the swelling like that of *M. nemestrinus*. Thus at least two species of this genus fall under section *a* of the above-given table. On the other hand, it is by no means certain that all the forms related to *rhesus* and *fuscatus* can be ranged with these species under section *a'*. For example, P. L. Sclater (P. Z. S. 1864, p. 710) says that a female of the Formosan Macaque (*M. cyclopis*) upon reaching maturity "acquired a most extraordinary development of the parts surrounding the organs of generation." The figure that accompanies this description, however, shows a long lobate swelling extending on each side down the back of the thigh and along the proximal third of the tail—a development quite unlike anything known to me in other species. It is significant, too, that Sclater speaks of this swelling as if it were permanent and not periodic. If permanent the development must probably be of a different kind from that now under discussion. If periodic and connected with menstruation it must indicate an important physiological difference between *M. cyclopis* and *M. rhesus*, two species structurally somewhat nearly related.

The swelling may be nothing but a useless correlative or accompaniment of the physiological processes incidental to menstruation. But, in my opinion, the development of a highly vascular, sensitive, and thin-skinned outgrowth of this nature—an obvious inconvenience to the monkey, since it involves special precautions to prevent injury, impairs activity, and is liable to laceration when quarrels arise—probably, rather than otherwise, carries with it some compensating advantage to the species. What may this be? Possibly the following considerations may throw some light on the subject. The similarity in form and colour between male and female Monkeys leaves no clue to the sex of a particular individual when seen at a distance. The males, moreover, are not apprised by the sense of smell of the condition of the females when "on heat" as are the males of Carnivora, Ungulata, Rodentia, and of other orders of Mammals. Hence it may be that the function of the swelling in question is to serve as a source of information to the males on the two points mentioned above. I think it may be claimed that such information is of use for the maintenance of the species. But whether the usefulness in these particulars of the swelling be or be not the factor that has guided its evolution, it is difficult to see how such a coloured excrescence can fail to convey the said information in the case of animals so intelligent and keen-sighted as Monkeys. For, as is fully attested by flowers like scarlet geraniums and by

fruits like ripe tomatoes or cherries—which are conspicuous, be it noted, for the purpose of attracting attention,—no colour is more conspicuous in green foliage by daylight than bright red. Red is also in an eminent degree visible at a great distance in the open, as a scarlet uniform proves. The crimson swelling, therefore, must, it appears, reveal to the males the sex and condition of adult non-pregnant females alike in the case of Mangabeys which live in the forests and of Baboons which frequent open rocky country.

Again, preferential mating cannot perhaps be altogether eliminated as a factor in the question. It may be that the colour and inflammation appeal to the æsthetic sense and sexual emotions of the males and act as an aphrodisiac impelling them to pair with females in which the characters are pronounced rather than with those in which they are poorly developed or absent. Preferential mating on the part of females was regarded by Darwin and others as the principal agent in fostering and fixing (not causing *ab initio*) ornamental colours and crests characteristic of males. If females are thus influenced, why not males? Whether or not the theory can be logically and confidently applied to animals probably remote from Man in mental processes, it seems illogical to exclude it as a probable factor in determining the development of female sexual ornamentation in the case of animals with so many human attributes as Baboons and Monkeys.

Menstrual Hæmorrhage.

In females of two species of Baboons, namely, a Chacma (*Papio porcarius*) and a Yellow (*P. cynocephalus*), I have noticed that the period of "heat" is heralded by inflammation of the genito-anal area and is followed after a day or two by a show of blood which continues for four or five days, during which time the inflammatory swelling gradually increases in size. The quantity of blood emitted varies greatly in the two specimens. In the Chacma it is relatively small, sufficient only to stain with small patches the floor of the cage; in the Yellow Baboon, a younger animal, the amount is at least ten times as great, so that the cage becomes quite unsightly. It is probable, I think, that the variation in the quantity given out by the two animals is merely an individual characteristic and is not connected with their specific distinctness. After the hæmorrhage stops, the swelling continues to grow and extends laterally so as to conceal completely the ischial callosities and the naked skin adjacent*. It reaches its maximum in about two weeks' time and remains at that stage for about one week. It then begins to shrink and in

* The swelling involves the whole of the circumanal area, so that the anal and the vaginal orifices are thrust considerably behind their normal position. Pairing between the sexes takes place after the hæmorrhage has ceased. The correlation between the swelling in the female and the extreme length of the intromittent organ in the male of Baboons is obvious.

about another two weeks has disappeared, so that the female at a distance is indistinguishable from the male. After a few days' rest inflammation again sets in and is almost at once followed by the appearance of hæmorrhage.

In the case of the female Chacma, the data upon which the foregoing epitome is, in the main, based are as follows:—

April 11-12 ...	Hæmorrhage.	Inflammation very perceptible.
" 14 ...	"	Swelling still larger.
" 16 ...	No hæmorrhage.	" "
" 20 ...	"	" "
" 25 ...	"	Swelling full-sized.
" 26-30 ...	"	" "
May 1-4 ...	"	Swelling gradually shrinking.
" 14 ...	"	Swelling disappeared.
" 18 ...	Hæmorrhage started.	Inflammation slight.
" 22 ...	" continued.	Swelling increasing.
" 25 ...	No hæmorrhage.	" "
" 30 ...	"	" full-sized.
June 6 ...	"	" sunk to half size.
" 12 ...	"	Swelling nearly disappeared.
" 14 ...	"	" " "
" 15-18 ...	"	No swelling.
" 19-20 ...	"	Very slight swelling and inflammation.
" 21 ...	Hæmorrhage started.	

Thus between four and five weeks—or, to be more accurate, thirty-two days—elapsed between the cessation of the hæmorrhage in April and its recommencement in May, and nearly four weeks—that is to say, twenty-seven days—between its cessation in May and its recommencement in June.

The period of "heat" in this Baboon may therefore be described with perfect accuracy as "menstrual," *i.e.* of monthly occurrence.

Hæmorrhage does not, however, take place in all female Baboons. There is, for example, a young female W.-African Baboon (*Papio sphinx*), now living in the Gardens, in which there is no show of blood; and although the swelling indicative of "heat" arises, it does not reach the enormous size characteristic of the Chacma, but involves merely the median subcaudal area of the rump without extending laterally over the ischial callosities. I do not know whether this is an individual peculiarity, or whether it is typical of the species, or whether it is merely assignable to the youth of the Baboon in question.

So far as my experience goes, hæmorrhage does not, as a rule, occur—or only occurs in a negligible quantity—in females of the

genus *Cercopithecus* and also in the Rhesus, Common, and Japanese Macaques; but I learn from Dr. Hamish Nicol that a Bonnet Macaque (*M. sinicus*) he had for some years in captivity always showed a bloody discharge at menstruation, so much so as to redden the places where she sat and compel her confinement to the cage for the two or three days that it lasted*.

Reviewing the above-mentioned facts it seems to me to be impossible to draw any satisfactory conclusions with regard to the incidence of menstrual hæmorrhage in Cercopithecidæ. In Baboons it may or may not take place and may be great or little in amount. It has been noticed to occur in some profusion in a female *Macacus sinicus*, and not to occur appreciably in a female of the closely allied species *M. fascicularis*. Obviously, therefore, it cannot be associated with the inflammatory swelling of the genito-anal region; and it is hardly likely to have a specific value in taxonomy. Perhaps the nearest guess at the truth that can at present be made is the surmise that it is dependent on the constitution or health of the individual.

PREGNANCY AND PARTURITION IN MACAQUES.

In the first half of the current year three Monkeys were born in the Gardens, namely: a Japanese Macaque (*Macacus fuscatus = speciosus*) on Jan. 10th; a hybrid between a male Common Macaque (*Macacus fascicularis = cynomolgus*) and a female Pig-tailed (*M. nemestrinus*) on March 1st; and a hybrid between the same male Common Macaque and a female Rhesus (*M. rhesus*) on April 27th. Congress between the parents of the Japanese Macaque was not seen, and the young was born at night. No observations, therefore, were made upon the period of gestation and parturition in this species.

The same remarks apply to the young born from the specimens of *M. fascicularis* and *M. rhesus*, except that the devouring of the placenta by the mother was noticed by the keeper in charge.

In the case of the hybrid *M. cynomolgus* and *M. nemestrinus* practically all the stages of parturition were watched. Unfortunately the young was born dead, or died soon after birth †.

Pregnancy.

Neither the Pig-tailed nor Japanese Macaque was known to be pregnant, in spite of the large size of the young. In the case of the Japanese Macaque this was due to the long and thick hairy winter coat of the mother; and in the case of the Pigtail to the

* This Monkey, I hear on the same authority, was addicted to masturbation—a habit by no means uncommon in males of some Baboons and Anthropoid Apes (Chimpanzee, Orang), but of very rare occurrence, I believe, in females.

† I was not myself present on the occasion. For the information given above I am indebted to the two keepers, Harrod and Rodwell, whom I cross-examined independently without finding any important discrepancies in their accounts.

inactivity of the Monkey, which was out of health and habitually sat with her knees pressed against her abdomen and her arms folded across them. The Rhesus, however, who was very active, showed decided signs in the enlargement of the nipples and the swelling of the abdomen, more particularly in its anterior portion behind the thorax. As compared with the human species the alteration in appearance due to pregnancy was small, although the fetus was comparatively larger in the Monkey. A week or two before the birth of the young, the Rhesus in one night lost all the hair off her cheeks. The skin was perfectly healthy, and looked as if it had been shaved clean. The bareness gradually spread on to the front of the shoulders and chest, extending ultimately to and round the nipples. It persisted until the young was about six weeks old; but within two months of birth the naked areas were covered with a coating of short hair.

Period of Gestation.

A small and not fully grown specimen of the Pig-tailed Macaque (*Macacus nemestrinus*) was observed to be in season in the latter part of August, 1905*, and to be covered more than once by a male of the so-called Common Macaque (*M. fascicularis*). There was no subsequent menstruation. Hence it may be inferred that conception took place some time between the middle of August and the beginning of September.

Soon afterwards the Monkey was removed from that cage and placed, together with another female of the same species, in a cage with an adult male hybrid between a Pig-tailed and Common Macaque bred in Singapore by Mr. H. N. Ridley. The behaviour of this male towards the two females was markedly different. Beyond tyrannising over the female in question and keeping her in a state of nervous subjection, he treated her with complete indifference. The other female, on the contrary, was regarded with decided favour. Possibly his disregard for the pregnant female was due to her condition. This may have brought about some subtle change in her, a difference or deprivation of odour may be, which perhaps robbed her of an attractiveness she might otherwise have held for him. In the winter she was placed in another cage and was not in company with a male Monkey of any kind until the young was born on March 1st.

Judging by analogy of the human species, the fœtus was very nearly, but not quite, at full term. The nails were completely formed; but the testicles had not descended into the scrotum. They had passed out of the abdominal cavity and were lying in the pelvic rim, the left a little lower than the right. Inguinal

* I am able to fix this date within a few weeks from the testimony of one of the keepers, Rodwell, who being a newly appointed and inexperienced hand was profoundly impressed by the excessive inflammation of the genito-anal area exhibited by the Monkey at the time. This man came on duty on Aug. 7th, and assures me that he noticed the phenomenon within the following week or two.

position of the testicles in the human foetus suggests a month's prematurity; but in the Monkey, where development is more rapid, it probably denotes a shorter period, perhaps about two or three weeks. Hence assuming that the young Monkey under discussion may have been premature by about that length of time on March 1st*, and that conception occurred at some date in the latter half of August, it may be concluded with some confidence that the period of gestation in the Pig-tailed Macaque is not more than seven and not less than six months. It does not appear to me that the data furnished by the present case justify a more exact estimate of its duration. The probability of the correctness of this calculation is supported by R. B. Sányál's† statement that a female *Cercopithecus cynosurus*, in the Calcutta Gardens, carried her young seven months.

Parturition.

The Pig-tailed Macaque in which parturition was observed refused food during the day, and seemed to be generally low-spirited and out of health. The precise time at which labour began is unknown. The first indication that it was in progress was the utterance of a scream by the mother late in the afternoon. The birth, a case of foot-presentation, took place about one hour afterwards. The Monkey remained seated on the perch during this time, aiding the extrusion of the young with her hands when a labour-pain supervened, and cleansing her offspring with her hands and licking them afterwards in the intervals.

Towards the end of the time, the contractions of the uterus took place at intervals of about five minutes, the screams and moans of the mother attesting the suffering she endured. The concluding stages and the severance of the umbilical cord could not be seen on account of darkness; but the placenta was found on the floor of the cage next morning detached from the young, which was dead, with its head partially crushed, as if by a fall or by being stepped upon. Whether the crushing of the head by either of these means was the cause of death, or whether the mother let the dead body fall on its head from the perch to the floor, is not known.

If this had been the only case to supply data regarding parturition in Monkeys, the following inferences might have been drawn: (1) that the process is painful; (2) that it lasts for about one hour; (3) that the placenta is not devoured by the mother.

But, so far as the suffering is concerned, there is no evidence

* I am not sure of the accuracy of this inference, because in the young male hybrid between *M. rhesus* and *M. fascicularis*, now living in the Gardens, the scrotum, which is of large size, appeared to be empty at birth and the testicles inguinal in position. The same appearance is presented by these organs now that the animal is five weeks old.

† Quoted by W. L. Sclater, *Mammals of S. Africa*, p. 9. Blanford also says that the period is about seven months in Indian Macaques (*Faun. Brit. India, Mamm.* p. 13).

that it is considerable in normal cases, and Dr. Steegmann's observations prove that the actual birth may be accomplished in not more than fifteen minutes. Both the suffering and the duration of the birth in the Pigtail must be attributed, I think, at all events in part, to its being a case of foot-presentation, which I assume, from the analogy supplied by other animals, to be abnormal*. Abnormality was further attested, as I afterwards learnt, by the leaving of the placenta by the mother, for Dr. Steegmann's evidence on this point was fully confirmed by the behaviour of the female Rhesus, who was actually seen by the keeper, Heffer, to devour the placenta entire.

Devouring the placenta by the mother seems to be the invariable rule in all species of Mammalia, with the exception of Man †. The habit has no relation to the natural food of the species, being common to purely herbivorous ruminants, to herbivorous or omnivorous rodents, to Monkeys, and to Carnivora. The catholicity of the habit suggests that it must have some significance from the point of view of utility to the species practising it. In the case of animals like Rabbits, Rats, and Carnivora, where the mothers lie up with helpless young, a certain measure of utility may lie in the necessity for keeping the spot clean and sweet-smelling.

That this is not a complete explanation, however, is suggested by the reflection that in the case of Ungulata the young are active and soon after birth wander away with the mother. The same argument applies to Monkeys, where the young are born in trees and are carried away by the mother directly afterwards. Again, some animals, as is shown by the female N.-American Wolf (*Canis occidentalis*), now in the Zoological Gardens, stay for a couple of days with their young without feeding. In instances of this kind it is conceivable that the eating of the placenta has a nutritive as well as a hygienic significance. But this view of the matter does not meet the case of Antelopes and their allies, which will start grazing as soon as the young is born. That the habit has some deeper meaning than those discussed above seems therefore to be probable. Perhaps, as has been suggested to me by Dr. J. Rose Bradford, the hastening of milk-secretion is its underlying physiological cause. In this hypothesis may possibly be found the explanation of the delay that commonly occurs in the human female between parturition and lactation, since practical synchronism between the two phenomena is met with in placentivorous mammals.

The amount of hæmorrhage that took place after birth differed greatly in the Japanese and Rhesus Macaques. In the Rhesus scarcely any was noticed, but in the Japanese it continued for two days and was quite considerable in quantity.

* Dr. F. G. Parsons, F.Z.S., suggested at the Meeting when this paper was read that the length of time occupied by the birth might have been due to the young being the first to which the mother had given birth.

† I have been unable to discover if the instinct has been retained by any savages.

CONDITION AND BEHAVIOUR OF THE YOUNG AT AND AFTER BIRTH.

At birth, Monkeys of the genera *Macacus* and *Cercopithecus* are clothed with hair not differing materially in thickness, length, and distribution from that of their parents. In this respect they differ markedly from newly born Chimpanzees, which, as I am told by Dr. Steegmann, are nearly naked at birth. The smallest Chimpanzees that have come under my notice were thickly coated like the adults, with the exception of one young female, perhaps from twelve to eighteen months old, in which the head was bald, but became covered subsequently. Dr. Steegmann, on the contrary, has had in his hands newly imported specimens, believed to be about six months old, which were almost destitute of hair. Thus, in the nakedness of the young, Chimpanzees are more like Man than they are like Cercopithecine Monkeys. They show, indeed, the commencement of the postponement in the growth of the body-hair characteristic of Man, where, apart from its local development at puberty in both sexes, it only appears with any degree of luxuriance upon the appendages, ventral surface, and to a lesser degree upon the back in some, mostly middle-aged or old males*.

In the young of the Japanese Macaque and in the hybrid *M. rhesus* × *M. fascicularis* the colour differs considerably from that of the adults of these species. The hairs are uniformly tinted throughout, being in the first-mentioned form olive-grey, and in the second blackish grey, without gloss and without any subapical pale area.

As recorded by Dr. H. O. Forbes, this was previously known to be the case in the Japanese Macaque, as also was the absence of the red hue in the face. It was not, however, previously known, so far as I am aware, that the infant coat is moulted during the fifth month and gradually replaced by a coat resembling in colour that of the parents. The little Japanese Macaque was born on Jan. 10th, and the moulting which set in near the beginning of May was finished by the end of that month, with the exception of a dark tuft of hair on each cheek, which was unchanged by the end of September.

Newly born Macaques differ extraordinarily in the matter of activity and independence from human babies, which remain practically helpless for at least a year. The Monkeys are able soon after birth to maintain a secure hold of their mother by clutching the hair of her sides with hands and feet, and within a week can crawl feebly about unaided. This was particularly noticeable in the case of the young Rhesus × Common Macaque, which I saw trying to creep over the straw of her cage when only four days old. When between four and five weeks old it could climb up the bars and about the perches of the cage with considerable activity and skill. The young Japanese Macaque appeared to be less pre-

* This remark applies particularly to the xanthochroic and melanochoic Europeans, and still more so to the Todas of Hindostan and to the Ainos of N. Japan.

cocious, but to what extent this was due to the greater solicitude of the mother in keeping the baby with her, either to protect it from the cold * or from the Monkeys in the adjoining cages, it is impossible to say. Certain it is, however, that long after the baby was able to crawl the mother habitually frustrated its efforts at independence by pulling it to her side before it could get out of arm's reach. The male took no share in nursing or tending to the young. He treated it with complete indifference, and with good-humoured tolerance allowed it to take the liberty later on of climbing over his back and pulling his hair. When sleeping, the parents usually sat front to front with the little one between them, completely concealed by their long and thick coats of hair. In addition to nursing and suckling the baby in the usual way, the mother kept it clean, as dogs and cats clean their puppies and kittens, namely by licking up the excrement and urine while being passed. It was amusing to see her every now and again seize the baby by the tail and inspect its hind-quarters for indications of excretion.

I have never seen the young Macaques suck more than one teat at a time. In this they differ from the baby Vervet (*Cerco-pithecus lalandii*) born in the Gardens in 1893, which is alleged to have held both nipples in its mouth at once (P. Z. S. 1893, p. 615). They soon began to feed on their own account. When four weeks old the baby Rhesus \times Common Macaque helped himself to his mother's bread and milk and at two months was trying, albeit ineffectually, to crack nuts. I did not see the young Japanese Macaque eat anything until six weeks old. At five months he was still being suckled. He was weaned when he was between seven and eight months old.

AGE OF MONKEYS.

I am not aware of any statistics as to longevity in Monkeys. It is interesting therefore to put on record the fact that Col. S. M. Benson kept, he informs me, a Rhesus Macaque alive for twenty-eight years. The animal ultimately died of heart disease, and was probably about twenty-nine years old at the time.

Supplement by Dr. E. J. STEEGMANN †.

My experience of birth amongst Monkeys is limited to one kind, the common Indian Rhesus, and the cases are few in number. All the females that gave birth to young ones were already pregnant when I bought them, and I have absolutely failed to

* This Monkey, be it remembered, was born on Jan. 10 in an unwarmed open-air cage separated by wire partitions from cages to the right and left, containing Baboons and Monkeys of diverse species. The baby of the Rhesus, on the contrary, was born on April 27th in a warmed house, and two days afterwards was transferred with its mother to a cage boarded off from adjoining cages.

† These notes were kindly compiled by Dr. Steegmann in reply to certain definite questions on matters about which my knowledge was defective or my observations wanted confirming.

breed from the commencement. I have therefore no facts whatever that can throw any light on the question of the length of gestation.

Altogether, I have had five Rhesus Monkeys born in captivity, four of them apparently at full time and the fifth prematurely. I have also had several other mothers which gave birth to young within six days of arrival.

The following facts are only ones on which I can speak with certainty from my own observations.

The signs of pregnancy in the female are not easy to recognise. I have purchased several under the impression that they were with young, and on subsequent post-mortem examination found no sign. Those females that were really pregnant showed considerable enlargement and prominence of the abdomen. The breasts were swollen, but in only one case could I detect any areola round the nipple, and this may of course have been normal. The pregnant animals appeared to be just as active as the others.

There was in all cases a very large amount of liquor amnii.

Unfortunately, I never saw the actual delivery of the young. In one case I could fix the time within 15 minutes, in the other I did not see the young ones till from two to three hours after birth.

I do not know how the mother separates the umbilical cord, but I suppose it is by biting. Examination of the abdominal end of the cord showed a condition that would have been caused by a clean bite rather than a tear. I have no doubt that the mother eats the placenta. I could never find a trace of it, even in the case that I saw within a quarter of an hour of delivery.

In the one case where the young was born apparently before full time, the mother had been ill some days previously. She was very wild and nervous, and resented any interference. The sign of ill-health was the one to which I generally attach a good deal of importance in Monkeys, namely, loss of appetite. I also noticed once or twice a slight discharge of what looked like blood-stained mucus from the vulva. This discharge may have been normal, though I never noticed it in any other Monkey before the birth of the young one. I have frequently seen a bloody discharge from the rectum in Monkeys, both male and female. In this particular case I found the young one dead in a corner of the cage. It had evidently been dead some hours, but had been born alive. There was no sign of the mother having killed it, at least there were no wounds or injuries to be seen, but she had tried to push it out of the cage, and was sitting as far away from it as she could when I first saw her. The placenta was still attached to the young by the umbilical cord, and no attempt seemed to have been made to separate it. No reliable data can be drawn from this placenta, as it was obviously not normal nor healthy. The young animal was fully developed, except for the teeth, which had not appeared. All the others that were born here had teeth.

The mother of this one died a few days after its birth, but the uterus was in too septic a condition for any satisfactory examination.

In all cases where the young were born alive the thing that struck me most was the extraordinary strength and activity they displayed practically immediately after birth. The one I saw when it was certainly not more than twenty minutes old could already cling by itself to its mother whilst she climbed about the cage. They hold on to the mother's fur by both hands and feet, and frequently also hold the nipple in their teeth. I am not able to form any opinion as to how long the young suckle; they can certainly eat solid food within less than a month of birth. One young Rhesus I had was born not more than a week before arrival. The mother died when it was between three weeks and a month old, and I had no difficulty in rearing it by hand, as it could drink and eat soft food.

One Monkey born here I kept with its mother for six months, and another for about seven. Both these young animals suckled all the time, although they also, during the greater part of it, shared the ordinary food given to the mothers.

The last point that is at all useful is the fact that young Rhesus Monkeys are born completely covered with hair, in all respects resembling the hair of the adult animal. I think that probably this is a feature in which they differ from Anthropoids.

I have reason to believe that Chimpanzees are born entirely or nearly naked. I have had eight young Chimpanzees imported. They were not less than six months old, though one of them was certainly more. Seven of these animals had very little hair indeed; most of them were practically naked on the ventral surface, but had scanty fur on the head and back. I have had a large number of other young Chimpanzees, but all of them had good coats. Unfortunately, all the seven uncovered young ones died of broncho-pneumonia soon after arrival, so I had no chance of observing when the coat appeared.

I tried an experiment to see if Rhesus would breed in captivity. One of the mothers whose baby had actually been born here was very tame and not easily frightened. I kept her with the young one, suckling all the time, for six months. I then put her in another large cage with an adult male Rhesus, and kept them together for another six months. During the whole of the time they were together they copulated frequently. Both my man and I witnessed this on many occasions. I then kept the female alone for three months. She had the appearance of being pregnant (enlarged abdomen and swollen breasts). At the end of three months she became ill and died. On post-mortem examination there was no sign of pregnancy. The uterus was no larger than that of an ordinary adult Rhesus, and the ovaries, &c., were normal. The post-mortem did not reveal the cause of death.

I cannot say anything about menstruation in the Rhesus during pregnancy or suckling, as I have not been able to make reliable

observations on this point even in the non-pregnant adult female. There is certainly no swelling of the vulva and perinæum such as occurs in the Baboon, and I have never noticed any discharge. As I have already said, the Rhesus often suffers from some inflammatory condition of the large intestine causing a discharge of bloody mucus from the rectum, and this may have been mistaken in some cases for menstrual blood*.

6. Additions to the Herpetology of British East Africa.

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[Received May 10, 1906.]

(Text-figures 96-98.)

Seven years ago I described and figured in these Proceedings† a species of the genus *Lacerta*, belonging to the group of *L. muralis*, discovered by Mr. F. J. Jackson in the Mau Ravine, Uganda. This was a very unexpected discovery, considering the range of the genus; it is now paralleled by Mr. Degen's find, also in Uganda, of a Lizard of the genus *Algiroides*, the known distribution of which was believed to be restricted to Sardinia, Corsica, the East Coast of the Adriatic, and Greece. The collection made in Uganda by Mr. Degen, which has been productive of so many new fishes, has also yielded a new Snake and a new Toad, which are here described.

ALGIROIDES AFRICANUS, sp. n. (Text-fig. 96.)

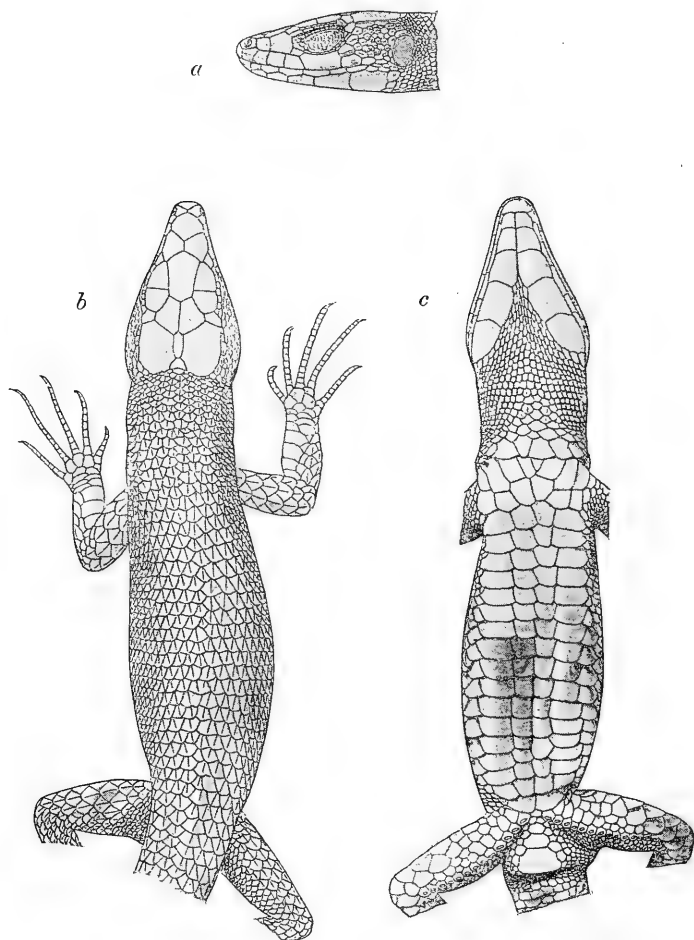
Head strongly depressed; snout rather long, obtusely pointed. Rostral not entering the nostril; a single postnasal; four or five upper labials anterior to the subocular; a series of granules between the supraoculars and the supraciliaries; occipital shorter and a little broader than the interparietal; temple covered with uniform small keeled scales. No gular fold; 19 scales in a line between the third chin-shields and the collar, those in front of the latter enlarged and faintly keeled; collar with serrated edge, composed of 6 plates. Dorsal scales more than twice as large as the laterals, diagonally keeled, obtusely pointed, the strong keels converging towards the median line; 24 scales across the middle of the body; two or three lateral scales correspond to the length of

* [Evacuation of apparently blood-stained faeces appears to be not an uncommon phenomenon in Monkeys. Dr. Mary Gordon, F.Z.S., tells me she has noticed it in a Diana (*Cercopithecus diana*) and a Mozambique Vervet (*C. pygerythrus*), but is not sure that the staining was caused by blood. I have myself been completely deceived by the faeces of a Chimpanzee, which, while in perfect health, passed a stool suggestive of serious intestinal ulceration. I subsequently learnt that she had been fed the previous day upon blood oranges! In any case, whether the staining is sometimes due to blood, as Dr. Steegmann says, and sometimes not, it appears to occur in Monkeys in other respects perfectly healthy and passing normal faeces. This conclusion may be useful to those who keep Monkeys, since it shows that the occurrence of such staining does not necessarily indicate treatment for colitis or enteritis.—R. I. P.]

† 1899, p. 96, pl. x.

a ventral. Ventrals in 6 longitudinal series, median and outer series considerably narrower than the others, and 18 transverse series. Praeanal plate with two small azygous plates in front of it and small scales on the sides. The hind limb reaches between the

Text-fig. 96.

*Algiroides africanus.*

a, side view of head; *b*, upperside, and *c*, underside of body.

collar and the ear; foot once and one-fourth the length of the head. Femoral pores 13-15. Coppery brown above, with a well-defined dark brown lateral band and small dark brown spots on

the back; a light streak from the upper lip to the shoulder, interrupted by the lower border of the tympanum, and continued as a series of round spots on the body; upper surface of tail with dark and light bars; lower parts orange (green in spirit), the throat yellowish.

A single male specimen from Entebbe.

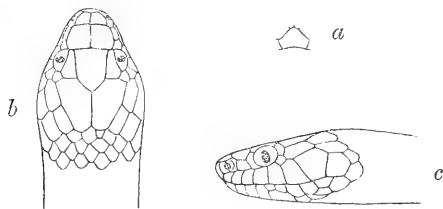
From snout to vent.....	51 millim.
Head.....	14 „
Width of head.....	9 „
From end of snout to fore limb...	20 „
Fore limb.....	22 „
Hind limb.....	30 „

This lizard resembles strikingly *A. nigropunctatus* D. & B., from the East Coast of the Adriatic and the Ionian Islands, differing principally in the scaling of the temple and in the single postnasal shield.

LEPTODIRA DEGENI, sp. n. (Text-fig. 97.)

Rostral small, a little broader than deep, just visible from above; internasals not or but slightly broader than long, much shorter than the præfrontals; frontal once and a half as long as broad, a little longer than its distance from the end of the snout, shorter than the parietals; loreal much longer than deep; one præ- and two postoculars; temporals 1+2; eight upper labials, fourth and fifth or third, fourth, and fifth entering the eye; three

Text-fig. 97.



Leptodira degeni.

a, rostral, *b*, upper, and *c*, side views of head.

pairs of chin-shields, the anterior longer than broad and in contact with five lower labials. Scales smooth, in 19 rows. Ventrals 170-175; anal entire; subcaudals 32-33. Dark brown above, the outer rows of scales lighter, or whitish in the centre; upper lip and lower parts yellowish white, with a brown line along the middle of the tail.

Total length 450 millim.; tail 50.

Two specimens from Entebbe.

Distinguished from *L. hotambœia* Laur. by the narrower rostral, the longer loreal, and the absence of black on the temple.

BUFO VITTATUS, sp. n. (Text-fig. 98.)

Crown without bony ridges; snout short, rounded, with distinct canthus; interorbital space concave, narrower than the upper eyelid; tympanum very distinct, nearly as large as the eye and close to it. Fingers rather pointed, first not extending beyond second; toes one-third webbed, with simple subarticular tubercles; two moderate metatarsal tubercles; no tarsal fold. The tarso-metatarsal articulation reaches the tympanum. Upper

Text-fig. 98.

*Bufo vittatus.*

parts with round or oval warts of unequal size, which are conical on the sides; parotoids narrow, feebly prominent, broken up into warts. Reddish brown above, with six interrupted black longitudinal bands on the back and cross-bands on the limbs; pale brick-red beneath, with large greyish spots.

From snout to vent 37 millim.

A single female specimen from Entebbe.

Near *B. funereus* Bocage. Distinguished by the shorter inner finger and the much larger tympanum.

May 29, 1906.

FREDERICK GILLETT, Esq., Vice-President, in the Chair.

Mr. R. H. Burne, F.Z.S., exhibited, on behalf of Prof. Stewart, some dissections prepared for the Museum of the Royal College of Surgeons from material derived from the Society's Gardens. The specimens included the head of a Ki-wi (*Apteryx mantelli*) in sagittal section, showing the relatively large size of the olfactory parts of the brain and the complexity of the olfactory chamber; the head of a Crowned Crane (*Balearica regulorum*), showing the dilatible pharynx, which by its inflation when the bird crows causes a sudden distension of the gular wattle, and apparently acts as a resonating-chamber; preparations of the cheek-pouches of a Spotted Cavy (*Calogenys paca*) and the stomach of a fœtal Giraffe (*Giraffa camelopardalis antiquorum* ♂ × *G. c. wardi* ♀).

Dr. L. W. Sambon exhibited a series of diagrams illustrating the transmission of diseases by Insects and Ticks.

Prof. Robert T. Jackson exhibited a photograph of the Champley collection of eggs of the Great Auk taken before the collection was dispersed, and made remarks on specimens of the bird that had lately come under his notice. He also exhibited a long-focus lens for museum work and dissections.

The Secretary exhibited the skull of a Wild Boar that had lately been dug up during building operations in James Street, Oxford Street, W.

Mr. R. E. Holding exhibited and made remarks upon the skull and horns of a fine male so-called Wild Irish Goat. He stated that these animals existed in considerable numbers in the mountainous district of the West of Ireland, and were undoubtedly domesticated Goats which had taken to a wild life and had so become to all intents and purposes feral; that they were of wary disposition and sure-footed, and difficult to get a shot at. At times, however, during the breeding-season the males came into the lowlands to the she-goats and so were occasionally shot. The age of the specimen exhibited was probably 7 or 8 years.

Mr. Holding also exhibited the skull of a male domestic Cat, in which the posterior border of the orbit was complete. In the majority of the existing *Felidæ* this portion of the orbit remained open throughout life. There were, however, about four or five existing species, viz. *Felis viverrina*, *F. subrugosa*, *F. planiceps*, in which the orbit was complete; there was also a figure in de Blainville's 'Ostéographie' called *F. longicaudata* in which this condition was also

characteristic. Whether the specimen was a reversion to those existing species which had a complete orbit, or whether it was simply a case of individual variation, it was difficult to ascertain.

Mr. Holding also exhibited a large calculus weighing 5 lb. 6 oz., taken from the descending colon of a Horse, and remarked that calculi were fairly common amongst older horses bred and reared in towns, where there was a preponderance of dry and impure food, and where, as in London, the water was largely impregnated with impurities; the composition of these calculi being usually 50 p. c. ammonio-phos. of magnesium, 20 p. c. of calcic phosphates, with soluble salts and fatty material—as shown in the concentric rings.

The following papers were read:—

1. The Rudd Exploration of South Africa.—V. List of Mammals obtained by Mr. Grant in N.E. Transvaal. By OLDFIELD THOMAS, F.R.S., and HAROLD SCHWANN, F.Z.S.

[Received May 11, 1906.]

After completing the work at Knysna, of which we gave an account in our last paper*, Mr. Grant journeyed by way of Delagoa Bay and Pretoria to the Zoutpansberg District of the Transvaal, a region hitherto practically untouched, so far as the collections in the National Museum are concerned. Indeed, the whole drainage-area of the Limpopo had been remarkably little worked, such few collections as had been sent from within it having been from its northern part in Matabililand or the western in Bechuanaland, the Limpopo part of the Transvaal having been quite neglected.

In this interesting region Mr. Grant has worked with his usual energy and success, and his collection includes 250 specimens belonging to 51 species. This fine series, by Mr. Rudd's generosity, is, as before, added to the treasures of our National Museum.

The localities at which the collection was made were two—Klein Letaba on the low veldt, and Woodbush on the high veldt; and these localities are so distinct from each other both geographically and zoologically, that we have thought it advisable to separate altogether the collections received from them and to write two distinct lists as follows:—

I. KLEIN LETABA.

Klein Letaba is situated in about 23° 21' S. and 30° 40' E., on a branch of the Letaba River, which runs south-eastwards to join the Olifants River, uniting again still further eastwards with the main stream of the Lower Limpopo. It is at an altitude of about 1000 feet to the east of and below the high range of the Drakensberg.

* P. Z. S. 1906, p. 159.

Its mammal fauna proves to be more like that of the high veldt than one would have expected from the difference in altitude, so that we are disappointed to find fewer of the coast and tropical forms than we had hoped, and it is evident that to get the true coast fauna a still lower level must be visited.

Even here, however, several interesting northern forms have been added to the South African list, the most notable being a representative of the Nyasan *Raphicerus sharpei*, an Antelope so strikingly different from any South African species that the tardiness of its discovery is somewhat surprising. Other interesting forms are a new *Helogale* and two new Genets.

Mr. Grant's notes on the Klein Letaba district are as follows:—
“The low veldt, that is the country under the Berg, is mainly undulating grass country with long stony rises and some few kopjes and mountains.

“It is thickly timbered, principally with Mopani (Shinatsi of the Tchangaan); a large, fine-growing tree called Ntuma, which bears a small green fruit; the Marula, on the berries of which *Funisciurus cepapi* feeds and from which the natives make beer; ‘wait-a-bit’ thorns (“Ikaya”); and wild fig and cream-of-tartar trees.

“Water is scarce in the dry season and only to be found in the main rivers that intersect the country, except for some few pools left in the rocks in some of the spruits. The soil is sandy and very fertile in good rainy seasons. The climate is not healthy, and the weather generally very warm. The thermometer frequently records 106° and seldom less than 90° in the shade.

“The natives are a tribe called the Tchangaan, and are an offshoot of the Zulu nation. They have a language of their own, but all understand Zulu and speak it readily. Though very keen on hunting big game, they gave but little assistance in securing small mammals.”

1. *MINIOPTERUS NATALENSIS* Smith.

♀. 1275, 1299, 1300.

As already noted in our Knysna paper, the *Miniopterus* of South Africa generally, apart from the extreme southern coast region, is a brown species, very uniformly coloured, its head quite like its body. The forearms of these examples measure 44, 44·5, and 45 mm.

To this species, of which the type is still in the British Museum, we refer Sundevall's *Vesperugo scotinus*, kept separate by Dobson because of its much smaller size. But in so distinguishing it he only took account of the Madagascar specimens he referred to it, with forearm 38–39 mm., and ignored the fact that Sundevall himself gave the forearm measurement as 44 mm., a size quite similar to that of other examples of *M. natalensis*. One of Sundevall's typical specimens, collected by Wahlberg, is also in the Museum collection.

Of the *Miniopteri* previously sent home by Mr. Grant, those

from Klipfontein, Namaqualand, and Ngoye Hills, Zululand, referred by us on Dobson's authority to *M. schreibersi*, now both prove to be referable to the present species.

"This species, which is not very common, does not appear until it is quite dark."—C. H. B. G.

2. SCOTOPHILUS NIGRITA Schr.

♂. 1272, 1285, 1289, 1311. ♀. 1271, 1293.

These specimens are rather paler than a Zululand skin which may be taken as representing *S. n. dingani* Smith, described from the country "between Natal and Delagoa Bay." Perhaps they will prove to be similar to *S. n. planirostris* Peters, the Zambesi form, of which we have as yet no good specimens available.

"Fairly common, but apparently confined to the low country. Makes its appearance soon after sundown, and is strong and rapid on the wing."—C. H. B. G.

3. NASILIO BRACHYRHYNCHUS Smith.

♂. 1315. ♀. 1224, 1247, 1280, 1309, 1318.

Two of the females were pregnant, with one fœtus each. One of Mr. Darling's specimens from Mazoe, however, "gave birth to two very large young after capture," so that these animals do not always have only one young.

With regard to the generic position of this animal, we are of opinion that it is fully time that the three very distinct groups contained in "*Macroscelides*" should be recognised as genera.

These may be briefly distinguished as follows:—

I. MACROSCELIDES.

Type.

Macroscelides Smith, Zool. Journ. iv. p. 435

(1829) *M. proboscideus*.

Rhinomys Licht. Darst. Säug., text to

pl. xxxviii. (1834) *M. proboscideus*.

A. a. of W. Sclater's synopsis of *Macroscelides* *.

Lower molars two. Bullæ much enlarged.

Macroscelides, as thus restricted, would contain only two species, *M. proboscideus* and *M. melanotis*.

II. ELEPHANTULUS.

Type.

Elephantulus Thos. & Schw. Abst. P. Z. S.

No. 33, p. 10, June 5, 1906..... *E. rupestris*.

A. b. of Sclater's synopsis.

Lower molars two. Bullæ normal, not specially enlarged.

This genus would contain the great mass of the Elephant-Shrews, and its range extend from Algeria (*E. rozeti*) to the Cape.

* Mamm. S. Afr. ii. p. 146 (1901).

III. NASILIO.

Type.

Nasilio THOS. & SCHW. Abstr. P. Z. S.No. 33, p. 10, June 5, 1906..... *N. brachyrhynchus*.

B. of Selater's synopsis.

Lower molars three in number, a small cylindrical m_3 being present behind the large m_1 and m_2 . Bullæ normal.

To this genus there belong the forms described as *brachyrhynchus*, *fuscus*, *schinzi*, and *malosæ*, but the specific or subspecific standing of each of them is as yet by no means settled.

"Tchangaan name 'Madauri.'

"Common and inhabiting all stony places on the flats, hillsides, or mountains. When pursued they take cover under any available object, even the old piping lying on the veldt. They are diurnal only and were not observed in pairs."—C. H. B. G.

4. FELIS OCREATA CAFRA Desm.

♂. 1295.

"Tchangaan name 'Goye.'

"The specimen sent was the only Wild Cat seen at Klein Letaba and was shot while sunning itself in the daytime on the open veldt. It is considered a great delicacy by the natives."—C. H. B. G.

5. GENETTA LETABÆ, sp. n.

♂. 1242.

A Genet of the *G. tigrina* group, but with the tail longer than the head and body, and the skull much constricted and heavily ridged.

Size rather greater than in Cape specimens of *tigrina*, hind feet considerably longer.

Fur comparatively short, rather finer in texture than in *G. ludia* (*infra*), rather coarser than in *G. tigrina*; long hairs about 20 mm. in length, underfur about 15.

General ground-colour of upper surface including flanks rather greyer than "cream-buff"; dorsal crest not so marked as in *G. ludia*, extending from the anterior point of the lumbar region to the root of the tail; spots edged with black, centres varying from dark tawny to chestnut, mostly of oblong shape, about one inch in length, smaller, darker, and rounder on the flanks. Underfur slate-grey. Long hairs of the light ground-colour grey for the basal third, middle third white, distal third black. Under surface of body light buffy, the sternal region marked with a few faint brownish spots, bases of the hair slate-grey. Head considerably darker than ground-colour of body, cheeks smoke-grey; forehead rather darker, tips of hairs tawny. Ears of medium length rounded, darker than in *G. ludia*. Inter-ramia, throat, and chest light yellowish grey, the last speckled with a few light reddish spots; fore limbs coloured like ground-colour of back, not black as in *G. tigrina* or *G. ludia*; posterior surface of hind limbs blackish owing to the dark underfur, remainder of hind limbs and feet coloured like back. Tail

longer than head and body, covered with long fine hair; about ten black rings, alternating with narrower ones, yellowish above, creamy white below, the last two not complete above, leaving a black streak on the upper surface.

Skull of the same general size as in Cape specimens of *G. tigrina*, but more delicately built, more constricted over the frontals, and more heavily crested. Nasals narrow and running to a point posteriorly, their lateral edges not roughly parallel as in *tigrina*; ascending processes of the maxillaries produced considerably behind the posterior limit of the nasals, postorbital constriction elongated; sagittal crest unusually developed, commencing immediately behind the postorbital processes and running the whole length of the brain-case. Teeth as in *G. tigrina*, the third upper premolar with no internal cusp.

Dimensions of the type (measured in the flesh):—Head and body 487 mm.; tail 519; hind foot 90; ear 48.

Skull—greatest length 90 mm.; basal length 83; zygomatic breadth 44; nasals 20×5 ; interorbital breadth 10.5; brain-case breadth 31.8; palatal length 40.5; length of bullæ (including paraoccipital process) 17.1; greatest diameter of p^4 9.4; outer diameter of p^4 8; transverse diameter of m^1 7.5; length of p_4 6.3, of m_1 7.3.

Hab. Klein Letaba.

Type. Male. B.M. no. 5.12.9.15. Original number 1242. Collected 24 July, 1905.

This very interesting species appears to be the Zoutpansberg representative of *G. tigrina*, and is, as might be expected, rather more thickly and coarsely haired. It may be distinguished from that animal by the rufous centres to the spots, by the absence of black on the under surface of the body and on the fore and hind limbs, and by the tail being longer than the head and body. The skull is chiefly remarkable for the very conspicuous constriction of the postorbital region and the greatly developed sagittal crest. It might have been supposed that these skull-characters, varying during life and only present in an advanced state in extreme age, as is certainly the case in most genera, are worthless as specific characters. But it is to be noted that in the British Museum's large series of skulls of *G. tigrina* no other specimen shows these peculiarities to anything like the same extent, although many are obviously older than the type of *G. letaba*, which has its basilar suture still unclosed.

“Tehangaan names ‘Ngauny’ (for the large brown-spotted species) and ‘Tisimba’ (for the smaller dark-spotted species). Both species are apparently uncommon. They frequent the kloofs, river-banks, and open bush veldt, are nocturnal in their habits, and feed principally on beetles.”—C. H. B. G.

6. GENETTA LUDIA, sp. n.

♂. 1276, 1297.

A Genet of the *G. dongolana* type, with black dorsal stripe and small rusty-red spots.

Size considerably larger than in Cape specimens of *G. tigrina*, tail longer than head and body. Fur of medium length, stiff and rather coarse, about 50 mm. long on the median crest, about 30 mm. on flanks.

Ground-colour on back and flanks pale sandy, whiter than cream; dorsal crest strongly marked, jet-black, extending from neck to base of tail; spots tawny, becoming darker on flanks, small, numerous, arranged in five or six rows. Underfur grey basally, pale sandy yellow terminally. Light ground-colour hairs white for their proximal two-thirds, distal third black, occasionally with a faint intermediate tawny ring. Under surface of body rather lighter than cream-buff. Underfur fine, thick, grey (no. 7) basally, sandy terminally. Head sandy grey lighter than body, the long hairs with white tips; infraorbital spot, not defined posteriorly, merging into the grey of the cheeks; ears rounded, covered with short whitish-grey hairs; lips and interramia dark brownish black; throat and chest white with faint yellow suffusion. Upper surface of forearm rather yellower than back, speckled with small black spots; feet yellowish white or buffy; under surface of upper arm smoky grey suffused with creamy white, forearm brownish black, sharply contrasting with it. Hind limbs below the knee jet-black, with the exception of a line of the ordinary ground-colour passing down the front of the limb to the ankle-joint; feet dirty white with a few black hairs interspersed. Tail longer than head and body, thickly covered with long coarse hair, having about ten black rings, broadest towards the tip and narrowest at the base; upper surface of the white rings conspicuously yellow owing to the presence of tawny hairs.

Skull decidedly larger than in *G. tigrina*, more heavily built, the anterior wing of the squamosal more widely curved, postorbital breadth greater, bullæ more noticeably constricted in the middle; third upper premolar with a very well-marked internal cusp.

Dimensions of the type (measured in the flesh):—

Head and body 486 mm.; tail 496; hind foot 99; ear 59.

The corresponding measurements of a *G. tigrina* (B.M. no. 5.5.7.41.) from Knysna are as follows:—

Head and body 443; tail 397; hind foot 81; ear 49.

Skull—greatest length 93 mm.; basal length 85.5; zygomatic breadth 46.4; nasals 18.8 × 7; interorbital breadth 16; brain-case breadth 31.6; palatal length 44; length of bullæ 19.5; greatest diameter of p^4 9.1; outer diameter of p^4 8; transverse diameter of m^1 7.5; length of p_4 6.5; of m_1 7.2.

Hab. Klein Letaba.

Type. ♂. B.M. no. 5.12.9.17. Original number 1276. Collected 5 Aug., 1905.

This species may be distinguished from *G. tigrina* by its very different external proportions and by the whole of the under surface of the body and fore limbs being dark brown or black in *tigrina* and only the forearm black in *G. ludia*.

The close resemblance this species bears to *G. dongolana*,

H. & E., is very remarkable, though it may be easily distinguished by its larger size.

7. *HERPESTES GRACILIS PUNCTULATUS* Gray.

♂. 1307. ♀. 1288.

“Tchangaan name ‘Mungauba.’

“This species is not common. It frequents the open bush veldt and lives in holes or in hollow trees and feeds chiefly on insects.”—C. H. B. G.

8. *HELOGALE BRUNNULA** Thos. & Schw.

Abstr. P. Z. S. No. 33, p. 10, June 5, 1906.

♂. 1218, 1219, 1262, 1263, 1264. ♀. 1229, 1265, 1274.

A brown species, not so black on head and limbs as *H. parvula*. Colour above uniform brown finely ticked with buffy whitish, the general effect between “bistre” and “vandyke brown,” with a certain warmth in the tone not present in *H. parvula*, which more approaches ‘seal-brown.’ This warmth is due to the underfur being broadly dull buffy or clay-colour for its terminal half, while in *H. parvula* it is smoky grey. Under surface not conspicuously different from upper. Head greyer than back, with a slightly olive tone; in *H. parvula*, on the other hand, the head is if anything more blackish than the back. Limbs like body, grizzled and ticked, not darkening terminally to black as in *H. parvula*. Tail of the same general colour, evenly tapering, the terminal pencil inconspicuously blacker.

Skull much as in *H. parvula*, except that the bullæ are decidedly larger and more evenly inflated, the increase being particularly noticeable in their posterior, mastoid portion.

Dimensions of the type (measured in the flesh):—

Head and body 207 mm.; tail 165; hind foot 42; ear 21.

Skull—basal length 44 mm.; greatest breadth 29·3; inter-orbital breadth 8·2; breadth of brain-case 22; palatal length 24; breadth between outer corners of p¹ 16·8; greatest horizontal diameter of p⁴ 5·6; of m² 3·5.

Hab. Klein Letaba, Zoutpansberg District. Alt. 1050’.

Type. Male. B.M. no. 5.12.9.22. Original number 1263. Collected 30 July, 1905.

The eight specimens of this *Helogale* are all precisely similar in colour, and all equally different from a co-type of *H. parvula* in the Museum Collection. Unfortunately the locality of *H. parvula* is not known, though from the general account of Wahlberg’s localities given by Sundevall in his paper on the birds, the present region might have been the “Caffraria superior, juxta tropicum.” However, since the Letaba *Helogale* does not agree

* [The complete account of this new species appears here; but since the name and preliminary diagnosis were published in the ‘Abstract,’ it is distinguished by the name being underlined.—EDITOR.]

with *H. parvula*, the latter must have been obtained further south, perhaps on the Crocodile River.

H. brunnea may readily be distinguished from *H. parvula* by its head being paler instead of darker than the body, by its buffy-tipped underfur, and by its head and feet not darkening terminally.

“Tchangaan name ‘Mashli.’

“Fairly common in the low country. They were observed in parties of from four to eight, and live and take refuge in the deserted ant-heaps. They become commoner towards the Portuguese frontier.”—C. H. B. G.

9. FUNISCIURUS CEPAPI Smith.

♂. 1223, 1228, 1237, 1261, 1281, 1283, 1286, 1287, 1291, 1293, 1302, 1303, 1317. ♀. 1227, 1232, 1244, 1268, 1277, 1282, 1292.

“Shot in tree” is on most of the specimens, so the species is evidently an arboreal one.

“Tchangaan name ‘Mashinyane.’

“Very common on the low veldt, to which it is confined. These Squirrels breed and sleep in a hollow tree, in which they take refuge when pursued. They are easily captured, and form an article of food with the natives.”—C. H. B. G.

10. GRAPHIURUS MURINUS Desm.

♂. 1269.

This example shows strongly the peculiar staining of the chest-hairs, on which Smith's name of *erythrobronchus* was based.

“Tchangaan name ‘Ndabidabi.’

“The specimen sent was found asleep in the woodwork of an outbuilding and was very fat. This species is not easy to obtain as it hibernates during the winter.”—C. H. B. G.

11. TATERA BRANTSII Smith.

♂ ♀. 1305.

“Tchangaan name ‘Masingaan.’

“Common and gregarious in habits. Forms burrows in sandy places but never of any great size.”—C. H. B. G.

12. TATERA MILIARIA SALSA Wrought.

♂. 1255. ♀. 1233, 1301.

13. ARVICANTHIS DORSALIS Smith.

♂. 1260, 1284, 1312. ♀. 1241, 1290, 1316.

“Tchangaan name ‘Matsutsa.’

“This species is fairly common on the low veldt, where it apparently replaces *A. pumilio*, to which its habits are similar. It frequents the grassy flats and thick undergrowth in the kloofs. Diurnal only and a vegetarian.”—C. H. B. G.

14. *STEATOMYS PRATENSIS* Peters.

♂. 1217, 1238, 1254, 1270. ♀. 1221, 1222, 1230, 1239, 1248, 1252.

Specimen 1270, a male, is immensely larger than any of the other individuals of the series, but it is very old, its teeth being quite worn down. Its skull is 26.5 mm. in total length, thus equalling the typical skull of *S. bocagei*, but the latter belonged to a much younger individual. The two equally old female skulls measure 25 mm. in length.

“Tchangaan name ‘Ntenyane.’

“Common and confined to the low country. They sleep throughout the winter, roughly from April to October, in a grass nest at the end of their burrow. All the specimens were dug out and were excessively fat and unable to move fast. The natives, who consider them a great delicacy, say they cannot find them in the summer, and firmly believe they turn into bats.”—C. H. B. G.

15. *MUS CHRYSOPHILUS* de Wint.

♂. 1245, 1267, 1304. ♀. 1256.

“Tchangaan name ‘Magundane.’

“Common everywhere, especially so in the undergrowth in kloofs and in outbuildings. Nocturnal only.”—C. H. B. G.

16. *MUS COUCHA* Smith.

♂. 1220, 1225, 1226, 1237, 1250, 1306. ♀. 1234.

“Tchangaan names ‘Mkundlo’ or ‘Magundane’ (a rat). Very common.”—C. H. B. G.

17. *LEPUS ZULUENSIS* Thos. & Schw.

♂. 1266. ♀. 1294, 1313.

In our paper dealing with the mammals obtained by Mr. Grant in Zululand a Hare, belonging to the *saxatilis*-group, was described as a new subspecies under the name of *Lepus saxatilis zuluensis**. On the receipt of the material with which the present paper deals a careful examination of the whole group was undertaken, and we are led to the conclusion that no intergrading takes place between the large-eared Hare, *Lepus saxatilis*, and its eastern representative. We therefore consider the small-eared one to be worthy of specific rank.

“Tchangaan name ‘Nfundla.’

“This species is fairly common in stony places and on the sandy flats, especially round old mealie-patches. They move about only at night and spend the day under a bush or in the long grass.”—C. H. B. G.

18. *RAPHICERUS SHARPEI COLONICUS*, subsp. n.

♂. 1278, 1279.

Similar in all essential characters to the true *sharpei* of Nyasa,

* P. Z. S. 1905, i. p. 270.

but the feet decidedly longer, though both the specimens are immature. In three fully adult specimens of *sharpei* the hind feet, including hoofs, measure 196–198 mm., while in the two Letaba individuals, which still retain their milk-dentition, this dimension is 208 and 215 mm.

General colour slightly richer and more purplish than in true *sharpei*, the intermixed white hairs more numerous. Throat, chest, and belly purplish buff, the line of demarcation on sides of belly little marked; in *sharpei* the under surface is white or whitish with but little tinge of buffy.

Skull much as in *sharpei*, but the bullæ appear to be slightly larger.

Dimensions of the type, taken in flesh:—

Head and body 722 mm.; tail 76; hind foot, without hoof 195; ear 89.

Skull—greatest length 126 mm.; basal length 112; greatest breadth 64; nasals 35 and 15; muzzle to orbit 59; muzzle to front of mp² 30.

Horns, length 38 mm.; diameter at base 12.

Type. Immature male. B.M. no. 5.12.9.81. Original number 1279. Collected 10 August, 1905.

“Shot on grass-covered hillside, dotted with trees.”—C. H. B. G.

The discovery of the peculiar Nyasan Steinbuck *Raphicerus sharpei* south of the Zambezi makes an important addition to the known fauna of S. Africa. Possibly it has been obtained before, but sportsmen might easily have confounded it with the Grysbok, which it resembles by its hoary-mixed coat, though its short horns, even when adult, and the absence of supplementary hoofs, show that it is really quite distinct from that animal.

The British Museum owes to the kindness of Col. Manning several specimens of *R. sharpei* from Mpimbi, Nyasa, and these, though fully adult, are so uniformly smaller than the two obtained by Mr. Grant, that we think it advisable to give a subspecific name to the Transvaal form.

19. *RAPHICERUS NEUMANNI CAPRICORNIS*, subsp. n.

♂. 1258. ♀. 1314.

Similar to the East African Steinbuck in all respects, except that the bullæ are very markedly larger, and the nasals are rather smaller and narrower.

Dimensions of the type, measured in the flesh:—

Head and body 814 mm.; tail 65; hind foot 236; ear 102. Fore-hoofs, length anteriorly 26.5, transverse breadth 19.

Skull—greatest length 147 mm.; basal length 128; zygomatic breadth 72.5; nasals 43 × 17; muzzle to orbit 71; muzzle to anterior premolar 36; palatal length 74; length of upper molar series (alveoli) 45; bullæ, greatest diameter on inflated part 24.5, height below level of glenoid surface 20, greatest breadth between inflated parts of opposite sides 49.5.

Horns, length 92 mm.; diameter at base 13·5.

Type. Adult male. B.M. no. 5.12.9.78. Original number 1250. Collected 27 July, 1905.

On a comparison of the numerous beautiful specimens of *Raphicerus* obtained during the Rudd exploration with such East African examples as are available, we find that the latter are readily distinguishable from the Cape forms by their paler general colour and by the greater extent of their white facial markings. Their eyes are completely ringed with white, their lips are white, the edges of the ears are more broadly whitened, and there is a considerable increase in the extent and brightness of the white chin, throat, and limb-markings. Their skulls are rather larger.

In all these respects the Letaba Steinbucks absolutely agree with the East African specimens, and differ from the Cape ones, not being in any way intermediate; and we therefore think we should recognize *neumannii* as a distinct species, and consider the Transvaal form of it—characterized by its very large bullæ—as a special subspecies.

The dark coronal horseshoe-mark is absent in the male, slight in the female.

20. CEPHALOPHUS GRIMMII L.

♀. 1259, 1300.

“Tchangaan name ‘Munti.’

“Very common everywhere, especially in long grass and patches of bush. They vary a great deal in colour and size.”—C. H. B. G.

21. CERVICAPRA ARUNDINUM Bodd.

♂. 1296, 1298.

“Tchangaan name ‘Mhlangu.’

“Fairly common, observed singly or in pairs, occasionally even three together. This species feeds during the night and drinks at sundown and between dawn and sunrise.”—C. H. B. G.

II. WOODBUSH.

Woodbush lies on the slopes of the Drakensberg Range, about 30 miles to the north-east of Pietersburg, at an altitude of about 4500 feet. Its fauna is therefore that of the high veldt in general, and the collection gives us valuable information as to the north-eastern range of the high-veldt animals. New forms are less numerous than in the Letaba collection, but we have found occasion to describe a new Elephant-Shrew and a new *Crocidura*, while several rarities, notably *Myosorex tenuis* and *Cynictis selousi*, are added to our series.

Mr. Grant has sent us the following notes on the Woodbush District and the High Veldt:—

“The high open veldt which extends round Pietersburg for

many miles consists of grass-covered flats and undulating country dotted with kopjes and long stony ridges, with here and there patches of cactus and thorn trees. Euphorbias (Naboom) and milk-bush are common in the kopjes, though water is by no means plentiful. When the country is dry and grass is scarce, the country is very 'karoo'-like and most monotonous to travel over.

"The Woodbush Hills are part of the northern spurs of the Drakensberg, and very similar to the high veldt of Zululand both in vegetation and climate.

"Woodbush village lies in the hills of the same name, but at a rather lower elevation than the hills proper. It is surrounded by rocky country fairly well timbered, but not nearly so thickly as the 'bush-veldt.' The vegetation consists chiefly of mimosa-thorn (Acacia), large specimens of Euphorbias, fig-trees (Moga) along the streams, and Ntuma trees on the warmer sides of the large kloofs.

"The natives throughout the high veldt are Basuto, and, except in a few instances, gave no assistance in collecting specimens."

22. CERCOPITHECUS ALBIGULARIS Sykes.

♀. 1340.

This is the second record of this East African species in South Africa proper. Sclater* mentions the capture of the first specimen at Umtali in Mashonaland.

"Basuto name 'Duru.'

"Common, but difficult to obtain on account of its wariness. This species inhabits the deep kloofs in the depths of the forests, seldom visiting the open parts."—C. H. B. G.

23. ELEPHANTULUS RUPESTRIS MYURUS, subsp. n.

♀. 1137.

Similar to the typical *rupestris* from Namaqualand in general colour and proportions, but with a much more closely-haired and untufted tail.

Fur soft and silky, about 10 mm. in length on middle of back. General colour of upper surface between drab and fawn-colour, passing into yellowish drab on flanks; under surface pure white, bases of hairs blackish slate. Eyes not so conspicuously ringed with white as in the typical subspecies, the white line partially interrupted posteriorly. Ears of medium length, light drab externally, not rufous-brown as in *rupestris*, and with no rufous hairs internally, only white. Nuchal region light rufous in colour, not so markedly so as in the typical Namaqualand race. Upper surface of hands and feet pure white. Tail long, closely covered with minute hairs, reddish brown above, white below, not tufted at the tip.

Dimensions of the type (measured in the flesh):—

Head and body 127 mm.; tail 154; hind foot 34; ear 26.

* Mammals of South Africa, vol. i. p. 12 (1900).

Skull (damaged)—nasals, length 15; length of upper tooth-row 20·2, of lower tooth-row 18·8.

Hab. Woodbush, North-eastern Transvaal.

Type. Female. B.M. no. 6.4.3.2. Original number 1137. Collected 17 May, 1905.

This subspecies can be easily distinguished from the typical one by its much lighter-coloured tail and by the absence of a tuft.

“Basuto name ‘Umsiti.’

“This species is undoubtedly very rare on the high veldt.”—C. H. B. G.

24. *CROCIDURA ARGENTATA* Sund.

♂. 1186.

“Basuto name ‘Mezitiri.’

“This species was not observed in the low country, and the specimen sent home was the only one seen.”—C. H. B. G.

25. *CROCIDURA SYLVIA*, sp. n.

♂. 1114, 1134, 1143, 1148, 1153, 1156, 1199, 1200, 1210.
♀. 1203, 1352.

A dark-coloured Shrew, probably allied to *C. fumosa* Thos., but with a less hairy tail and narrower skull.

Fur long and velvety, about 6 mm. in length on the middle of back. General colour of upper surface between “seal-brown” and “clove-brown,” darker on the rump. Under surface paler and browner. Hands and feet brown. Tail more than half the length of head and body, not incassated; bristle-hairs present only at the base, much fewer than in *fumosa*; dark brown, almost black, above and below.

Skull finer, narrower, and more slenderly built than in *fumosa*, but *i*¹ stronger and larger.

Dimensions of the type (measured in the flesh):—

Head and body 81 mm.; tail 43; hind foot 15; ear 8·5.

Skull—condylo-incisive length 21·5 mm.; basal length 19·5; greatest breadth 9·0; length of upper tooth-row 9·0; *i*¹ to *p*¹ 4·8.

Hab. Woodbush, Zoutpansberg District. Alt. 4500 ft.

Type. Male. B.M. no. 6.4.3.10. Original number 1200. Collected 14 June, 1905.

This species may be distinguished from any other South-African *Crocidura* by its very dark colour and the scarcity of the bristle-hairs on the tail—characters that might lead to its confusion with *Myosorex sclateri* unless a comparison of the skulls were made.

“Very common on the high veldt, not observed in the low country. Inhabits vleis and thick grass by the river-banks.”—C. H. B. G.

26. *CROCIDURA* sp.

♂. 1147.

27. MYOSOREX TENUIS Thos. & Schw.

♂. 1109, 1113, 1121, 1126, 1140, 1144, 1149, 1157, 1158, 1160, 1209, 1327, 1329, 1330, 1336. ♀. 1110, 1325, 1326.

The present series was obtained in the Woodbush Hills at a height of 4900 feet, and the single specimen on which the species was founded was caught by Mr. Grant at Zuurbron in the Wakkerstroom District of the Transvaal at an altitude of 4600 feet. It is therefore probable that *tenuis* is the high-veldt representative of *M. varius*, to which it is certainly more allied than to *M. sclateri*, the latter differing from it very considerably in external measurements and skull-characters. Its only point of agreement with *sclateri* is in its general colour, and not, as we stated in the second account of Mr. Rudd's exploration of South Africa*, in the length of its tail. Although the difference between the types of *sclateri* and *tenuis* in this measurement is only 8 mm., extreme specimens show a difference of nearly twice this, and the average may be considered as about 12 mm.

"Very common on the kopjes, cultivated lands, and the vegetation on the banks of streams."—C. H. B. G.

28. GENETTA LETABÆ Thos. & Schw.

♂. 1159, 1177.

These specimens are practically identical with the type of this species described in the first part of the paper. No. 1177 is young and naturally proportionately smaller, and both specimens have slightly redder spots, but the difference is so slight as to be negligible.

"Basuto name 'Chipa.'

"Rather uncommon. Inhabits the kopjes and bush-covered hillsides. Nocturnal only."—C. H. B. G.

29. HERPESTES GALERA Erxl.

♀. 1139, 1142, 1155.

"Basuto name 'Muliza.'

"Uncommon. Inhabiting vleis and thick reed-beds by the rivers. Apparently feeds on tadpoles, frogs, crabs, &c. Nocturnal only."—C. H. B. G.

30. HERPESTES GRACILIS PUNCTULATUS Gray.

♂. 1173, 1198, 1212, 1356, 1357. ♀. 1125, 1130, 1138, 1346.

"Basuto name 'Kanu.'

"This species was observed in the forest on the Woodbush hills, though it is common everywhere, especially by the rivers. Its food consists principally of insects."—C. H. B. G.

31. CYNICTIS SELOUSI de Wint.

♂. 1178. ♀ 1361.

The only specimens of this remarkable species hitherto received

* P. Z. S. 1905, i. p. 132.

are the skull obtained by Mr. Selous, on which the species was founded, and an example collected by Mr. P. C. Reid at Linyati, and figured in our 'Proceedings'*

"Basuto name 'Manhauta.'

"Rare everywhere. Nocturnal only."—C. H. B. G.

32. *CANIS MESOMELAS* Ehrenb.

♀. 1348.

"Basuto name 'Pugure.'

"Not uncommon, but seldom seen and very difficult to trap. A considerable source of annoyance to the farmers, who persecute them at all times and seasons."—C. H. B. G.

33. *ICTONYX CAPENSIS* Kaup.

♂. 1193.

"Basuto name 'Kopani.'

"Not uncommon, frequenting the kopjes and open country at night in search of food."—C. H. B. G.

34. *TATERA BRANTSII* Smith.

♀. 1171, 1196.

"Basuto name 'Leboka'."—C. H. B. G.

35. *TATERA MILLIARIA SALSIA* Wrought.

♂. 1172, 1175, 1176, 1187, 1188, 1211. ♀. 1164.

This is the series on which Mr. Wroughton founded the subspecies †.

36. *OTOMYS IRRORATUS* Bts.

♂. 1131, 1132, 1158. ♀. 1133, 1134, 1135.

These specimens approximate in colour to the *Otomys laminatus* described by us in an earlier paper on Mr. Rudd's mammals, though their laminal formula shows them to be true *irroratus*.

"Basuto names 'Beba' and 'Ibuka.'

"In the Woodbush hills they were found on the steep grass-covered hillsides some considerable distance from water."—C. H. B. G.

37. *DENDROMYS MESOMELAS* Bts.

♂. 1338.

This specimen has the black dorsal stripe less prominent than appears to be usual.

38. *MUS CHRYSOPHILUS* de Wint.

♂. 1181, 1191. ♀. 1124, 1128, 1154, 1165, 1169, 1205, 1208, 1339.

"Basuto name 'Lohauto' (a rat).

"Common everywhere, especially in the cultivated lands."—C. H. B. G.

* P. Z. S. 1901, i, p. 2, pl. i.

† Ann. Mag. N. H. (7) xvii. p. 485 (1906).

39. *MUS COUCHA* Smith.

♂. 1116, 1131, 1204, 1319. ♀. 1111, 1112, 1127, 1132, 1179, 1207, 1323, 1349, 1350.

Specimens nos. 1204, 1111, and 1127 are slightly lighter in colour than the remainder of the series, which is otherwise very uniform. No. 1127 shows the multimammate character very clearly, which is the only character that in many cases serves to distinguish the members of this very difficult group from *Mus colonus* Bts.

40. *MUS DOLICHURUS* Smuts.

♀. No number.

41. *ARVICANTHIS PUMILIO DILECTUS* de Wint.

♂. 1115, 1117, 1135, 1150. ♀. 1118, 1122, 1123, 1146.

"Basuto name 'Dari.'

"Common on the high veldt, but not observed in the low country. Diurnal only."—C. H. B. G.

42. *DASYMYS INCOMTUS* Sund.

♀. 1353.

"Basuto names 'Beba' and 'Ibuka.'

"Apparently very rare, as the specimen sent was the only one seen."—C. H. B. G.

43. *SACCOSTOMUS CAMPESTRIS* Pet.

♂. 1337.

"Basuto name 'Lohauto.'

"Rather rare and apparently confined to the high veldt. The pouches contained seeds of various plants."—C. H. B. G.

44. *GEORYCHUS* sp.

♂. 1163, 1170, 1185, 1189, 1201, 1202, 1321, 1324. ♀. 1161, 1322.

Until this group has been monographed we are not prepared to commit ourselves to an exact specific determination.

"Basuto name 'Puga.'

"Common, especially in cultivated lands, where it forms runs. In the low country the scarcity of rain during my stay prevented their working, and so none were trapped."—C. H. B. G.

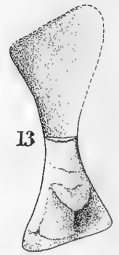
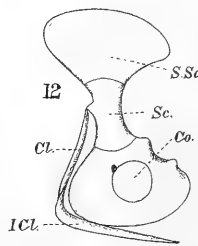
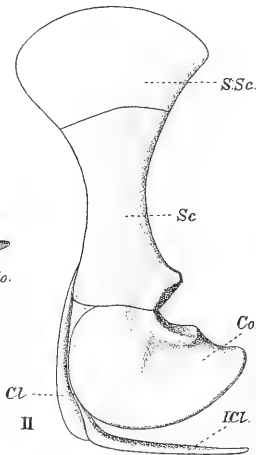
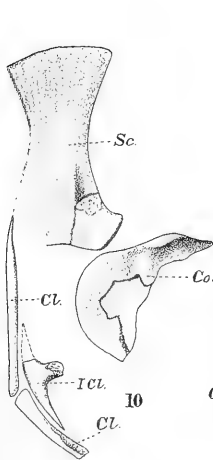
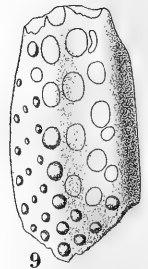
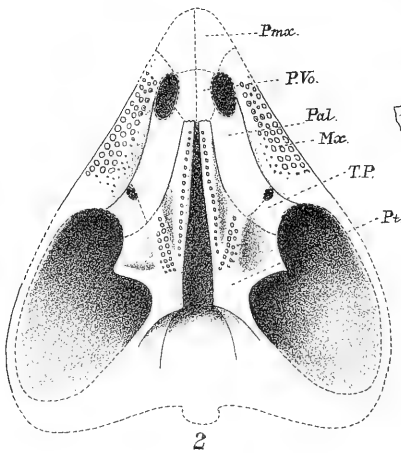
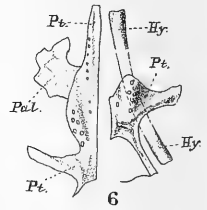
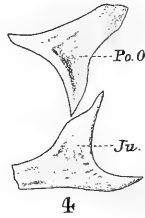
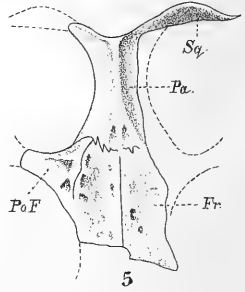
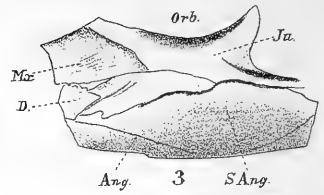
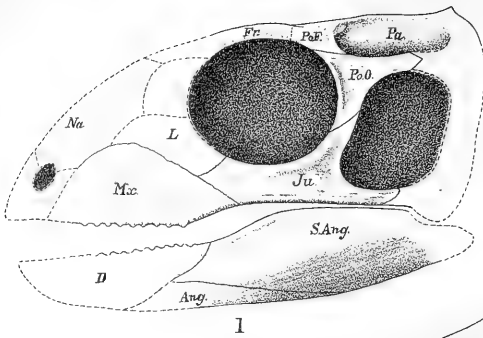
45. *PEDETES CAFER* Pall.

♂. 1347. ♀. 1345, 1360.

"Basuto name 'Sidula.' Tchangaan name 'Jengwy.'

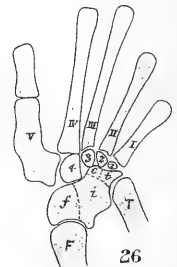
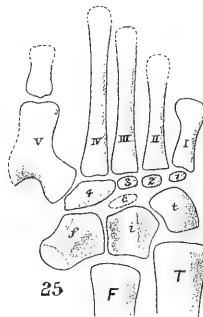
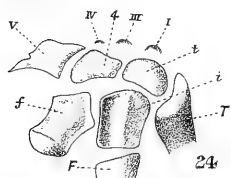
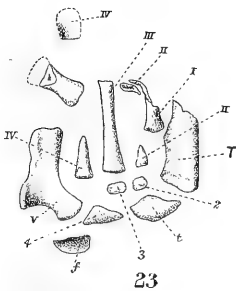
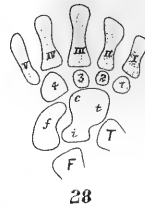
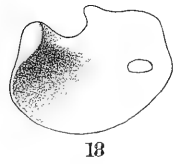
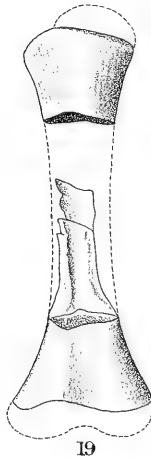
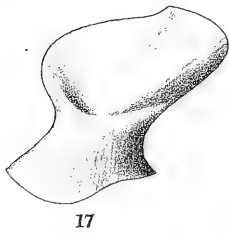
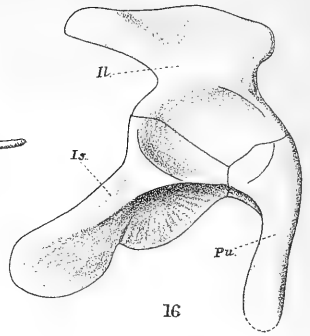
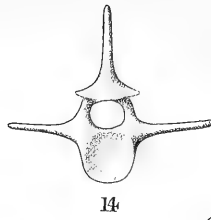
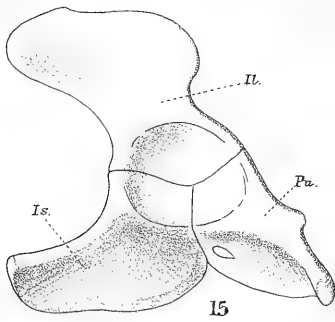
"Fairly common on the high veldt. The natives reported them to be in the low country, and though I found some of their holes at Klein Letaba, none were recent. They do great damage to the mealies."—C. H. B. G.





R. Broom del.

M. P. Parker lith.
Parker & West imp.



R. Brocm del.

HOWESIA BROWNI.

M P. Parker lith.
Parker & West imp.

46. *LEPUS ZULUENSIS* Thos. & Schw.

♂. 1151, 1166, 1174, 1355. ♀. 1152, 1180, 1206, 1213.

"Basuto name 'Muda.'

"Very common in all stony places. It is not found on the flat open country round Pietersburg, where it is replaced by *Lepus ochropus*."—C. H. B. G.47. *LEPUS OCHROPUS* Wagn.

♀. 1215. Pietersburg.

"Common, but confined to the high veldt round Pietersburg."—C. H. B. G.

48. *PRONOLAGUS CRASSICAUDATUS* Geoff.

♂ juv. 1328.

"Curiously uncommon, considering the great stretches of country suited to its habits. I only observed two of these Hares during my stay here."—C. H. B. G.

49. *PROCAVIA CAPENSIS* Pall.

♂. 1182. ♀. 1194, 1344.

"Basuto name 'Imbile.'

"Not nearly so common as *P. brucei*, with which it inhabits the same kopjes and kranztes. Diurnal only."—C. H. B. G.50. *PROCAVIA BRUCEI* Gray.

♂. 1133, 1342. ♀. 1184, 1193, 1354, 1359.

"Basuto name 'Imbile.'

"This species is much commoner than *P. capensis*, but is much more difficult to secure, being more wary."—C. H. B. G.51. *CEPHALOPHUS GRIMMII* L.

♂. 1214. ♀. 1129, 1167, 1341, 1351.

"Basuto name 'Imputi.'

"Common at Woodbush, but scarcer on the flats round Pietersburg. It feeds during the night and spends the day lying on the kopjes".—C. H. B. G.

2. On the South African Diaptosaurian Reptile *Howesia*.
By R. BROOM, M.D., D.Sc., C.M.Z.S., Victoria College,
Stellenbosch.

[Received May 15, 1906.]

(Plates XL. & XLI.*)

About a year ago I published in the Records of the Albany Museum † a preliminary notice of a very interesting small

* For explanation of the Plates, see p. 600.

† "Preliminary Notice of some new Fossil Reptiles collected by Mr. Alfred Brown at Aliwal North, S. Africa." Rec. Alb. Mus. Grahamstown, vol. i. pt. iv. p. 269 (1905).

fossil reptile, remains of which had been discovered by Mr. Alfred Brown near Aliwal North. As the animal somewhat resembles *Sphenodon* in size and general appearance and is evidently a Rhynchocephaloid reptile, I thought it befitting to name the genus *Howesia*, in honour of the late Prof. G. B. Howes, who has done such brilliant work on the osteology of *Sphenodon*, and whose early death has left such a serious gap in the ranks of morphologists.

In Mr. Brown's collection there are three specimens which I regard as belonging to *Howesia*. Specimen A, which I take as the type, is a very badly crushed and imperfect skull. The middle parts of both mandibles are preserved, including portions of both dentaries, the right jugal, much of both maxillaries, a large part of both pterygoids, parts of the hyoid, and a few other crushed and fragmentary bones. Specimen B, which there is little doubt belongs to the same genus and species, consists of a number of bones of the skull, crushed and much displaced, parts of most of the cervical vertebræ, the left shoulder-girdle and the left humerus. Among the cranial bones the following can be identified with some degree of certainty—frontals, parietals, postfrontal, postorbital, squamosal, jugal, maxillary, and pterygoid. Specimen C consists of the pelvis, most of the bones of the hind limbs including the tarsus, and a considerable number of caudal vertebræ of a Rhynchocephaloid reptile which may provisionally be regarded as belonging to the same genus and species as specimens A and B. In the absence of head there is of course an element of doubt, but as all the specimens are from the same horizon, and as the pelvis in specimen C is such as we should expect to find in *Howesia* from the size and characters of the skull and shoulder-girdle, I shall assume that it belongs to the same species as the others.

Skull.

Though both specimens of the skull are in a very unsatisfactory condition, it is nevertheless possible to make out most of the principal points in the cranial anatomy. In the main the skull resembles fairly closely that of *Sphenodon*, though there is a marked difference in the dentition. At the time the preliminary note was written I was unable to determine with certainty whether the rows of *Hyperodapedon*-like teeth were borne by the maxilla or by the palatine or by both. As the result of the further development of specimen A, it would appear that the teeth are on the maxilla, and on the maxilla only.

The maxilla is shaped as in the better known Diaptosaurian reptiles *Procolophon* and *Palæohatteria*. The facial portion is flat and triangular, and probably about 25 mm. in length and 12 mm. in depth. The inferior or tooth-bearing portion is thick and rounded. In specimen A one of the maxillæ measures 5 mm. in thickness; in specimen B a maxillary fragment is 5.5 mm. in thickness. In front the tooth-bearing portion is considerably thinner—at least as thin as 3 mm. In the middle portion of the maxilla there are three rows of obtusely pointed teeth, but

perhaps in front there may be only one or two rows. Behind, there are four rows of similar-sized obtusely pointed teeth, and on the inner side of the bone three additional rows of more minute teeth, which apparently do not meet the dentary and are unworn. The teeth seem to have a thin layer of enamel and to be implanted in the bone rather than ankylosed to it. When the jaw is worn, the teeth and bone together form a grinding-surface. The exact relations of the teeth to the jaw could be certainly determined only by sectioning one of the fragments, and this I do not feel at liberty to do.

A large part of the jugal is preserved in specimen B, and in specimen A the cast of almost the whole bone. It forms practically the whole of the lower border of the orbit. In its relations to the maxilla, to the postorbital, and to the quadrato-jugal it is almost identical with that in *Palæohatteria*. There is clear evidence of a lower temporal fossa bounded below by the posterior process of the jugal. Pl. XL. fig. 3 represents the cast of the jugal in specimen A and fig. 4 part of the jugal in specimen B.

The postorbital bone is preserved in perfect condition in specimen B. It is triangular, and strikingly like the corresponding bone in *Sphenodon*. It divides the upper from the lower temporal fossa and, in part, both from the orbit. It is represented in fig. 4.

The postfrontal is preserved in specimen B. It is a small triangular bone not unlike that of *Sphenodon*. It articulates by a long suture with the frontal and by a short one with the parietal. It is shown in fig. 5.

The frontals are broad and rather flat. They form only a short part of the supraorbital margins between the prefrontals and the postfrontals. The whole of the supraorbital ridge is slightly elevated, owing to there being a depression along the frontal bone and on to the postfrontal. On the whole of the upper surface of these bones, but chiefly in the depression, are a number of shallow pits, which suggest the possibility of their having lodged glands in connection with the skin. The narrowest part of the interorbital region measures 10.5 mm., and the greatest measurement across the frontals is 14 mm.

The parietals are well preserved in specimen B. They are ankylosed, and like those of *Sphenodon* form, in their posterior two-thirds, a low median ridge. In the anterior third this median ridge divides into two feeble ridges, which pass forwards and outwards and end at the suture between the parietal and the frontal. To the naked eye there appears to be no parietal foramen, but when the bone is examined microscopically there is seen to be a small median foramen about as large as a pin-point. I think there can be little doubt that this is a rudimentary parietal foramen. It measures about .5 mm. in greatest length. Posteriorly the parietals pass outwards to meet the squamosals as in *Sphenodon*.

Though portions of the squamosal and probably quadrato-jugal, exoccipitals, and a few other bones are present, they are either too

imperfect or insufficiently displayed, or the determination too uncertain to warrant description.

A portion of the nasal preserved shows that the bone was of considerable size, as in *Paleohatteria*.

In specimen A a number of bones of the palate are preserved. Though these are imperfect, yet as the pterygoids are fairly complete it is possible to make an approximate restoration of the palate.

The pterygoids are of the triradiate type found in most early reptiles, such as *Dimetrodon*, *Proterosuchus*, *Procolophon*, &c., and, as in these genera, are dentigerous. The anterior process is long and narrow, and along apparently its whole length is a single row of small teeth, which must lie almost parallel with the corresponding row on the pterygoid of the opposite side. The posterior half of the anterior process is about twice as broad as the anterior, and on it is a second dental ridge with at least two rows of fairly well-developed teeth passing forwards and slightly outwards from near the back end of the inner dental ridge. The anterior ridge articulates by much of its outer side with the palatine. From the posterior part of the toothed portion of the bone the median process passes outwards and slightly forwards. It appears to be devoid of teeth. From about the same point the posterior process is sent backwards and outwards, doubtless to meet the quadrate. This process is broad, fan-shaped, and concave, and recalls rather forcibly the posterior process of the pterygoid in *Procolophon* and *Dimetrodon*.

The palatine is very imperfect, but it appears to be moderately flat and devoid of teeth.

A considerable portion of each mandible is preserved, but not in a very satisfactory condition. The dentary carries four rows of small obtusely pointed teeth almost exactly similar to those of the maxilla. Unfortunately, only the back part of one dentary is preserved, and the cast of the back part of the other. The preserved portion is 4 mm. wide. The post-dentary portion of the jaw has a swollen appearance, recalling that of *Procolophon*, but it is much larger in *Howesia*. The bone which forms the greater part of the outer side I believe to be the surangular. In situation it quite agrees with the supposed surangular in *Procolophon*, but in the latter genus it is much smaller. In *Proterosuchus* the surangular is also of very large size. There appears to be a small but distinct coronoid bone. The angular seems to form nearly the whole of the lower border of the posterior two-thirds of the jaw. In the middle of the jaw there is a very large cavity as in *Procolophon*.

Lying on the pterygoids were two long, rounded, slightly curved rods of bone at least 22 mm. in length. These are probably hyoid bones.

Vertebrae.

Though portions of many cervical and caudal vertebrae are preserved as well as parts of a few others, they are for the most part not

sufficiently well displayed or preserved to permit of a satisfactory examination. The cervical vertebræ are about seven in number, and from the position of the shoulder-girdle we may infer that *Howesia* had a neck of about the same length as the skull. The axis has a large spine almost of mammalian type. Of the other cervical vertebræ, only the zygapophyses are displayed. There are no dorsal or lumbar vertebræ preserved. There appear to have been two sacral vertebræ, as in *Erythrosuchus*. Twelve caudal vertebræ are preserved, but not well displayed. The first of these is probably the 3rd caudal. It has well-developed transverse processes and spine. Across the transverse processes it measures 26 mm., and the total height of the vertebra as preserved is 24 mm. There is probably not much of the spine missing. The body is much constricted, as in Phytosaurs, Pelycosaurs, and most primitive reptiles, and appears to be amphiplatyan or amphiœlian. It is certainly not distinctly notochordal. A well-developed intercentrum lies between this vertebra and the next. The second preserved vertebra (probably 4th) has a small chevron, and the succeeding vertebræ have very long double-headed chevrons. In the case of the supposed 5th caudal, the chevron as preserved is 24 mm. long, and in the 6th it is probably even longer. Except in being slightly smaller, the posterior caudals are very similar to the anterior; they have the same slender transverse processes and similar long chevrons.

Shoulder-girdle.

Though the shoulder-girdle is rather badly preserved, sufficient remains to show all the principal features. The scapula is comparatively short and moderately flat. Its greatest length is 29 mm. The upper end is 16 mm. wide, and has evidently supported a large cartilaginous suprascapula. The posterior border curves gently and uniformly to the glenoid cavity. The anterior border is badly preserved, there being only indications of the cast. In fig. 10 (Pl. XL.) a view is given of the shoulder-girdle as preserved, and in fig. 11 a restoration of the whole girdle. The lower end of the scapula is probably 14 mm. wide, and there is no evidence of any notch. The coracoid is very imperfect, but the whole of the anterior half and the glenoid portion are preserved. It has evidently been a large flat rounded bone. There is no coracoid foramen seen in the specimen so far as preserved. Perhaps the foramen was in the cartilage at the anterior and upper corner of the bone. There is no precoracoid. The interclavicle is a slender T-shaped bone, but only a part of the upper end is preserved. The clavicles are long, fairly straight bones which meet each other above the interclavicle. The length of the one which is fully preserved is 23 mm.

Humerus.

The humerus is in bad preservation, the upper half being represented only by a much weathered impression. The length

of the bone is about 34 mm. Both the upper and lower ends are broad, and they make with each other an angle of about 60° . The delto-pectoral ridge is fairly well developed, but the imperfect impression does not show very clearly its relations to the shaft. There is apparently no epicondylar foramen. The lower end of the bone measures about 10 mm. It has evidently been capped by a large pad of cartilage.

Pelvis.

The remains in specimen C are much better preserved than in either A or B. All the pelvic bones are preserved and in almost true apposition. The under and outer sides of both pubes and ischia have been displayed, and the inner side of the right ilium.

The pelvis is a slightly modified variety of the well-known plate-like type found in all primitive Diaptosaurian reptiles. The ilium is broad and flat, and its axis is directed upwards and backwards from the acetabulum. It is presumed that the acetabulum is of large size from the shape of the lower part of the ilium, and probably it had a thick coating of cartilage. The acetabular portion of the ilium measures 19 mm. across. Above the acetabulum the bone becomes constricted and measures only 12 mm. across. From this point the upper part forms a fan-like expansion, which measures 25.5 mm. from front to back. The greatest length of the ilium is 34 mm., and the least, measuring from the surface for articulation with the ischium to the anterior part of the crest, 22 mm. On the inner side of the ilium is a hollow depression just above the constricted portion, with a second slight depression behind it and separated from it by a low ridge. These depressions are for articulation with the two sacral ribs.

The ischium is a flat semicircular bone not unlike the flat bone in *Procolophon* or *Stereosternum*. Though the acetabular portion is not displayed in *Howesia*, it is probably of much larger size than in these other genera. It seems probable that the ischium sloped downwards and inwards at an angle of about 45° . The whole margin of the bone has manifestly been bordered by cartilage except the margin which is directed upwards. The lower margin for about 17 mm. is fairly straight, and forms, with the bone of the opposite side, a symphysis with probably comparatively little cartilage between. Anteriorly there is another fairly straight margin of 10 mm., which served as an articulation with the pubis, probably again with but little cartilage between the bones. Between the two ischia and the two pubes there is left a lozenge-shaped gap, like the anterior fontanelle in the head of a babe. This may have formed an obturator foramen, but I am of opinion that it was completely covered by cartilage.

The pubis, though of the plate-like type, does not resemble at all closely the flat pubes of *Procolophon*, *Stereosternum*, or *Palaeohatteria*. This is owing to the fact of the anterior third of the bone being bent rather abruptly down so as to form an angle of about 75° with the posterior part. The deflected portion has its outer and inferior end terminated by a thick margin, which seems

to have been covered by cartilage. Whether this cartilage has only been a narrow border round the front of the bone, or a well-developed prepubic cartilage, the evidence does not conclusively show. About the middle of the outer side of the pubis is a well-marked bony process. There is a large pubic foramen in the bone near its posterior and upper corner. The greatest length of the pubis is 25 mm., and the greatest breadth 19 mm.

In fig. 15 (Pl. XLI.) is shown a side view of the pelvis slightly restored as regards the acetabulum. All the bones are shown in what is believed to be true side view. In fig. 16 there is given for comparison a view of the pelvis of the large South-African Phytosaur *Erythrosuchus*. Here the pubis and ischium are also of the plate-like type, but the modification is carried further than in *Howesia*. The pubis is bent down still further and the lower part stouter. The symphyseal portions of both pubis and ischium are directed more inwards. Fig. 18 shows the left pubis as viewed from below and slightly from behind and the outer side.

Femur.

Portions of both femora are preserved, and both the upper and lower ends of the left are in good condition. The bone is slightly curved downwards towards its lower end, as is the case in the femur of the Crocodile. Both ends have been largely cartilaginous. Pl. XLI. fig. 20 represents the appearance of the proximal end. There is a large trochanter which has probably been devoid of cartilage, and a large, flat, semicircular surface which has supported the cartilaginous head. The lower end of the bone is broad and powerful, and has doubtless had large cartilaginous condyles.

Tibia and Fibula.

The left tibia is practically complete, but the lower third is slightly displaced, owing to a fracture which occurred during the animal's life and united with the fragments in a slightly false position. The bone is much expanded at the proximal end, which has a rounded upper surface and had probably little cartilage on it. Its greatest width is 16 mm. The bone is much constricted in the middle, measuring only 5 mm. across. The lower end is not much expanded, and probably had a well-developed pad of cartilage. The total length of the bone is 50 mm.

The fibula is slender in the middle and considerably expanded at both ends. It has a slight double curve. It is probably a little shorter than the tibia.

In fig. 21 a view is given of the front of the tibia restored so far as the correction of the slight displacement of the lower fragment. Fig. 22 shows the tibia and fibula as preserved in the specimen.

Pes.

A considerable portion of the right foot is preserved, and though some of the bones are displaced it is possible to make a fairly satisfactory restoration of both the tarsus and metatarsus.

Figs. 23 and 24 show two views of the tarsus as preserved. There are seen to be three large bones in the proximal part of the tarsus, and the tibia seems to be in connection with the inner and the fibula with the middle one. These three bones we may fairly confidently regard as tibiale, intermedium, and fibulare. On the outer side of the foot is a large curved bone which is manifestly the 5th metatarsal. This is supported by a large tarsale which we may regard as the 4th. The other tarsal elements are small. If these determinations are correct, then it would appear that the foot has been folded on the leg and the sides crushed together. Making allowance for the crushing the foot may be restored as in fig. 25.

The tibiale is an irregularly oval-shaped bone and is the smallest of the elements of the proximal row. The intermedium is a large rectangular bone. On its under or posterior surface there is a large groove. The fibulare forms a well-marked heel process. There is no centrale displayed, but it is probable that one existed though it may have been cartilaginous. Of the distal tarsal bones the 1st, 2nd, and 3rd are of small size, each supporting a single metatarsal. The 4th tarsale is about as large as the tibiale and supports both the 4th and 5th metatarsals. The 1st metatarsal is rather short and stout. The 2nd, 3rd, and 4th are all imperfect at their distal ends, but the 2nd is considerably longer than the 1st, and the 3rd and 4th much longer than the 2nd. It is not certain whether the 3rd or 4th is the longer, but the little evidence available points to the 4th being the longest of the metatarsals.

Affinities of Howesia.

The only animals with which it seems necessary to compare *Howesia* are *Sphenodon*, the Gnathodonts *Hyperodapedon*, *Stenomelopon*, and *Rhynchosaurus*, the Phytosaurs, and the Proterosaurs such as *Palaeohatteria*. The jugal, postorbital, and post-frontal bones bear considerable resemblance to the corresponding bones in *Sphenodon*, but almost quite as much to those of the much more primitive Diaptosaurians, the Pelycosaurs, and of *Palaeohatteria*. There is also considerable resemblance to the facial bones of *Rhynchosaurus*. In the other Gnathodonts the resemblances are obscured by the specialisations. The frontals and parietals are more like those of *Rhynchosaurus* and even of *Stenomelopon* than of *Sphenodon*, and the resemblance is increased by the fact of the parietal foramen being practically absent in *Howesia*. The maxillary and dentary dentition is unlike that of any other reptile hitherto known except *Hyperodapedon*; and though this latter genus is extremely specialised, the mode of implantation of the teeth in the bone is so essentially similar to that in *Howesia*, as to suggest a relationship between the genera. The palate is more primitive than in either *Sphenodon* or *Hyperodapedon*, and resembles more that of the Pelycosaurs. It also bears some resemblance to the palate of the Rhynchocephaloid reptile, *Proterosuchus*.

The shoulder-girdle differs from the earlier types in having no preacoracoid. In many respects the girdle resembles that of

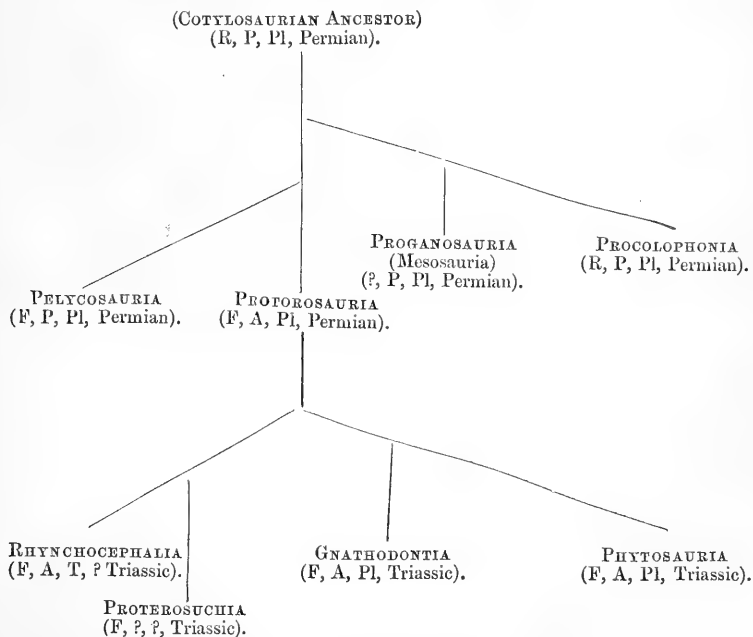
Sphenodon, but the imperforate condition of the coracoid is a feature found in a few Diaptosaurians.

The pelvis is not much modified from the type found in most Diaptosaurians. The plate-like pubis and ischium are found in *Rhynchosaurus*. In the Phytosaur *Erythrosuchus* the pelvis is very similar in structure; in *Sphenodon* the pelvic structure is very different.

It is impossible to compare the tarsus with that of most allied forms, as little is known of the tarsus in the Gnathodonts or Phytosaurs. There is, however, an undoubted resemblance between the tarsus of *Howesia* and that of *Sphenodon*, and this is more marked when that of the embryo is considered. The similarity is so close, that it is difficult to doubt that it indicates a relationship. In *Procolophon* we also see some affinity. It is interesting to note the similarity of the mode of articulation of the 5th metatarsal.

Taking the various points into consideration, I conclude that *Howesia* is a very slightly specialised Gnathodont. It seems to show, moreover, that the Gnathodonts are not true Rhynchocephalians, but are probably more nearly related to the Phytosaurs. I incline to agree with Osborn in placing them in a distinct order, no doubt showing some points of resemblance to the Rhynchocephalians, but not so nearly related to them as is generally held.

In the following table an attempt is made to indicate the phylogenetic relationships of the Diaptosaurian orders:—



icates that the skull has the temporal region roofed or fenestrated; the second letter, P or A, indicates that a precoracoid is present or absent; and the third, Pl or T, that the pelvis is plate-like or triradiating. It will be observed that all the orders occurring in the Permian have the pelvis plate-like, all have notochordal vertebræ, and most have retained the precoracoid, while all those that first appear in the Trias show no trace of a precoracoid. I have included among the Diaptosaurians a new suborder, or possibly order, Proterosuchia, of which *Proterosuchus* may be taken as the type. Boulenger is inclined to place it near to *Ornithosuchus*, but the palate is very different in the two genera, and the presence of rows of teeth on the pterygoids of the African genus seems of sufficient importance to remove it from the Phytosauria. It seems to me worthy of being placed in at least a distinct suborder. The Phytosauria might, I think, be included among the Diaptosaurians. Further research in the Permian and Triassic rocks is pretty certain to reveal a large number of new groups—groups which are ancestral to the Plesiosaurs, the Chelonians, the Lizards, and the Ichthyosaurs at least.

EXPLANATION OF THE PLATES.

Ang., Angulare; *c.*, centrale; *Cl.*, clavicle; *Co.*, coracoid; *D.*, dentary; *F.*, fibula; *f.*, fibulare; *Fr.*, frontal; *Hy.*, hyoid; *i.*, intermedium; *I.cl.*, interclavicle; *Il.*, ilium; *Is.*, ischium; *Ju.*, jugal; *L.*, lachrymal; *Max.*, maxilla; *Na.*, nasal; *Orb.*, orbit; *Pa.*, parietal; *Pal.*, palatine; *Pmax.*, premaxilla; *Postf.*, postfrontal; *Posto.*, postorbital; *Pt.*, pterygoid; *P.Vo.*, prevomer; *Pu.*, pubis; *S.Ang.*, surangular; *Sc.*, scapula; *Sq.*, squamosal; *S.Sc.*, suprascapular; *T.*, tibia; *t.*, tibiale; *T.P.*, transpalatine; 1, 2, 3, 4, tarsalia; I, II, III, IV, V, metatarsalia.

PLATE XL.

- Fig. 1. Restoration of skull of *Howesia browni*. Nat. size.
 2. Restoration of palate of *Howesia browni*. Nat. size.
 3. Specimen A showing portion of mandible and cast of jugal and other bones. Nat. size.
 4. Jugal and postorbital bones of *Howesia browni* (specimen B). Nat. size.
 5. Portion of upper surface of skull of *Howesia browni* (specimen B). Nat. size.
 6. Remains of palate as shown in specimen A. Nat. size.
 7. Portion of left dentary showing teeth (specimen A). $\times 3$.
 8. Middle portion of left maxilla showing teeth (specimen A). $\times 3$.
 9. Posterior part of left maxilla showing teeth (specimen B). $\times 3$.
 10. Shoulder-girdle as preserved (specimen B). Nat. size.
 11. Restoration of shoulder-girdle of *Howesia browni*. Nat. size.
 12. Shoulder-girdle of young *Sphenodon*, after Howes & Swinerton.
 13. Humerus of *Howesia browni*. Nat. size.

PLATE XLI.

- Fig. 14. Anterior caudal vertebra of *Howesia browni*. Nat. size.
 15. Side view of pelvis of *Howesia browni*. Nat. size.
 16. Side view of pelvis of *Erythrosuchus africanus*. $\times \frac{10}{10}$.
 17. Inner view of right ilium of *Howesia browni*. Nat. size.
 18. Under view of left pubis of " " "
 19. Front view of left femur of " " "
 20. Proximal end of left femur of " " "
 21. Front view of left tibia of " " "
 22. Side view of left tibia and fibula of *Howesia browni*. Nat. size.
 23. View of the foot as preserved. Nat. size.
 24. A second view of the foot as preserved. Nat. size.
 25. Restoration of the tarsus and metatarsus of *Howesia*. Nat. size.
 26. Foot of *Sphenodon punctatus*. Stage R. Magnified.
 27. " " " Stage Q. Magnified, after Howes & Swinerton.
 28. Foot of *Procolophon trigoniceps*. Nat. size.

3. On the Vascular System of *Heloderma*, with Notes on that of the Monitors and Crocodiles. By FRANK E. BEDDARD, M.A., F.R.S., &c., Prosector to the Society.

[Received May 11, 1906.]

(Text-figures 99-106.)

Although much work has been done upon the blood-system of the Lacertilia, especially by Rathke and Hochstetter*, there remain a number of important genera of which we have at present either no knowledge whatever, or the very slightest only. Among these is the genus *Heloderma*, with the general anatomy of which the recent investigations of Boulenger, Stewart, and particularly Shufeldt† have made us well acquainted. In the present communication I bring before the Society some facts concerning the blood-vessels of this Lizard in continuation of former contributions to the anatomy of this Order of Reptiles‡.

Having had the opportunity, during the last year or two, of dissecting several examples, comprising several species, of *Varanus*, I incorporate these notes into the present communication for the reason that *Heloderma* is in some respects not very remote from *Varanus*§, and indeed shows certain apparent resemblances to that genus in the arrangement of the blood-vessels, as will be pointed out in the course of the following pages.

Since both in *Heloderma* and *Varanus* there is a departure in many directions from the arrangement of the blood-vessels found in other Lacertilia (e. g. *Iguana*, Skinks, Geckos, *Ophisaurus*, *Amphisbæna*, *Anguis*), and on the whole in the direction of greater complication, it seemed to me important to compare the ascertained facts with those relating to the Crocodilia, since the vascular system of the Crocodilia is perhaps the most advanced among the Reptilia. In this department I am able to add some details to the classical treatise of Rathke, in addition to the facts accumulated by Jacquart and Hochstetter, whose contributions will be referred to on a later page. Of the Crocodilia I have been able to dissect several species belonging to more than one genus.

(1) *On some Veins and Arteries in Heloderma suspectum.*

In a specimen of *Heloderma suspectum* which died in the Society's Gardens in January of the present year, the veins were turgid with blood, and therefore in an excellent state for anatomical observation. I had the arterial system injected, and am therefore able to give, as I trust, some reliable notices of various

* Morph. Jahrb. xix. 1893, were earlier papers are referred to.

† Boulenger, P. Z. S. 1891, p. 109; Stewart, *ibid.* 1891, p. 119; Shufeldt, *ibid.* 1890, p. 148.

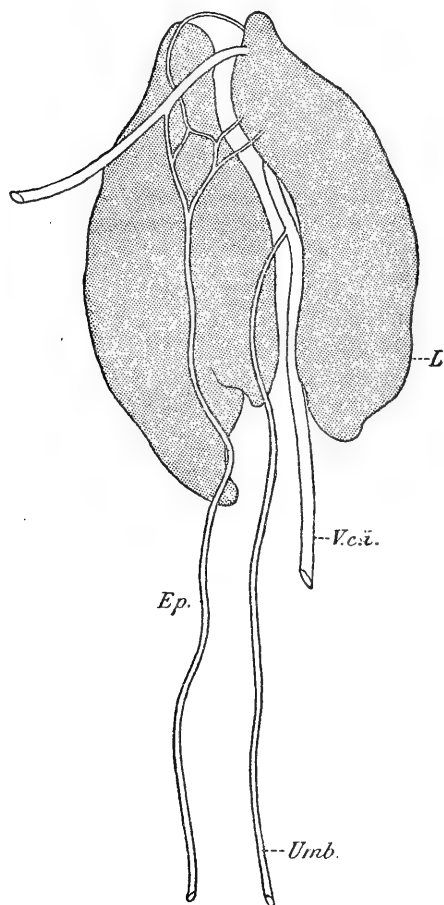
‡ In P. Z. S. 1904 and 1905.

§ This is not a prevalent view though adopted by Baur. See Boulenger (P. Z. S. 1891, p. 116) for discussion of the subject.

arteries and veins in this genus, of which we have at present no knowledge save a few notes by Dr. Shufeldt*.

Umbilical Vein.—It is extremely interesting to find in *Heloderma* very considerable vestiges of the umbilical vein of the

Text-fig. 99.



Ventral surface of liver and related veins in *Heloderma suspectum*.

Ep. Epigastric vein; *L.* Liver; *Umb.* Umbilical vein; *V.c.i.* Postcaval

fœtus. This vein ends off somewhat obscurely posteriorly, gradually fading away without being connected, so far as I could

* "Contributions to the Study of *Heloderma suspectum*," P. Z. S. 1890, p. 148. This paper concludes with a full bibliography.

ascertain, with any veins in the posterior region of the abdomen. It runs, of course, upon the ventral side of the abdominal cavity lying to the left of the anterior abdominal vein. This position at first led me to think that the vein in question was a left anterior abdominal vein, such as is met with in addition to a right in the Crocodilia invariably and in the Chelonia generally. I think, however, that the facts which I have to state about this vein disprove the idea that it is a second anterior abdominal vein and prove it to be a persistent umbilical. This vein is by no means a ligamentous rudiment such as Hochstetter has described and figured * the umbilical to be in *Anguis fragilis*. It contains plenty of blood; but it looks rather like an artery owing to its pink colour—due, I imagine, to thickish walls. It is, however, not an artery; for anteriorly it could be followed between the lobes of the liver ventrally, and perhaps about halfway along the length of the liver was traced into communication with the vena cava posterior, which latter, on separating the lobes of the liver, can be seen lying between them. It could be distinctly observed at the same time that various branches of the epigastric vein (see p. 609) which enter the liver near the entry of the umbilical did not communicate with the vena cava but entered the liver-substance. There can be no confusion therefore of this presumed persistent umbilical vein with a branch of the epigastric system of veins. It is further to be noted that the umbilical vein is in its relations to adjoining viscera more like that of birds than of the Boidæ, where alone among existing Sauropsida—so far as we know at present—this vein persists in the adult. That is to say, the vein is lost to sight until the two lobes are separated at about the middle of the liver as in the Class Aves, instead of extending beyond the liver as in the Python † for example, and joining the vena cava in front of that organ. On another page ‡ I call attention to the possible persistence of the umbilical vein in the Monitor lizards, which vein, however, shows certain differences from that which I describe in *Heloderma* as an umbilical. There is no doubt, however, that the vein in *Heloderma* corresponds to what is clearly the persistent umbilical in the Anaconda, &c. in bearing no part in the circulation, *i. e.* in not being furnished with branches.

Anterior Abdominal Vein.—This vein is, as is universal among the Lacertilia §, a single median vein, and was very full of blood in the specimen which I dissected. The origin of the vein in the pelvic region seems to me to be more like that of *Varanus* than of such other Lizards as have been examined. Of *Varanus arenarius* (= *V. griseus*) Hochstetter || has written :—“Ein zweiter wichtiger Differenzpunkt betrifft die Lage der Wurzel der Abdominalvene,

* Morph. Jahrb. xix.

† Beddard, “Contributions to the Anatomy of the Ophidia,” P. Z. S. 1906, vol. i. p. 28.

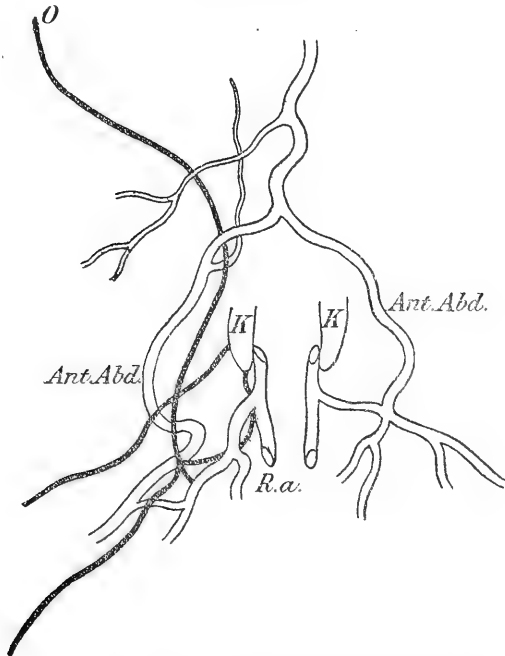
‡ Below, p. 611.

§ Excepting possibly *Varanus* (see below, p. 611).

|| Morph. Jahrb. xix. p. 467.

die sich bei *Varanus* als unmittelbare Fortsetzung der *V. ischiadica* präsentirt." The accompanying figure given by Hochstetter* shows this point clearly, the vein in question merely giving off a branch in passing to the afferent renal behind the kidney. In *Lacerta*, &c., on the other hand, it is rather that the ischiadic vein joins the afferent renal and gives off the anterior abdominal as a branch before doing so, and that this junction takes place at or near the middle of the kidney. *Iguana*† and some other lizards agree with *Lacerta* in these points; but hitherto *Varanus* has stood alone among the Lacertilia, though showing resemblances, in the arrangement of the vein under discussion, to the Crocodiles.

Text-fig. 100.

Origin of anterior abdominal vein in *Heloderma suspectum*.

Ant. Abd., Two roots of anterior abdominal vein; *K*, Kidneys; *R.a.*, Renal afferent veins; *O*, Fat-body artery (this and others, *i. e.* femoral and sciatic arteries, indicated in black).

In *Heloderma*, however, there is a distinct likeness to the *Varanidæ* which cannot be overlooked. In the accompanying illustration the roots of the anterior abdominal are shown upon both sides of the body (text-fig. 100), and it will be observed that

* *Loc. cit.* Taf. xvi. fig. 17.

† Beddard, P. Z. S. 1904, vol. i. p. 442.

they are somewhat asymmetrical; a fact which does not disguise the resemblance which they bear in details to the corresponding veins of *Varanus*. On the right side, the two veins which issue from the leg are connected below the pelvic region by an anastomosis whose calibre is as great or nearly so as that of the two veins which it joins. The junction lies to the dorsal side of the femoral artery which crosses it below. The more anterior of the two veins, which I presume to be the sciatic, then bends upon itself, but passes directly into the anterior abdominal vein, of which it forms the right root. The other vein, the femoral, receives the usual lateral caudal vein and joins the right branch of the caudal, forming with it the renal afferent vein of the right kidney. This junction takes place behind the kidney. The ischiadic artery lies dorsal of this vein, and is crossed ventrally by the conjoined femoral and lateral caudal. It appears from Hochstetter's figure that the relative positions of these blood-vessels is exactly the reverse in *Varanus*, that the artery is ventral of the vein. On the left side of the body, the likeness to *Varanus* is exhibited in a more striking way, since the junction of the veins in the leg is more normal. The two veins of the leg unite with each other, and shortly thereafter divide into the left root of the anterior abdominal vein and a branch joining the left renal afferent vein behind its point of contact with the corresponding kidney. Just before this division the common trunk from the leg receives the lateral caudal. The arrangement of these various veins is therefore exactly as in *Varanus*, and thus differs equally from that prevalent among the *Lacertilia*. The anterior abdominal is chiefly concerned with the blood returned from the fat-body, from which it receives a considerable number of affluents. I noticed only one branch from the fat-body to join the right root of the anterior abdominal, the rest poured their contents into the common trunk.

The hepatic portal system of this Lizard is more complex than that of many other Lizards. In addition to the usual veins, derived from the parietes and viscera, common to the *Lacertilia* as a whole, there are, as will be seen from the following account, certain veins which are not represented, or are rarely represented, in other genera of the *Lacertilia*.

System of Vertebral Veins and branches to Liver.—It is the rule among the *Lacertilia* for the azygos and the vertebral veins and their branches to the liver to be mainly developed upon the right side of the body, and for the separate gastro-hepatic affluents of the portal system to be independent not only of the main portal vein, but also of the dorsal parieto-hepatic veins running from the body-wall to the liver-substance. In these various particulars the venous system of *Heloderma* is rather different from that of other Lizards.

The *Azygos Vein* in *Heloderma* is short and to be found only

upon the right side of the body, its usual position not so much in the *Lacertilia* as in the *Ophidia* generally.

It is of very limited extent in the present lizard, and after reaching the neighbourhood of the vertebral column plunges at once into the thickness of the parietes. It appears on the surface for a brief interval between the two following intercostal arteries. Five intercostal arteries then intervene before the next appearance superficially of the vertebral vein, which is here developed upon both sides of the vertebral column. The longitudinally running vein of the left side is the more important of the two and draws blood from six intercostal spaces; the right-hand vein is shorter but developed in the same region of the vertebral column as the left. The two vessels join and enter the liver near to its anterior end together by a common trunk. This trunk receives before it reaches the liver a branch from the stomach, the *gastro-hepatic*, which is in its turn composed of two vessels, one of which runs along the stomach forwards and the other passes along the stomach towards its posterior end. This posterior *gastro-hepatic vein* has other rather unusual relations with the portal system. It gives off a small branch which goes at once to the liver. Posteriorly it does not communicate with the general portal system of the alimentary tract as in other Lizards, but ends by joining the anterior abdominal vein behind the point where the latter receives the intestinal portal. The somewhat complicated relations of these several veins will perhaps be rendered clearer by an inspection of the accompanying diagram of their course (text-fig. 101). In possessing that anterior system of parieto-hepatic veins which are connected with the gastro-hepatic veins, *Heloderma* does not merely differ from the more typical *Lacertilia*, but agrees with the Boine snakes, the snake-like Lizard *Ophisaurus**, with *Hatteria*, and, as will be seen presently †, with the *Varanidæ*, though to a less extent with these also aberrant Lizards. The entire separation of the gastric from the intestinal portal system is also noteworthy; and it will be obvious that, in spite of the points of resemblance with other *Squamata* insisted upon, the details of this part of the venous system are peculiar to *Heloderma* and distinguish it from other *Lacertilia*.

Heloderma possesses, as do all other *Lacertilia* which have been examined, a series of veins entering the right lobe of the liver close to its posterior extremity, the *posterior dorsal parieto-hepatic veins*.

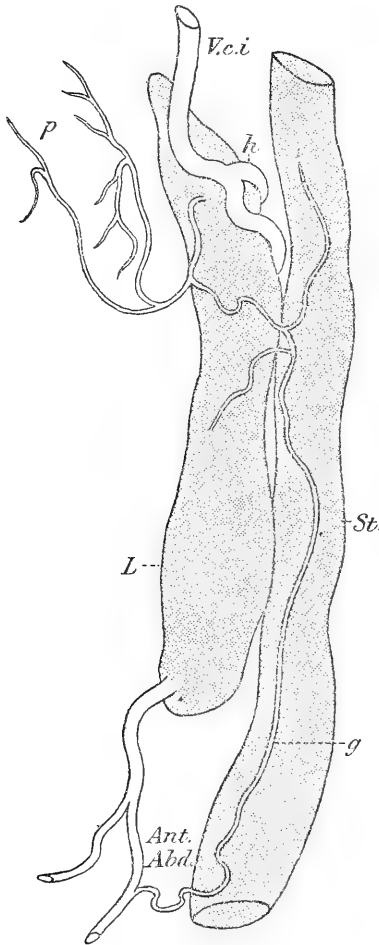
These vessels originate by several roots, which unite to form one trunk as in *Varanus*. There are four separate roots, which arise from the parietes on the right side of the body and lie between three intercostal arteries. The single trunk formed by their union enters the right lobe of the liver close to the postcaval vein, and by the aid of a fold of membrane which, as in so many

* Beddard, P. Z. S. 1905, vol. ii. p. 474.

† *Infra*, p. 616.

Lacertilia including *Varanus*, attaches the extremity of the liver to the lateral parietes. Two of the four roots lie between two intercostal arteries, each close to an artery. These do not join

Text-fig. 101.



Certain hepatic veins of *Heloderma suspectum*.

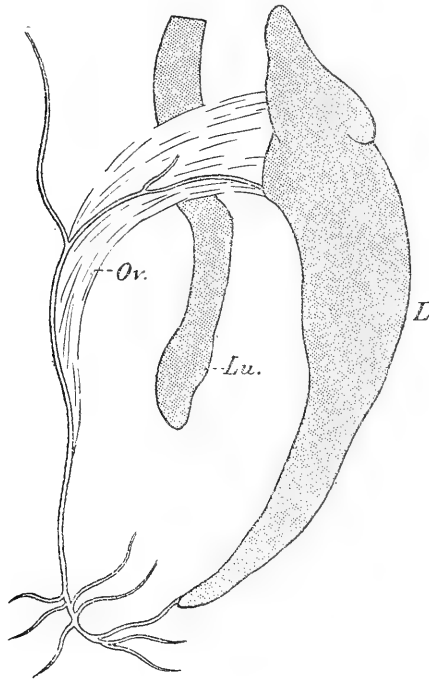
Ant. Abd. Anterior abdominal vein; *g.* Gastro-hepatic vein; *h.* Hepatic vein joining postcaval (*V.c.i.*); *L.* Liver (viewed laterally); *p.* Parieto-hepatic veins from right and left of mid-dorsal line; *St.* Stomach.

for some distance from their point of origin from the parietes. The second pair of roots lie between the second of the two inter-

costal arteries just referred to and the next; they join immediately to form one stem. The conjoint stem receives branches from the fat-body. The following intercostal is embraced by the two roots of a vein belonging to the same series, which, however, belongs to the suprarenal portal system.

Oviducal Vein.—The oviduct is borne by a membrane which is attached to the lateral parietes and anteriorly passes over the lung, becoming attached to its proximal section in its passage, and is inserted on to the liver. Anteriorly, therefore, this membrane is transversely disposed to the longitudinal axis of the body

Text-fig. 102.



Oviducal membrane in *Heloderma suspectum* showing attachment to liver.

L. Liver (pushed over to left and viewed laterally); *Lu.* Right lung;
Ov. Oviducal membrane bearing vein.

and arches over the distal part of the lung. This membrane bears a vein which follows its edge. Anteriorly, the oviducal vein gives off a branch just at the funnel of the oviduct, and another where the oviducal membrane arches over the lung, which runs towards the line along which the oviducal membrane is attached to the lung. It ends by entering the liver-substance,

and thus forms a part of the hepatic portal system. On the right side of the liver, a little process of liver-substance juts out to meet the vein. This does not occur in the case of the left-hand vein. The arrangement of oviducal membrane and the vein which it bears appears to me to be exactly the same as a corresponding series of structures which I described some time ago in the *Chamaeleon**.

Epigastric Veins.—These veins in *Heloderma* (text-fig. 99, p. 602) form a median unpaired system unlike the corresponding veins of *Varanus*. The principal vein of the system enters the liver very anteriorly quite close to the end of that organ. The epigastric generally, it is to be observed, is connected with the liver well in front of the entrance of the umbilical vein. The main stem of the epigastric was broken off, and a corresponding break on the largest branch of the abdominal vein may perhaps indicate the junction of the two. The main stem, whose actual course I am thus unable to map, gives off a backwardly running branch which extends beyond the liver. This latter stem is also connected directly with the liver itself by two branches which it gives off just before ending in the main stem of the epigastric. These form an anastomosis with each other, and there are altogether formed three exits into the liver, in addition, of course, to the main epigastric stem.

Arterial System.—Dr. Shufeldt, in his memoir already referred to †, has made a few comments upon the arteries arising from the aorta behind the heart. He has not, however, dealt in any way with the arteries at their point of origin from the heart. The general arrangement of the exits of the arteries does not seem to me to differ from what is found in the *Lacertilia* generally. The heart also is bound to the pericardium by the tag which is so general in the group. On the right side, the systemic trunk and the carotid run side by side for a long distance after their emergence from the common trunk by which they originate from the ventricle. The systemic trunk then doubles upon itself to pass back towards its point of junction with the aorta of the opposite side of the body, the carotid continuing its forward course. There is not the least trace, that I could discover, of the *ductus Botalli* joining the systemic and carotid arches, which is so prevalent among the *Lacertilia*. The contact between the two trunks concerned is so close and exists for so long a space, that there is, so to speak, every opportunity for the connection to have been preserved. Yet it is absent. In this feature *Heloderma* obviously agrees with *Varanus* and *Amphisbæna*, in which genera there is no such *ductus Botalli* to be found.

The left aortic arch gives off no branches. The right aorta gives off several pairs of intercostals as well as the subclavians, which, as in many Lizards, arise the one behind the other. As is the rule elsewhere, the left subclavian arises behind the right. Very shortly after the junction of the two aortæ arises a slender

* "Contributions to the Anatomy of the *Lacertilia*," P. Z. S. 1904, vol. ii. p. 9.

† P. Z. S. 1890.

œsophageal artery; there is then a considerable gap until, on a level with the anterior extremity of the liver, an artery arises which closely accompanies the branches of the vertebral vein already described, and supplies the liver and the stomach. There is then a considerable gap until the origin of the three usual arteries which supply the greater part of the alimentary tract. The first of these is that supplying the stomach, spleen, and commencement of the intestine; the two which follow are so close together that they may almost be said to arise in common. Of these the cæcal artery is the anterior.

§ *Summary of more important facts in the Vascular System of Heloderma.*

As compared with other Lacertilia, the following facts in the anatomy of the vascular system of *Heloderma* are particularly noteworthy:—

- (1) The absence of any *ductus Botalli* between the carotid and systemic arches. *Varanus* (as well as some other Lizards) agrees with *Heloderma*.
- (2) The origin of the anterior abdominal vein as a direct continuation of the ischiadic veins as in *Varanus* and the Crocodilia.
- (3) The persistence of the foetal umbilical vein as an affluent of the postcaval vein, not in front of the liver as in Snakes, but in the region of the liver as in Birds. It is possible that *Varanus* agrees in this*.
- (4) The existence of anterior parieto-hepatic veins as in Snakes and certain snake-like Lizards, in addition to the usual posteriorly developed veins opening, as in other lizards, into the extremity of the right lobe of the liver. Here also *Varanus* agrees with *Heloderma*.
- (5) The independence of the gastric portal system from the intestinal portal system. The veins of the stomach either open directly into the liver, or by way of the anterior abdominal vein †; they do not join the portal vein.

(2) *On the Venous System in the Genus Varanus.*

The only notes hitherto published upon the venous system of the genus *Varanus* relate exclusively to the species *V. griseus* ‡. Having made a careful dissection of this § as well as of two other species, and having accumulated some notes upon a few facts in

* Below, p. 611.

† The connection of the gastric veins with the anterior abdominal vein is of course also to be seen in the Crocodilia.

‡ Corti: *De Systemate Vasorum Psammosauri grisei*, 1847.—Hochstetter: "Beiträge z. Entwicklungsgeschichte des Venensystems, &c.," *Morph. Jahrb.* xiv. p. 464. The species is called *V. arenarius*, a synonym.—Beddard: "On the Venous System in Certain Lizards," *P. Z. S.* 1905, vol. i. p. 447.

§ Not the same individual described in the paper above quoted.

other species again, I am able to add something to the recorded knowledge of the venous trunks of this—as I consider it—aberrant genus of Lacertilia.

Hepatic Portal System.—The Lacertilia generally differ from the Chelonia and the Crocodilia in possessing but one anterior abdominal vein, while the latter, with the exception of *Dermochelys*, possess two*.

The Ophidia and *Hatteria* agree with the Lacertilia with some slight exception.

Thus in certain Boidæ† the anterior abdominal divides after the union of the two pelvic roots to reunite again before entering the liver. It is therefore noteworthy that *Varanus niloticus* (only this species among those which I have examined *ad hoc*) has, like these Ophidians, an anterior abdominal which is double for a part of its length. In one specimen the arrangement was as follows:—the right root of the anterior abdominal vein before joining the left root gives off two branches; the first of these is the right anterior abdominal, the second is a vein which brings blood from the ventral surface of the pelvis. The right anterior abdominal is of less calibre than the left or main anterior abdominal trunk; the two unite not far behind the junction of the portal vein with the conjoined anterior abdominal vessels. In a second specimen of the same species the anterior abdominal was also double; but I am unable to give exact details. So also with a third individual which was dissected by me a good many years ago, but of whose anatomy I possess notes.

It will be noted from the above description, that the double character of the anterior abdominal vein in *Varanus niloticus* may be rather different from that of the Python and nearer to that of the Crocodilia. For in the serpent the double vein occurs after the fusion of the two pelvic roots, while in *Varanus* the second, smaller, anterior abdominal vein is a direct offshoot of the corresponding pelvic root. It is, that is to say, separate from the very first. *Varanus* does not show, so far as I have observed, any signs of a doubling of the anterior abdominal vein at the liver end. If the comparison between *Varanus* and the Crocodilia be justified so far as concerns these features, it is clear that the posterior junction between the right and left anterior abdominals in *Varanus niloticus* is to be compared with the junction in *Crocodilus cataphractus*‡ between the two anterior abdominals, though the situation of this connecting vessel is not precisely the same in both reptiles.

Umbilical Vein.—Besides the two epigastric veins already described, there is a median vein which is connected posteriorly with the anterior abdominal and anteriorly opens into the post-caval vein between the two liver-lobes. Its course was ascertained

* Burne: "Notes on the Muscular and Visceral Anatomy of the Leathery Turtle," P. Z. S. 1905, vol. i. p. 320.

† Beddard: "Notes upon the Anatomy of Certain Snakes of the Family Boidæ," P. Z. S. 1904, vol. ii. p. 116.

‡ *Infra*, p. 620.

accurately. It does not form part of the liver circulation, but is definitely connected with the general circulation by means of the postcaval. It seems to me to be possible, although I am unable to offer any embryological evidence, that this vein is a persistent umbilical. It has very much the same relations as has the vein in *Heloderma**, which is, as I think, to be referred to a persistent umbilical, except for the fact that it communicates in *Varanus* with other veins; this is not the case with the umbilical of *Heloderma*, or of snakes, in which it occurs with one exception. That exception is *Bitis nasicornis*†, where I found that the undoubted umbilical vein was connected with the epigastric system. There is thus a precedent for a persistent umbilical connected in the adult with other veins among the Squamata.

The same is the case with the persistent umbilical of Birds and of *Echidna*‡. Thus the connection with the parietal and other veins is not at the least evidence against regarding this vein in *Varanus* as the persistent umbilical. Moreover, the connection does not occur in both of the species, in which I have detected what I believe to be a persistent umbilical. In *Varanus niloticus* the umbilical is connected just at its entrance into the postcaval with a forwardly running branch. On the other hand, in *Varanus exanthematicus* the vein had no such branch and appeared to end posteriorly without making any connection with the epigastric system or being elsewhere connected with the parietes. I have not any notes or sketches showing this vein in *Varanus griseus*, and its occurrence is not mentioned by either Corti§ or Hochstetter||. It is particularly difficult to prove a negative in the case of veins; and accordingly I prefer rather to dwell upon the presence of the vein that has just been described in two species of *Varanus*.

Azygos and Lateral Parietal Veins.—On the right side of the body is a vein which seems to correspond to the azygos of other reptiles, but to be of more limited extent than is often the case. The vein, in fact, plunges into the thickness of the parietes directly it reaches the side of the vertebral column. In another specimen the azygos consisted of two branches, which also disappear into the parietes at once. The vein of course arises from the right vena cava superior. I am inclined to think that Hochstetter is in error when he speaks of a vessel obviously corresponding in the following words:—"Eine dritte sehr mächtige [Intervertebralsvene] findet sich rechts als die vorderste im Brustraum und geht in weitem Bogen in die V. cava superior sinistra ¶ ein." From this azygos, before it reaches the side of the vertebral column, arises the posteriorly running lateral abdominal or, better, lateral parietal vein, as I propose to call it. The vessels have already been to some

* *Supra*, p. 602.

† "Contributions to the Anatomy of the Ophidia," P. Z. S. 1906, vol. i. p. 41.

‡ Cf. Beddard: "Anterior Abdominal Vein in Echidna," P. Z. S. 1884, p. 553; and Hochstetter in Semon, "Zoologische Forschungen," &c., Jen. Denkschr. 1895.

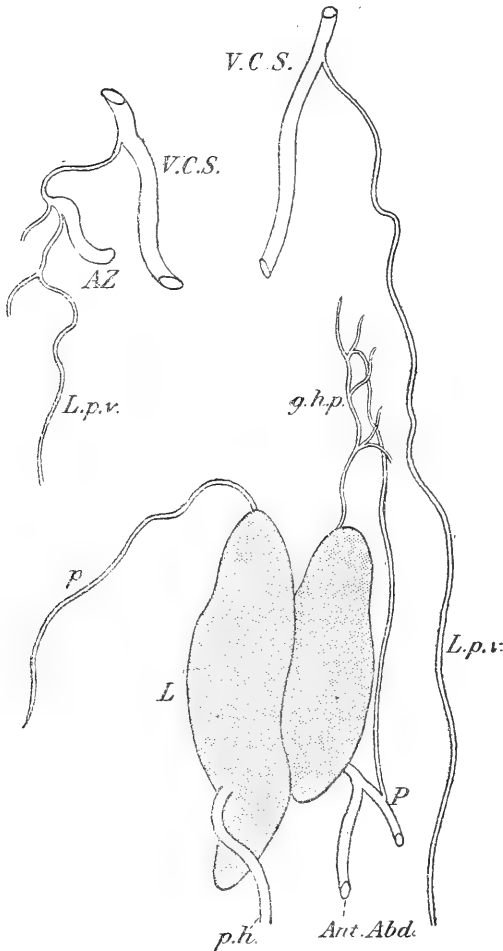
§ *Loc. cit.* (on p. 610).

|| *Loc. cit.* (on p. 610).

¶ Italics mine.

extent described by myself in the present species*. They are hardly referred to by Hochstetter.

Text-fig. 103.



Liver and certain adjacent veins in *Varanus griseus*.

AZ. Azygos; *Ant. Abd.* Anterior abdominal; *g.h.p.* Gastro-hepatic; *L.* Liver; *L.p.v.* Lateral parietal vein; *P.* Portal; *p.* Anterior parieto-hepatic vein; *p.h.* Posterior parieto-hepatic vein; *V.C.S.* Precaval veins (*venæ cavæ superiores*).

On the right side of the body in the example of *Varanus griseus*

* P. Z. S. 1904, vol. i. p. 448.

upon which I report here, the lateral parietal vein was defective here and there between its origin with the azygos stem from the right superior vena cava and the origin from it of the anterior hepatic branch. After this point it was present as a continuous vessel to some way beyond the origin from it of the suprarenal portal stem. On the left side of the body, the vein originates from the left anterior vena cava at a point nearer to the head than does the right. Thence it is traceable as a continuous vessel to a point just short of the origin from the parietes of the left suprarenal portal. Neither in this individual nor in those previously described by me* is there any connection with the pelvic veins. In other respects there is a fairly close agreement between all three specimens.

In *Varanus exanthematicus* I found rather different features in the azygos and lateral parietal veins. Both anterior venæ cavæ gave off a backwardly running vein. This vein on the right side arose in front of the subclavian and had a very short course upon the parietes. The vein of the left side arose behind the orifice of the subclavian vein and divided into two short branches. Neither of these veins was connected with the posteriorly situated lateral parietal veins. Posteriorly these veins were obvious on both sides of the body. On the right side they could be traced from opposite the testis into direct communication with the root of the anterior abdominal vein. In this connection therefore with the pelvic veins, the lateral parietal vein of *Varanus exanthematicus* appears to differ from that of *Varanus griseus*. On the left side, the connection with the left root of the anterior abdominal vein was also quite obvious, but there was a slight gap along the course of the vein. The connection of the lateral parietal veins with those of the hind limbs obviously brings *Varanus* more into line with other Lacertilia, where these veins are general and where such a connection occurs.

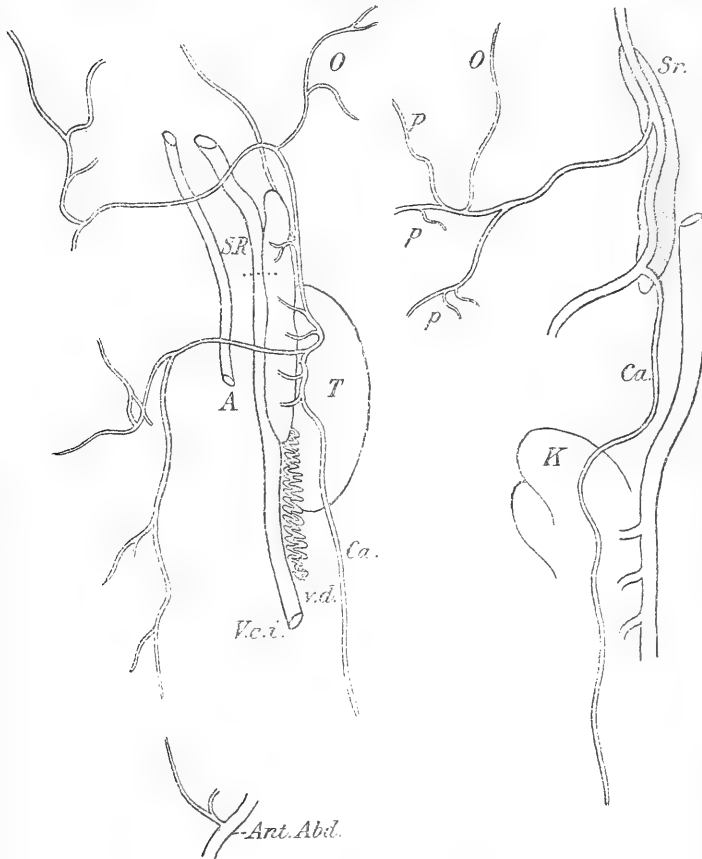
Remains of Posterior Cardinals.—Hochstetter has mentioned in the case of *Varanus griseus* a vein which runs along the vas deferens and which he termed the vena deferentialis, describing at the same time its connection with the suprarenal portal veins. The commencement of this vein from the afferent is also figured by him. I have elsewhere† compared this vein to a similar vein in the Boidæ and suggested its equivalence to the posterior cardinal. This view was obviously uncertain as long as the conditions obtaining in the female *Varanus* were unknown. For a vein supplying the vas deferens might be merely regarded as the necessary physiological equivalent of a vein supplying the oviduct and developed *ad hoc*, without any morphological meaning at all. The same vein, however, exists in the female. I found in a female *V. niloticus* that the afferent renal vein was prolonged headward of the kidney and ran alongside of the efferent renal vein over the suprarenal body, receiving the suprarenal portal vein, which will be described

* *Loc. cit.* (on p. 610).

† P. Z. S. 1906, vol. i. p. 21.

immediately. This vein also was found in a male *V. exanthematicus*. Its existence is probably therefore a characteristic of the Varanidae.

Text-fig. 104.



Veins of suprarenal body and adjoining regions in *Varanus exanthematicus* (left-hand figure) and *V. niloticus* (right-hand figure).

A. Aorta; *Ant. Abd.* One root of anterior abdominal; *Ca.* Posterior cardinal; *K.* Kidney; *O.* Vein from omentum; *S.R.* Suprarenal body; *p.* Parietal veins; *T.* Testis; *v.d.* Vas deferens; *V.c.i.* Postcaval.

Suprarenal Portal Veins.—These have been already recognised by Corti, Hochstetter, and myself in *V. griseus*. They vary somewhat in numbers and in arrangement in the several individuals which I have dissected.

These suprarenal veins, as is the case in other Lizards—it is not mentioned by Hochstetter for *Varanus*,—arise in two ways.

Some originate from the more lateral parietes, either actually from the lateral parietal vein when that is present in this region of the body, or from the area usually occupied by it. Others arise from the parietes near to the dorsal line, and are therefore connected with the posterior vertebral vein. In *Varanus niloticus* (text-fig. 104, p. 615) I found on the right side two suprarenal portal veins. The anterior of the two was formed by the union of three vessels springing from the lateral parietes. A small vein from the "omentum" joined this vessel. The posterior of the two suprarenals arose from the parietes close to the dorsal line. Both opened into the posterior cardinal vein where it traversed the suprarenal body. On the left side of the body, the anterior of three suprarenal portals arose from the body-wall close to the dorsal line, and thus corresponds exactly to the dorsal parieto-hepatic vein opposite to it.

In a specimen of *Varanus exanthematicus* the arrangement of these portal veins was a little different and is represented in text-fig. 104.

The lateral parietal vessel, after leaving the root of the anterior abdominal on the right side of the body, ends in the suprarenal portal in the way illustrated in the figure referred to. The vein thus emerging from the lateral parietal arches over the suprarenal body and divides into two branches, one anterior and one posterior. Each of these again divides into two to supply the suprarenal body, and is also connected with the posterior cardinal vein. A second suprarenal portal arises in front of that just described by a number of branches from the body-wall and joins the continuously running cardinal vein. It also receives a branch arising by many twigs from the "omentum" in the liver region. A third suprarenal portal is anterior to this again and enters the front of the suprarenal gland. On the left side of the body the arrangement was, save for minute details, the same as that which has been described upon the right side of the body. The fewness of the suprarenal portals is thus a characteristic of *Varanus* as contrasted, for example, with *Iguana**.

Dorsal Parieto-hepatic Vein.—In the chapter entitled "Systematis venosi fragmenta" † Corti speaks of "*Vena intervertebralis quae a posteriori pulmonis dextri extremitate obtecta, atque a foramine quodam intervertebrali scaturiens, se in accessorio hepatis lobulo prope venam renalem communem abdit.*" The vein is figured by Corti, and is also described by Hochstetter‡ in the same species of *Varanus*. I have already confirmed the statement of the two anatomists for *Varanus griseus*§, and I find now precisely the same arrangement in another example of the same species, of which this single vein is doubtless characteristic. It may be observed that in this species, as well as in *V. exanthematicus* and *V. niloticus*, *V. bengalensis*, and *V. ocellatus*, the vein in question is

* P. Z. S. 1904, vol. i. p. 443.

‡ *Loc. cit.* p. 466.

† *Loc. cit.* p. 48.

§ P. Z. S. 1904, vol. i. p. 448.

supported by a fold of membrane which attaches the "Hohlvenenfortsatz" of the liver to the parietes and forms a pocket as in *Iguana* and some other Lizards, including *Heloderma*. The single vein is not, however, a generic character of *Varanus*. It is single in *V. exanthematicus* and in *V. ocellatus*; but in two out of four examples of *Varanus niloticus* which I have dissected the conditions were different. In two small specimens there was only a single vein as in other species; in one large individual there were distinctly two veins, which reached and penetrated the liver separately; in the fourth specimen, also large, and a female like the last, there were also two veins, which, however, joined soon after their emergence from the parietes to form a single trunk entering the liver as such. In the two small individuals which were males (and not very well preserved in spirit) it seemed to me that there was a junction between two veins quite close to the body-wall. The more prevalent arrangement among the Lacertilia is that there are several of these veins* running a parallel course to the liver.

In addition to this vein (or, rarely, veins) the liver also receives blood from the dorsal or dorso-lateral parietes in its anterior region. In *Varanus griseus* Hochstetter has mentioned a vein—"eine Zweite Leibeswandvene dringt direkt in die kopfwärts gerichtete Spitze des rechten Leberlappens, diese wurzelt in der entsprechenden Partie der dorsalen Leibeswand" †. There is no further description of the vein. The vein in question is accurately described by Hochstetter as entering the very tip of the right lobe of the liver. It corresponds exactly in position to a vein from the stomach which enters the tip of the left lobe ‡. The origin of the vein from the parietes is of some interest. It originates in fact from a longitudinal vein, the lateral abdominal, whose relations to other veins has been already described. The same vein occurs in *Varanus niloticus*, where I found it fuller than in the example of *V. griseus*. The same vein plainly exists in *V. exanthematicus*, with the same connections with the vein of the dorso-lateral parietes.

The existence of these venous affluents of the portal system is of interest in comparing *Varanus* with other Reptiles. In the presence of vessels from the dorsal parietes joining the liver-circulation anteriorly as well as posteriorly, *Varanus* differs from *Lacerta*, *Iguana*, and some other Lacertilia. It agrees, however, in this with *Heloderma*, as has been already set forth in the present communication§. The connection, however, in this latter instance is with the vertebral vein, while in *Varanus* the hepatic affluent in question is only indirectly connected with the vertebral vein system, and arises directly from the lateral abdominal vein, which

* I may take this opportunity of referring to another character which I have found only in one species, and not in a considerable number of others. In *V. gouldi* the apex of the heart has a gubernaculum tying it to the pericardium. This is generally stated to be absent, and I have not found it in *V. bengalensis*, *V. griseus*, *V. niloticus*, and *V. exanthematicus*.

† *Loc. cit.* p. 466.

‡ *V. infra*, p. 618.

§ *V. supra*, p. 606.

is a particularly prominent vein in the Varanidae as contrasted with other families of Lacertilia. In the connection of the lateral vein system with the hepatic circulation, *Varanus* shows a point of resemblance to the Crocodilia, where such a connection also occurs, and with which I deal in a subsequent page of the present communication*. I do not, however, lay so much stress upon this comparison as upon the difference which *Varanus* shows in this part of its circulatory system from other Lacertilia.

Gastro-hepatic Vein.—It is important to note that *Varanus* differs from many other Lacertilia † in the limitation of the gastro-hepatic veins to a single vein. Hochstetter has already correctly noted that there is but one vein of this series which enters the extreme anterior tip of the left liver-lobe. I have found exactly the same state of affairs in an example of *Varanus griseus* recently dissected. I find also exactly the same vein occupying the same position in *V. exanthematicus*. In *Varanus niloticus* the same gastro-hepatic vein was present and appeared to be particularly large. It is a point worthy of note that the position of this vein, that is of its place of entrance, is exactly the same in the left lobe as the anterior parieto-hepatic vein in the right lobe. It is possible that the great width of the liver in *Varanus* is responsible for the separation of two veins which in *Heloderma* ‡ enter conjointly, the liver being in that Lizard narrow anteriorly.

(3) *On some Veins in the Crocodilia.*

Although the main features of the vascular system generally, including the veins, in the Crocodilia are fairly well known §, there are a few details which have not received attention; and, moreover, there yet remains, as it seems, a good deal to be ascertained before the variations of the venous system from genus to genus is at all understood. I shall show in the following pages that the veins with which I deal are by no means uniformly disposed in all Crocodiles. The observations which I place before the Society were almost entirely conducted upon well-injected specimens, and are therefore, as I hope, trustworthy as records of positive fact. It is obviously less possible to insist upon the absolute reliability of negative facts.

§ *Azygos Veins or Venæ Vertebrales.*

Rathke's description of the azygos veins would not give rise to the impression that they show differences among different

* *V. infra*, p. 622.

† Not, however, from *Phelsuma madagascariensis* and *Tarentola annularis*, where there is also but one gastro-hepatic vein.

‡ Above, p. 607.

§ See especially: Rathke, "Untersuchungen über die Entwicklung und den Körperbau der Krokodile," Braunschweig, 1866; Jacquart in Ann. Sci. Nat. (4) ix. 1858, p. 129; Hochstetter in Morph. Jahrb. xix. 1893, p. 476; Jourdain in Ann. Sci. Nat. (4) xii., 1859; Beddard in P. Z. S. 1905, vol. ii. p. 466.

kinds of Crocodiles. This vein (the vena vertebralis communis)*, is stated to arise from the anterior cava as a single trunk and to have a very short course superficially along the vertebral column, disappearing from sight—"nach dem er die vierte V. intercostalis absendend hat in den Kanal des Rückgrats um sich mit den Venæ spinales zu verbinden." It has thus, as he remarks, only a short course, which terminates immediately behind the fourth rib. There is no indication given as to what species or which species this description refers to. The general account of the venous system is stated merely to refer to "ältere Krokodilen," though definite species are now and again referred to in footnotes appended to the description; not so, however, in the case of the veins which concern us here. There is no evidence that I can extract which points to any particular species. I find, however, that there are variations, and that the three species which I have examined do not agree.

In *Crocodylus cataphractus* the azygos veins answer pretty well to the descriptions given by Rathke; though there are certain differences, and also some other matters not touched upon by Rathke, to which I desire to direct attention. The number of ribs in this species is not mentioned by him †. I find that there are only 12 pairs, *i. e.* 2 false anterior ribs, 7 true ribs, 3 posterior false ribs. The azygos veins are of exactly the same size on both sides of the body. They arise from the anterior cava on each side behind the origin of the subclavian. On the right side of the body the origin was by two distinct affluents, forming with each other and the vena cava a triangle ‡. I did not find any such double origin on the left side. The vein runs in a directly transverse direction (*i. e.* transverse to the longitudinal axis of the body), and close to the vertebral column on each side plunges at once into the parietes. Thence it never reappears upon the surface of the musculature as a longitudinally running vessel, but remains completely buried and hidden below it.

The azygos vein is closely accompanied by the corresponding artery (arteria vertebralis communis), which also rises below the surface of the musculature, but is visible at intervals below the peritoneal membrane. At a point about halfway between the origin from the vena cava and the disappearance into the parietes, both artery and vein give off a longitudinally and posteriorly running branch along the lateral body-wall which has its counterpart (in the case of the vein) in *Varanus* §.

In *Osteolaemus tetraspis* the azygos veins show features of difference which obviously aid in establishing the justice of the generic separation of this Crocodile. As the following statement of fact is based upon the examination of two individuals, I imagine that it can be taken as a description of the normal conditions obtaining in this species. The azygos arises from the vena cava, at least

* *Loc. cit.* p. 255.

† *Loc. cit.* p. 55.

‡ *Cf.* p. 620, where the same state of affairs is described in *Osteolaemus tetraspis*.

§ See p. 616.

on the right side, in common with the internal mammary*, from which it soon diverges and runs the usual course to near the dorsal middle line.

It is remarkable that on the left side (only, not on the right) the azygos arises by two origins—a thicker anterior trunk, and a much more slender posterior vessel. This is quite analogous to what has already been described in *Crocodylus cataphractus*, including the asymmetry, which is still more remarkable. The azygos also gives off, precisely as in *Crocodylus cataphractus*, a vein running along the lateral thoracic parietes. Arrived at the side of the vertebral column some little way in front of the origin of the *longus colli* muscle (also as in *Crocodylus cataphractus*), the azygos does not plunge into the thickness of the parietes as in the last-mentioned Crocodile, but runs back quite superficially as in a Mammal. It is thus displayed for the whole of its course to as far back as where the dorsal parieto-hepatic trunks communicate with it. This course corresponded (at any rate in one of the two specimens dissected) to 6 ribs. The chief difference, therefore, which this species shows from *Crocodylus cataphractus* is in the possession of superficially running azygos veins.

In *Caiman sclerops* the two azygos veins arise symmetrically with regard to each other from their respective jugulars, right and left. In both cases they arise behind and not very near to the subclavians and separately from the jugular, *i. e.* not in common with any other vein. Each is closely accompanied by the corresponding artery which is a branch of the carotid. I could detect no lateral parietal branch of each vein; but as the specimen was quite a small one, they may have remained undetected. Each azygos reaches the dorsal line far forwards at the level of the fourth rib in front of that whose vertebra bears the origin of the *longus colli* muscle. Then the vein disappears and does not run superficially on each side of the body; but some way in front of the liver it reappears and passes in a slightly sinuous course to the end of the liver, where it gives rise in the usual way to the hepatic branches, which will be described later. Thus the present genus agrees to some extent with *Osteolemus* in the superficial course of the two azygos or posterior vertebral veins, there being the difference that in *Caiman* the vein runs superficially only posteriorly. The artery is superficial throughout.

Anterior Abdominal Veins.—These veins, which, as is well known, are completely double in the Crocodylia, show certain differences in different species. Rathke has called attention † to the fact that the two veins often differ in calibre. He does not mention certain points to which I shall now refer.

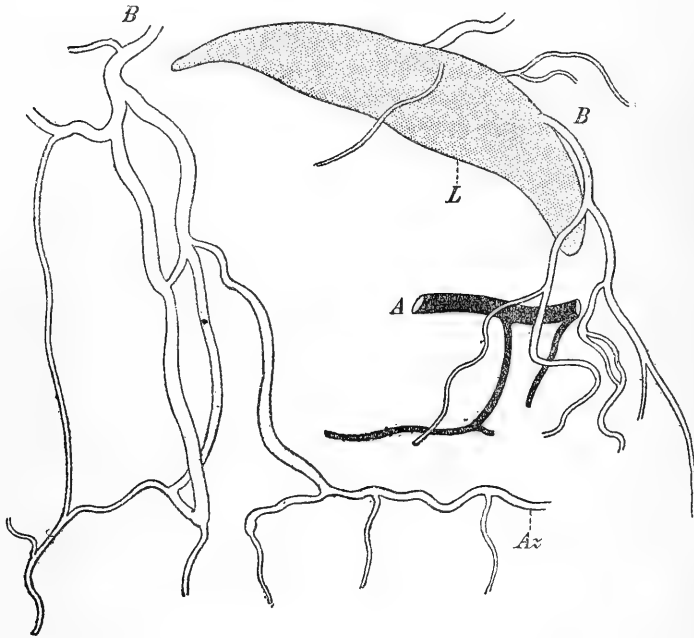
In *Crocodylus cataphractus*, as in *Crocodylus acutus*, a slender vessel leaves the left anterior abdominal vein some way behind the liver, and running obliquely forwards joins the right anterior

* Whether this is also the case with *C. cataphractus* I am not able to say. According to Rathke they are separate in origin.

† *Loc. cit.* p. 257 footnote.

abdominal vein not very far from the edge of the liver. In the smaller example of *Osteolemus tetraspis* which I have dissected I could detect no such connection at all; the two veins were quite independent throughout their course. In a larger specimen of this species, a vein ran from the left anterior abdominal and was observed to pass obliquely forwards; I lost it in the neighbourhood of the gall-bladder, and so am inclined to suspect that it did not join the right anterior abdominal but entered the liver separately. Its point of origin, moreover, was further forward than the connection in *Crocodylus cataphractus*.

Text-fig. 105.



Portal veins of liver in *Osteolemus tetraspis* (left-hand figure) and *Crocodylus cataphractus* (right-hand figure).

A. Aorta; Az. Azygos of left side; L. Liver; B. Entrance into liver of veins connected with azygos.

Though I am uncertain as to the destination of the branch of the left anterior abdominal vein in *Osteolemus*, I have noted and been able to follow the course of an apparently identical vein in *Caiman sclerops*. The left vein in this Crocodylian is smaller than the right, and a little way behind the liver it divides into two branches, of which the right is rather the thicker. The latter enters the liver in the furrow between the two lobes and receives a branch from the stomach before so entering. The left branch enters the portal system of the left lobe. The division of the left

anterior abdominal takes place almost exactly on the middle of the stomach, as also in an example of *Alligator mississippiensis* with which I have been able to compare this Caiman. Moreover, in both Alligators the right branch received a twig from the stomach which underlay (when the reptiles were examined in the usual position of dissection) the left division of the left anterior abdominal. The same branching is described by Jacquart in the "Caiman à museau de brochet," but the details seem a little different.

The material does not at present exist for a comparison of the different genera of the Crocodilia, and for a classification based upon the entire structure of these reptiles. It is in the meantime interesting to note—though it is obviously premature to found any generalisation upon the facts—that the West African *Osteolemus* does show certain points of likeness to the American Crocodilia in respect of some of the veins that have been dealt with in the foregoing pages. In *Alligator*, as shown by Jacquart's figure of *Alligator lucius**, and by my own observations, which I take the opportunity of recording in the present communication, upon *A. mississippiensis*, the two anterior abdominal veins are *not* connected by an obliquely running commissure †. The same vein is also absent or at least modified in *Caiman sclerops*. On the other hand, as I have shown, certain species of the genus *Crocodilus* possess it. Now this connecting vein is absent or at least modified in *Osteolemus*. Again, the latter genus has the two azygos veins exposed superficially along their course, while in *Crocodilus* the same veins are for the most part entirely buried under the musculature. In this particular also *Osteolemus* agrees with the species of *Alligator* which I have referred to in the foregoing pages, viz. *Alligator mississippiensis*.

Dorsal and Lateral Parieto-hepatic Veins.—These veins, termed by Rathke venæ vertebralis postremæ, really consist, as was not noted by him, of veins arising from two sources. There are veins connected with the vena vertebralis posterior or azygos, on each side, or, if the latter be not visible superficially, emerging from the parietes close to the vertebral column, and there are trunks of more lateral origin from the parietes. Save for the Varanidæ ‡, this double origin of the dorsal parietal affluents of the hepatic portal system is not found among the Lacertilia, or at least has not been as yet recorded, and certainly does not exist in many forms. The presence of the lateral parieto-hepatic affluent is accompanied in both the Crocodilia and the Varanidæ by the development of a longitudinally running lateral parietal vein, which, though represented in the Lacertilia, is not so important in them. I have already given some account of these veins in *Crocodilus acutus* §. I am now able to give further details of this system in the Crocodilia from the examination of other species.

* Ann. Sci. Nat. *loc. cit.* pl. 3. fig. 1.

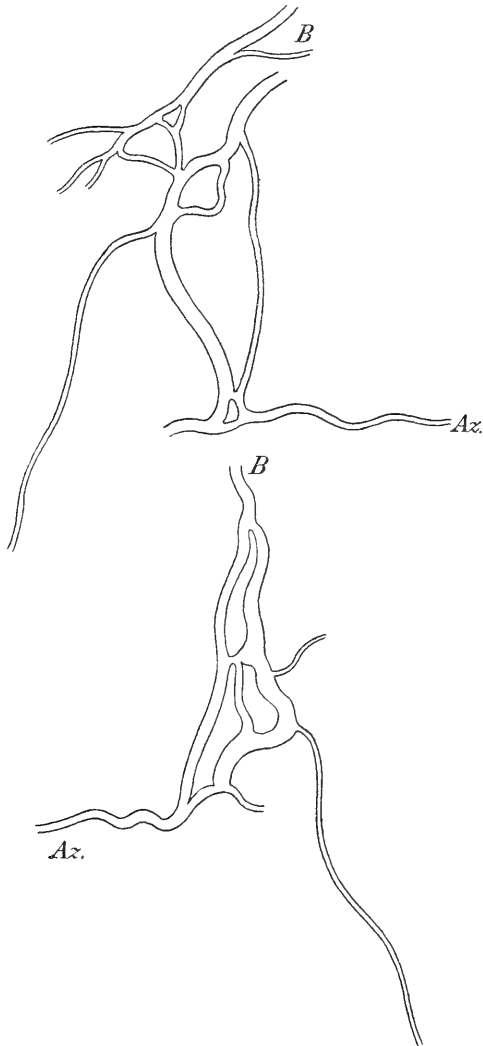
† It is noteworthy that in both *All. mississippiensis* and *Caiman sclerops* the left vein is nearer to the middle line than the right vein.

‡ *Supra*, p. 616.

§ P. Z. S. 1905, vol. ii. p. 466.

In *Crocodylus cataphractus* the arrangement of these vessels on the right side of the body was as is shown in the accompanying figure (text-fig. 105, p. 621). Two branches arise from the parietes close to the vertebræ, of which the anterior is the more slender;

Text-fig. 106.



Veins connecting azygos with liver in *Caiman sclerops*:

Upper figure the left side, lower figure the right side. Lettering as in text-fig. 105.

these unite some little way before they reach the liver. Shortly after reaching the liver, but before burying itself in the substance of the same, the vein receives another which is made up of three tributaries, of which two are from intercostal spaces immediately following those which give rise to the first two of these dorsal parieto-hepatic branches. The third vessel arises from the parietes laterally. The vein formed by the union of the five venous twigs which have been just enumerated enters the substance of the liver considerably to the right of the entrance of the right anterior abdominal vein. Between the two enters a vein which conducts only blood from the lateral parietes. As is also shown in the figure referred to, the posterior vertebral artery arises from the aorta and reaches the parietes between the two anterior intercostal veins. This is the same on both sides of the body.

These branches from the azygos to the liver are also arranged with perfect symmetry in relation to each series on the two sides of the body. They commence in each case opposite to the same vertebra. The actual sizes, however, of the several branches differ, though the total volume appears to me to be much the same. On the left side there are two thick trunks which are not far short of the azygos itself in calibre. These join before reaching the edge of the left lobe of the liver. After joining, the common trunk bifurcates into a wider and a narrower branch. The wider branch enters the liver at the apex of the left lobe immediately. The narrower branch receives almost at once a thinnish parietal branch, and passes downwards along the free posterior edge of the left liver-lobe to some way along that margin, though considerably short of the middle line. Here it enters the liver-substance independently of not only the anterior abdominal vein, but also of the lateral parietal and considerably to the left of both these veins. The wide calibre of these various veins contrasts with the very narrow corresponding intercostal arteries and their branches. This contrast is much more marked than in other regions of the vascular system, where the arteries and veins are more equisized.

I have examined only one individual of *Crocodylus cataphractus*, and it might therefore be supposed that the conditions observed being subject to variation were hardly distinctive of the species. Whether this be so or not I do not, know; but in any case there is so considerable an agreement between two individuals of *Osteolemus tetraspis* of which I have dissected the veins under consideration, that I describe the following conditions with some confidence as distinctive of that species. On the left side of the body there are four vessels belonging to the system of veins which is at present dealt with. The three anterior of these belong entirely and only to the vena vertebralis posterior, and they arise from it. The actual way in which these vessels join and rejoin with each other before reaching the liver is illustrated in the sub-joined figure (text-fig. 105, p. 621), and is rather more complicated than the arrangement found in *Crocodylus cataphractus* and *C. acutus*; that is to say, there are anastomoses between the trunks

in question before they finally join to enter the liver. An inspection of the figure will do away with the necessity of a detailed description. In addition to these three stouter vessels a more slender trunk arises (behind them) and is connected above with the veins running directly from the stomach to the liver. This vessel (in both specimens, I believe, but certainly in one) is also derived from the lateral parietes, and thus exactly corresponds to a similar vessel in *Crocodylus cataphractus*, which is also in the same way the last of the series.

In *Caiman sclerops* there are again differences of detail. The right and left sides are shown in the accompanying figures (text-fig. 106, p. 623). In both cases there is a branch from the lateral parietes, which, as in other Crocodilia, is the last of the series of the parieto-hepatic veins. On the right side only two trunks arise from the azygos, but the posterior immediately divides to shortly reunite with both of the primary branches. On the left side there are only two vessels arising from the corresponding azygos. These are fused immediately after their origin, but divide again at once. Further details will be obvious from an inspection of the illustrations. In comparing the course of these vessels in the several Crocodilia which I have had the opportunity of examining, it is possible to arrive at certain differences and agreements between the four species dealt with.

In the Crocodiles (*C. acutus** and *C. cataphractus*) the number of trunks forming the dorsal parieto-hepatic affluent of the portal system is greater by one or two than in either *Osteolemus* or *Caiman*. On the other hand, in the two last-named genera the interconnections between the several trunks before they unite to open into the liver are to be remarked, and are not seen in the two species of *Crocodylus*. Furthermore—but as this depends upon negative evidence, less stress is laid upon it—the vein in question in *Osteolemus* and *Caiman* is connected before its entrance into the liver with the stomach plexus of veins. It is interesting to observe that in this system of veins as well as in others *Osteolemus* and *Caiman* show likenesses to each other and corresponding differences from *Crocodylus*.

In addition to the constantly present laterally arising trunk which in all the Crocodilia examined joins the dorsal parieto-hepatic vein, there are other vessels also lateral in origin which have a separate entry into the liver. In *Osteolemus tetraspis* three slender veins arise from the parietes laterally more ventrally than the lateral affluent of the dorsal parieto-hepatic already described; each enters the liver separately. On the left side I could find only one corresponding vein. In *Crocodylus cataphractus* each lobe of the liver has also a corresponding vein originating from the lateral parietes. It enters the liver between the anterior abdominal and the dorsal parieto-hepatic veins. I have not observed this vein in other Crocodiles.

* P. Z. S. 1905, vol. ii. p. 486.

4. Description of the External Characters of an unborn Fœtus of a Giraffe (*Giraffa camelopardalis wardi*). By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Society.

[Received May 29, 1906.]

(Text-figures 107-109.)

On May 5th (Saturday) of the present year the female Transvaal Giraffe purchased by the Society in 1895* died, and was examined on the Monday following at the Prosectorium. The animal was found to be pregnant, and the fœtus was female.

Inasmuch as the fœtus was not of full-time, it became a matter of importance to determine its age and to compare its appearance with that of the newly born Giraffe. The newly born Giraffe has been described by the late Sir Richard Owen †, and the time of gestation varies from 431 to 444 days, according to his statements.

The age of the fœtus upon which I report here is a matter of inference. Mr. Pocock has been so good as to furnish me with the following facts bearing upon this question. It appears that the mother was "on heat" from May 1905 to the end of August or beginning of September. This condition then ceased. The reason for this cessation must have been either conception or the end of the period of heat. The latter view was the one taken until the death of the animal revealed the fœtus. Thus the fœtus was about 8 calendar months old. A nearer estimate than this cannot be formed. The fœtus may be said therefore to have passed about two-thirds of the normal period of gestation.

The most striking feature exhibited by the fœtus is undoubtedly the total absence of the least trace of the characteristic markings of the Giraffe. The colour was nearly uniform, and I give later a fuller description of the hues of the coat in various regions of the body. The horns are very prominent with long hairs, and a cartilaginous (?) horn-core could be felt within each. The early development of these as compared with some ruminants is noteworthy.

The proportions of the body are shown in the accompanying figure (text-fig. 107) and the lengths of different regions of the body and limbs are indicated by the table of measurements which follows. The most striking difference from the adult Giraffe is, as it appears to me, the comparative shortness of the neck, which is quite visible in the figure (text-fig. 107). The general appearance of the head and neck is, apart, of course, from the horns, not unlike that of a Lama; there is no particular suggestion of the

* See P. Z. S. 1895, p. 161.

† Trans. Zool. Soc. vol. iii. p. 21, and Comp. Anat. & Phys. Vertebrates, London, 1868, vol. iii. p. 739.

Okapi about this or any other region of the body. It will be noticed in the figure that the neck is much creased, more so than the skin of the body, which is perhaps indicative of a rapid growth in this region. The very soft hoofs terminate in quite pointed extremities.

Text-fig. 107.



Fœtus of Giraffe, illustrating the general proportions of the body.

The following are some of the principal measurements, many of which correspond with those tabulated by Owen for the newly born Giraffe.

	Feet.	inches.
From the muzzle to the root of the tail following the line of the back	3	5
From the muzzle to the interspace of the horns...		9
From the horns to the termination of the mane at the shoulder	1	9½
Length of the back, from the mane to the root of the tail		10½
From the base of scapula to the end of the fore- hoof (in straight line)	2	9½
From the base of scapula to olecranon		10
From the olecranon to the carpus		9½
From the carpus to the end of the hoof.....	1	3
Length of neck from occipital to anterior edge of scapula placed vertically	1	3
Length of back from anterior edge of scapula to root of tail.....	1	1½
Length of hind limb from superior border of ilium to end of hoof, measured in a straight line ...	2	6½
From border of ilium to fabella		9
From patella to calcaneum		11
From calcaneum to end of hoof	1	4

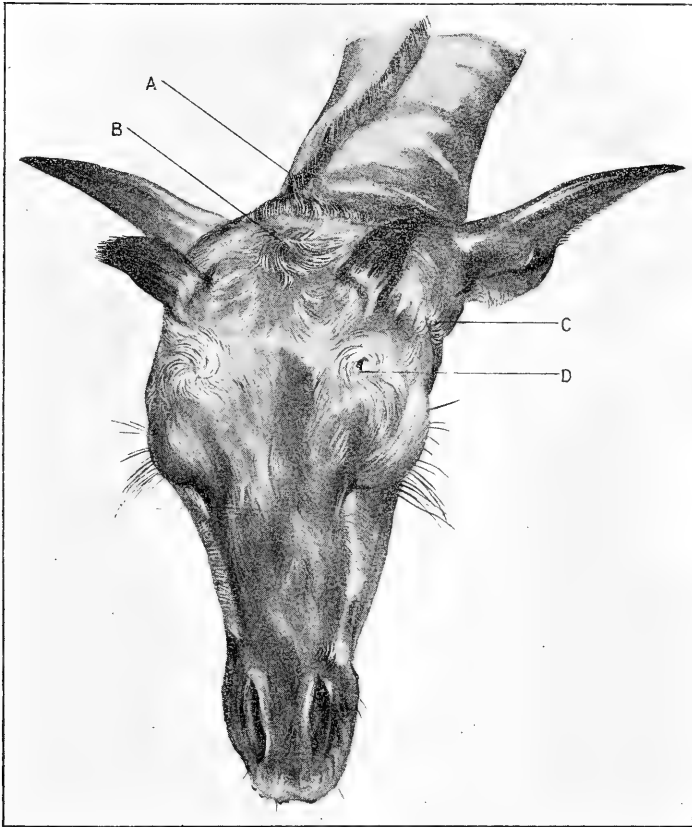
In comparing these measurements, we may note first of all that the fœtus described here is exactly half the length of the newly born Giraffe measured by Owen in the year 1839.

It is remarkable to find, from a further comparison of these measurements, that there is a serious discrepancy between the relative lengths of the neck and body in the fœtus examined by myself and in the newly born animal measured by Owen "a few minutes after its birth." According to the latter, the length of the back from the end of the mane to the root of the tail is considerably more than the length of the neck. According to my own measurement (with which, as will be seen, the drawing made independently of my own measurements agrees) the back is shorter than the neck. I feel convinced that, though I may have erred in failing to arrive at an extreme accuracy of measurement, so great an error cannot have crept in.

The *hairy covering* of the fœtus was in more than one respect interesting. At first sight it appeared to be for the greater part without hair at all. Examination with a lens, however, showed fine, very pale-coloured hairs everywhere in those tracts which a superficial study would pronounce to be naked. This very delicate hairy covering was, however, manifest upon the neck and legs as a whitish bloom when the skin was comparatively dry, not, however, upon the trunk and flanks. In those regions where the hair was thus evident without the use of a lens the hairs were naturally longer; still they had the same whitish colour, and the suggestion given is as if the neck and feet, and especially the feet, had been powdered.

The head was completely furry with longish close-set hairs, definitely brown in colour though palish, and showing distinct whorls. There was one whorl above each eye, another between the eye and the ear, and a median unpaired whorl in the occipital region. I saw nothing of the kind in the nasal region. The eyelashes were quite conspicuous (see text-fig. 108).

Text-fig. 108.



Head of fœtus of Giraffe.

A, commencement of mane; B, C, D, whorls of hair.

Besides this general hairy covering, most pronounced upon the head, there were other tracts covered with much stouter hairs. Each fore limb had (see text-fig. 109) a strongly marked tract, extending over a part of the carpus and a portion of the meta-

carpus for $5\frac{1}{4}$ inches, which was densely covered with strong hairs of a whity-brown colour. This tract was wider above and ended below in a fine point. It would touch the ground if the animal

Text-fig. 109.



Front view of fore foot of fetus of Giraffe.

A, patch of strong hair on the carpus and metacarpus.

were placed in a kneeling posture, as it was quite anterior in position. The posterior surface of each "hock" (calcaneum) had

a much less extensive, more feebly developed, and less sharply marked patch of hairs.

On the head each horn consisted of a fold of skin in which the separate and movable horn-core could be felt as of gristly consistency. This fold of skin was capped by long hairs, which were black at the extremity as in the newly born and adult Giraffe. The mane was quite visible as a distinctly marked tract of close-set longish hairs definitely fawn-coloured; it ended just below the shoulder. At the root of the tail and for a little way down it there was a continuation of this crest, but not nearly so well-marked or so circumscribed. The tuft of black hairs at the end of the tail was quite obvious. A smaller tuft of shorter whity-brown hairs also existed at the extremity of the tail below the black patch.

On the ventral median line in the abdominal region and upon the sternum was also a band of hair, not so pronounced as the mane, but still very conspicuous; this was not found between the legs, either hind or front.

Finally, the vulva was encircled with longish white hairs.

These are, I believe, the chief facts concerning the distribution of the hairy covering of the young Giraffe. The material does not exist for much comparison with the mode of hair-growth in other Ungulates, and it is therefore all the more important to record the facts with a view to future comparisons.

In the meantime I have been able to compare this fœtus with one of evidently not very different age of *Ovis vignei*. I propose, however, to accumulate more facts with regard to the distribution of the hair and other external characters in the fœtus of Mammals as opportunity serves me, and do not therefore give any detailed description of this fœtus, the characters of which, moreover, are probably well enough known.

I desire, however, to call attention to a patch of strongish hairs upon the wrist, exactly in the same position as the tuft of hair in the Giraffe illustrated in text-fig. 109. In the fœtus of *Ovis* the patch was of very much less extent, not reaching nearly so far down the metacarpus. It was, furthermore, not nearly so sharply marked off from the surrounding integument as in the Giraffe, though composed of hairs of exactly the same whity-brown colour.

June 19, 1906.

SIR EDMUND LODER, Bt., Vice-President, in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie during the month of May 1906 :—

The number of registered additions to the Society's Menagerie during the month of May was 391. Of these 169 were acquired by presentation, 25 by birth, 14 by purchase, 179 were received on deposit and 4 in exchange. The number of departures during the same period, by death and removals, was 229.

Among the additions special attention may be called to :—

Two Black-footed Cats (*Felis nigripes*) from the Zambesi, new to the Collection, presented by Mr. A. W. Guthrie on May 26th.

A male Eland (*Taurotragus oryx*) presented by the Duke of Bedford, K.G., President, on May 16th.

Three Thrush-like Bulbuls (*Ixocincla crassirostris*) from the Seychelles, a Black Hang-nest (*Cassidix oryzivora*) from Brazil, new to the Collection, and three Red-crowned Pigeons (*Alectraenas pulcherrima*) from the Seychelles, presented by the Earl of Crawford, K.T., F.R.S., F.Z.S., on May 14th.

The Hon. Walter Rothschild, Ph.D., F.Z.S., exhibited specimens of the Forest-Pigs *Hylochoerus meinertzhageni*, *Potamochoerus chæropotamus daemonis*, and *Potamochoerus johnstoni*, and made the following remarks :—

The adult male of *Hylochoerus meinertzhageni* Thomas is distinguished at a glance from *Phacochoerus* by the absence of the second pair of "warts" behind the tusks and the presence of gigantic warty excrescences below the eyes, some three times the size of those in *Phacochoerus*. It is also covered with much longer and thicker hair than *Phacochoerus*. The specimen exhibited is from the Nandi Forest.

Potamochoerus chæropotamus daemonis Major is distinguished at once by its intense black colour. The specimen exhibited is from Kilima-njaro.

The male of *Potamochoerus johnstoni* Major has the pelage dirty red mixed with a few black hairs, and it is generally intermediate in colour between that of *Potamochoerus chæropotamus* of S. Africa and *P. porcus* of W. Africa.

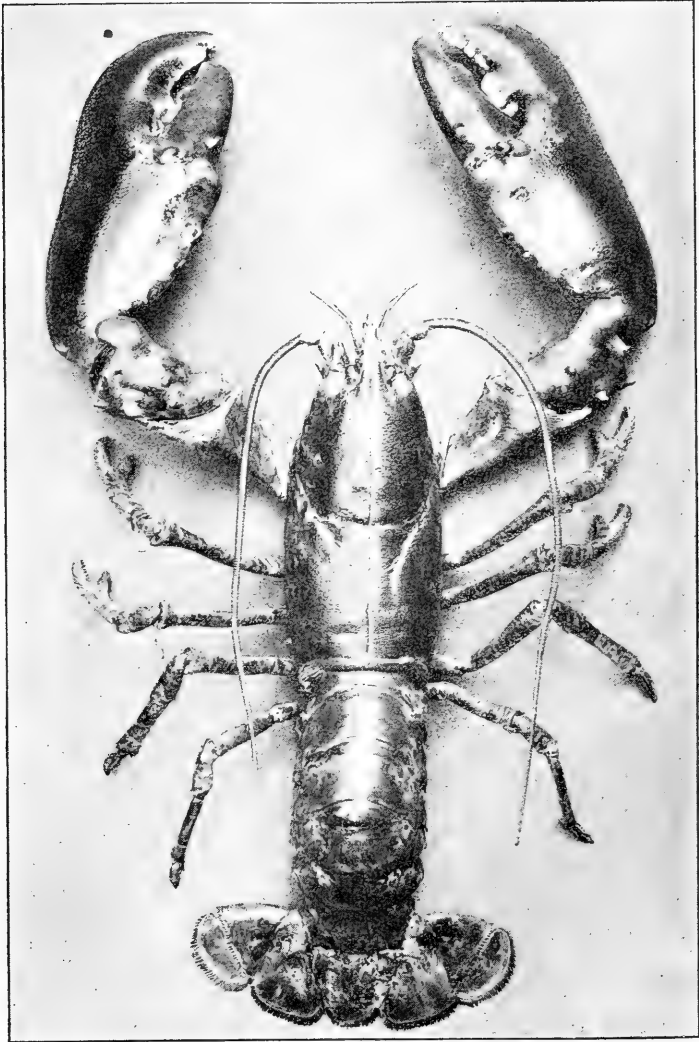
The skull shows the same distinctive features pointed out by Dr. Forsyth Major in P. Z. S. 1897, pp. 367-368. The supra-occipital is exactly as in the ♀ type, hardly incised at all, but the malar and squamosal are enormously thickened and shortened, more as in *P. larvatus*. The portion of the maxillary containing the tusk, however, is very attenuated, and though an old beast the tusk-stump is small.

The specimen was obtained at Fort Jameson, N.E. Rhodesia.

Mr. W. Savile Kent, F.Z.S., exhibited a series of lantern-slides, taken from photographs in natural colours, illustrating the Fish and associated fauna of the Polynesian Coral Reefs.

Dr. W. T. Calman, F.Z.S., exhibited a photograph of a Lobster

Text-fig. 110.



Lobster (*Homarus gammarus*) with similar chelæ.

(*Homarus gammarus* Linn.) with symmetrically developed chelæ (text-fig. 110, p. 633), recently presented to the Natural History Museum by the Directors of Harrod's Stores, Ltd. In the Lobster, as in many other Decapod Crustacea, the large chelæ are normally unsymmetrical on the two sides of the body, one being armed with blunt crushing-tubercles and being larger than the other, which has sharp, serrated cutting-edges. Occasionally, however, specimens are found, more frequently in the European * than in the American † species, in which both chelæ are of similar size and shape. In all such cases hitherto recorded, with the exception of one mentioned by Herrick on the authority of a fisherman, but doubted by Stahr, both chelæ were of the serrated, cutting type. It has been supposed that this might be due to regeneration after injury, since it is known that, in *Brachyura*, on removal of the crushing-claw, a cutting-claw is regenerated. Przibram ‡, however, failed to obtain such "heteromorphic" regeneration in the Lobster, and the present specimen throws still further doubt on the regeneration theory, since it possesses well-developed and quite typical crushing-chelæ on both sides of the body. In all other respects it is a perfectly normal male and weighed, when alive, four pounds ten ounces. It was caught near Stromness, Orkney, and its peculiar character was noticed by Mr. Thompson, manager of the Fish department in Harrod's Stores, by whom it was brought under Dr. Calman's notice.

Dr. Calman also exhibited, on behalf of Dr. A. Dugès, C.M.Z.S., a specimen of the Crustacean *Palæmon jamaicensis* Herbst, from the Atoyac River, Vera Cruz, Mexico.

Dr. C. G. Seligmann, F.Z.S., the Society's Pathologist, exhibited the aorta of a Tiger showing many aneurysms, and made the following remarks:—

The specimen shown to-night was derived from a tigress which had been for thirteen years an inmate of the Society's Gardens.

The aorta shows advanced arterial disease, most pronounced in the descending aorta, where there is marked atheroma and where, in a length of about 180 mm., there are fourteen aneurysmal swellings varying in size from that of a pea to that of a fair-sized plum. The two largest swellings, the walls of which are of stony hardness, occur close together on opposite sides of the artery. The tricuspid valves were perhaps thickened, and there may have been some tricuspid incompetence, but there was little or no change in the aortic valves, and, except in the neighbourhood of the aneurysms, there is no appreciable calcification of the vessels.

The kidneys showed changes of a chronic tubal character, without any marked excess of fibrous tissue.

* Stahr, Jena. Zeitschr. xxxii. p. 464 (1898).

† Herrick, "The American Lobster," Bull. U.S. Fish Comm. 1895, p. 143.

‡ Przibram, Zool. Anz. xxv. p. 12 (1902), and Arch. Entwicklmech. xix. p. 191 (1905).

The liver was tough and showed evidence of passive congestion.

The suprarenal glands also seemed tougher than they should have been, but no excess of fibrous tissue existed, and the relation of cortex and medulla seemed normal. Osteoarthritis existed in the large joints of both fore and hind limbs.

Considerable interest attaches to this case, since when Dr. R. N. Salaman read a note before this Society two years * ago on the death of the Polar Bear from the bursting of a false aneurysm, he was able to quote Professor McFadyean to the effect that he knew of no case of aneurysm in wild animals, and that this condition is extremely rare in the domestic carnivora.

Dr. Seligmann also exhibited some tail-feathers from a Common Pheasant (*Phasianus colchicus*), showing the markings peculiar to both sexes, and made the following remarks:—The feathers exhibited are derived from the tail of a cock of the Common Pheasant which is still alive, and which during the greater part of 1905 was deposited for observation in the Society's Gardens. The feathers were removed in July 1903 from the bird, then said to be between two and three years old. All of them show the same change; that is to say, the distal portion of each feather is male in pattern and colouring, while the proximal portion of the web shows the female character of these qualities. The bird from which these feathers were derived has shown no changes in any other part of its plumage, nor have its sexual habits been otherwise than normally male, and during the spring of the present year it fertilised a number of eggs. At the present time its appearance is fully male, and this has been the case ever since the summer of 1903, when the feathers shown, and others similarly marked, constituted the bird's tail. The history of this bird is that about Christmas, 1902, the base of the feathers of the tail, which were then predominantly male, began to show the female colouring and patterning at their bases, and that this spread as the feathers grew till in July 1903 the present condition was present. Unluckily there is no information as to its behaviour during the breeding-season of 1903, but probably its behaviour was normally male. The specimens shown have been deposited in the Museum of the Royal College of Surgeons, and one of them has been figured by Mr. S. G. Shattock and myself in the 'Transactions of the Pathological Society of London' for the current year.

The following papers were read:—

* Redcliffe N. Salaman: "On the Cause of Death of a Polar Bear recently living in the Society's Gardens," Proc. Zool. Soc. Lond. 1903, ii. p. 348.

1. On the Nudibranchs of Southern India and Ceylon, with special reference to the Drawings by Kelaart and the Collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne. By Sir CHARLES ELIOT, K.C.M.G., F.Z.S., Vice-Chancellor of the University of Sheffield.

[Received May 19, 1906.]

(Plates XLII.—XLVII.*)

The present paper is mainly an attempt to settle the synonymy of various Nudibranchiata of the Indo-Pacific with the help of material preserved in the Hancock Museum at Newcastle-on-Tyne. The genus *Doriopsilla* is discussed, and some new information as to the anatomy of several species (particularly *Platydoris formosa*, *Pl. papillata*, *Doriopsilla minviata*, *Kalinga ornata*, and several Pleurophyllidiidæ) is also given.

The material preserved at Newcastle, and kindly placed at my disposal by the authorities of the Museum, is of two kinds, collections and drawings. The oriental collections of Alder and Hancock appear to consist of three separate consignments sent from India. They are not kept separately, but can be distinguished.

(a) The collection made by Walter Elliot near Vizagapatam in 1853-4, and described by Alder and Hancock in the 'Transactions' of the Zoological Society for 1864, pp. 113-147. This collection contains an almost complete series of Alder and Hancock's types, all duly labelled; but, most unfortunately, many of them have been allowed to dry up entirely, and nothing whatever can be said of either their anatomy or their external appearance. In some cases it has been possible to extract the buccal parts from these dried morsels, but when there were only one or two specimens it was found that they had been already dissected by Alder and Hancock. The collection of "Diphyllidiadæ, Pleurobranchidæ, Bullidæ, and Aplysiadæ," mentioned by Alder and Hancock in the first paragraph of their paper, is also preserved, and the Pleurophyllidiidæ (= Diphyllidiæ) are noticed below. The hardness of the animals and the distinctness of the buccal characters make it possible to identify them. They were not named by Alder and Hancock.

Even the specimens which have not become dry are in poor condition, which is hardly surprising since they are more than fifty years old. But many of them have preserved their external appearance fairly well, and the hard parts, such as the teeth, armature of the genitalia and of the labial cuticle, &c., are uninjured. The ribbon of the radula, however, is generally decayed, so that the arrangement of the teeth is disturbed.

(b) A few specimens collected by Kelaart are sufficiently well preserved to repay examination, but, as in the previous collection,

* For explanation of the Plates, see p. 690.



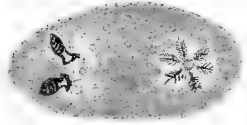
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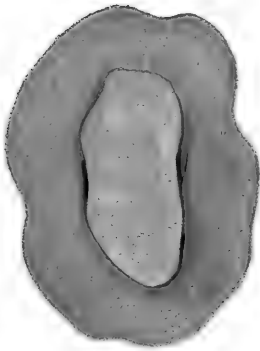
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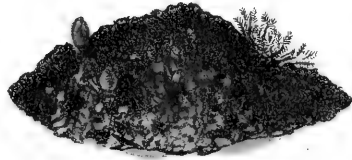
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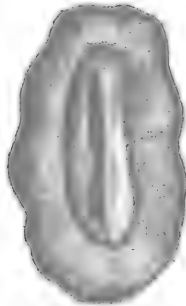
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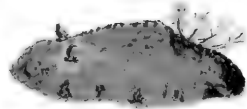
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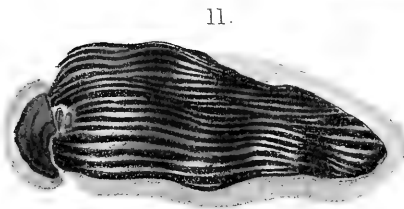
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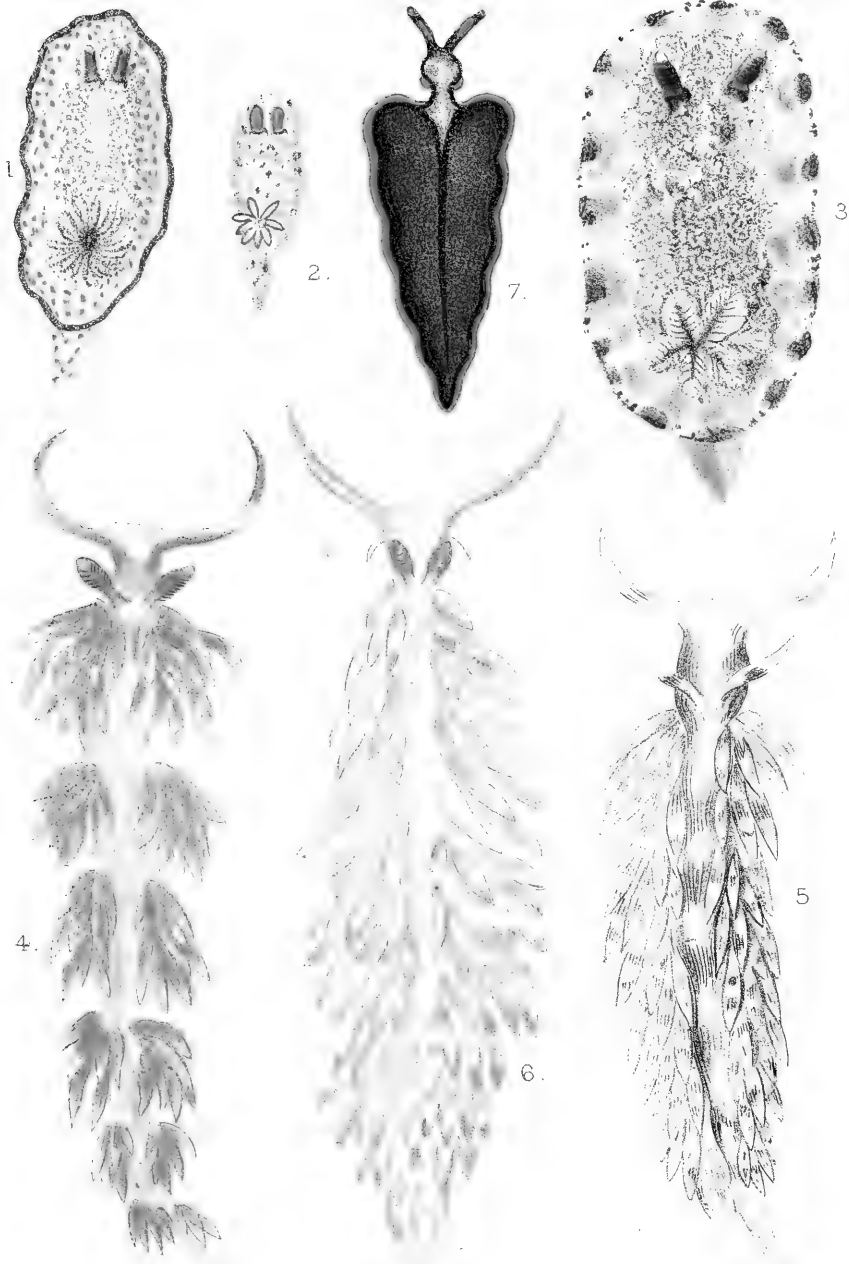
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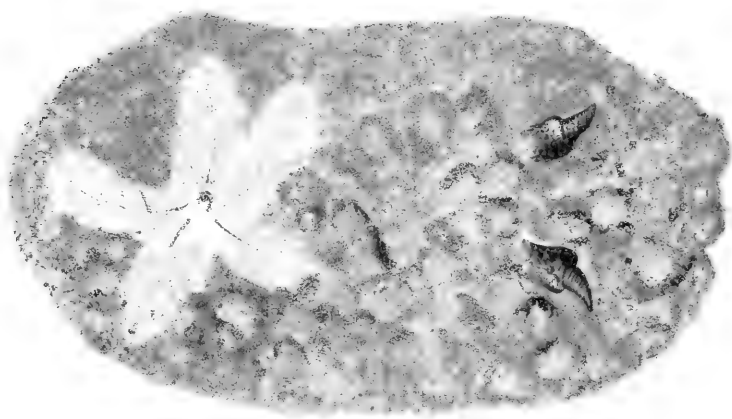
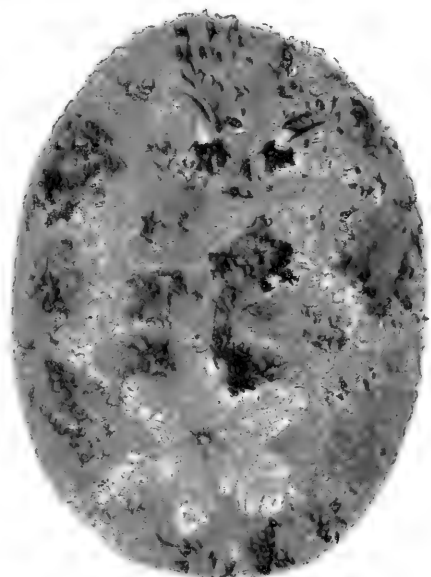
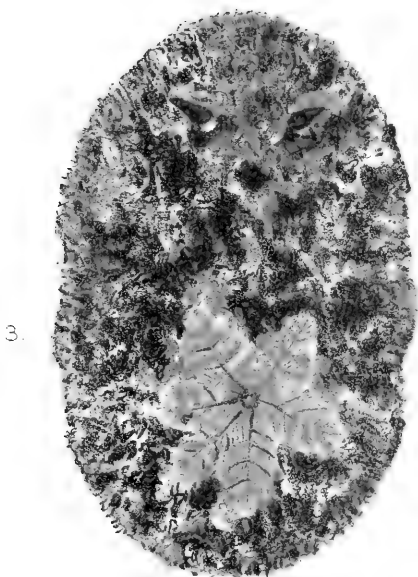
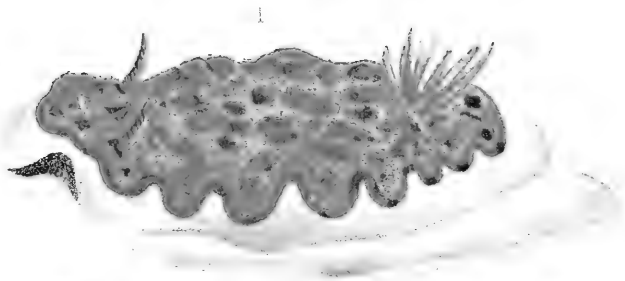
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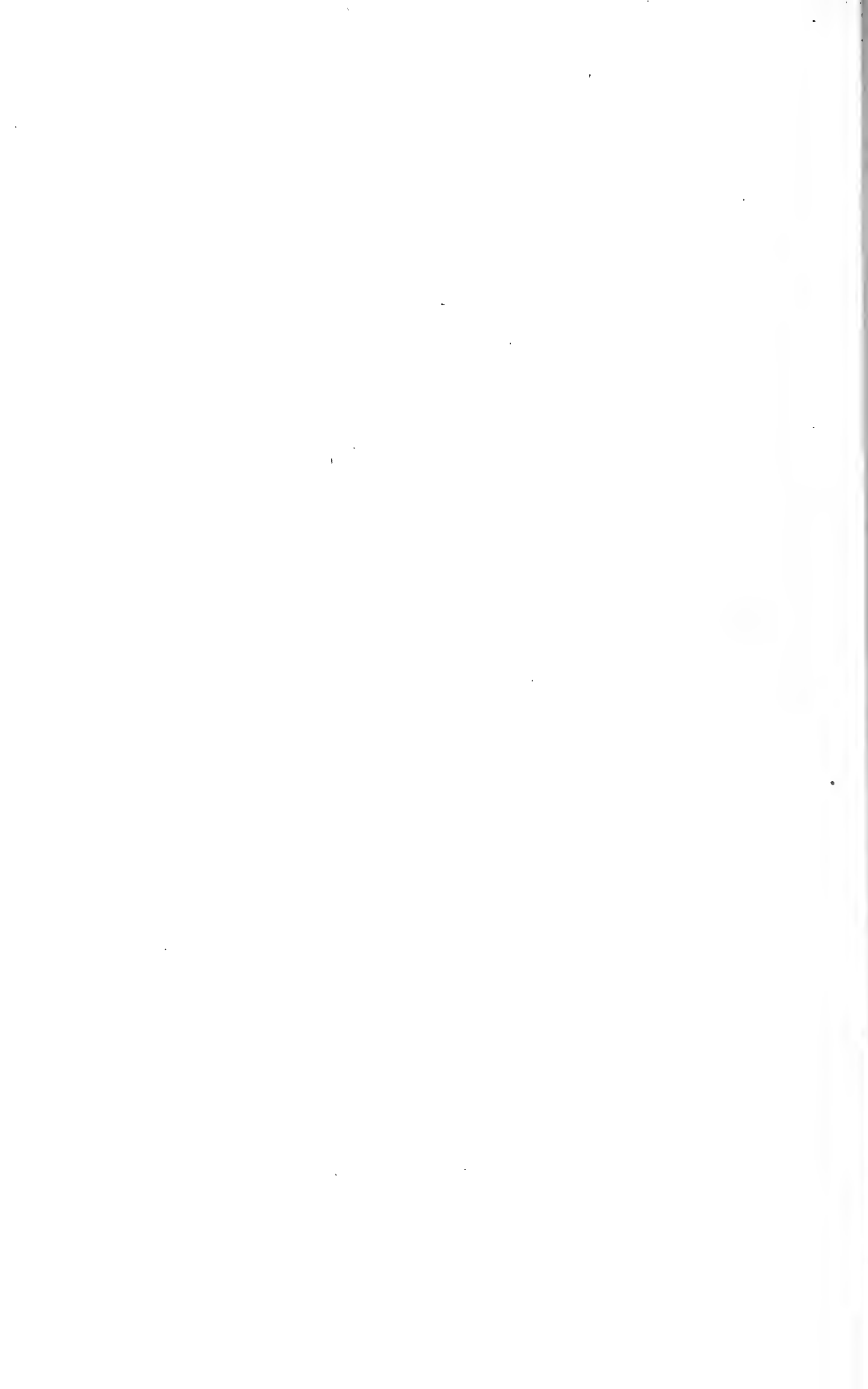
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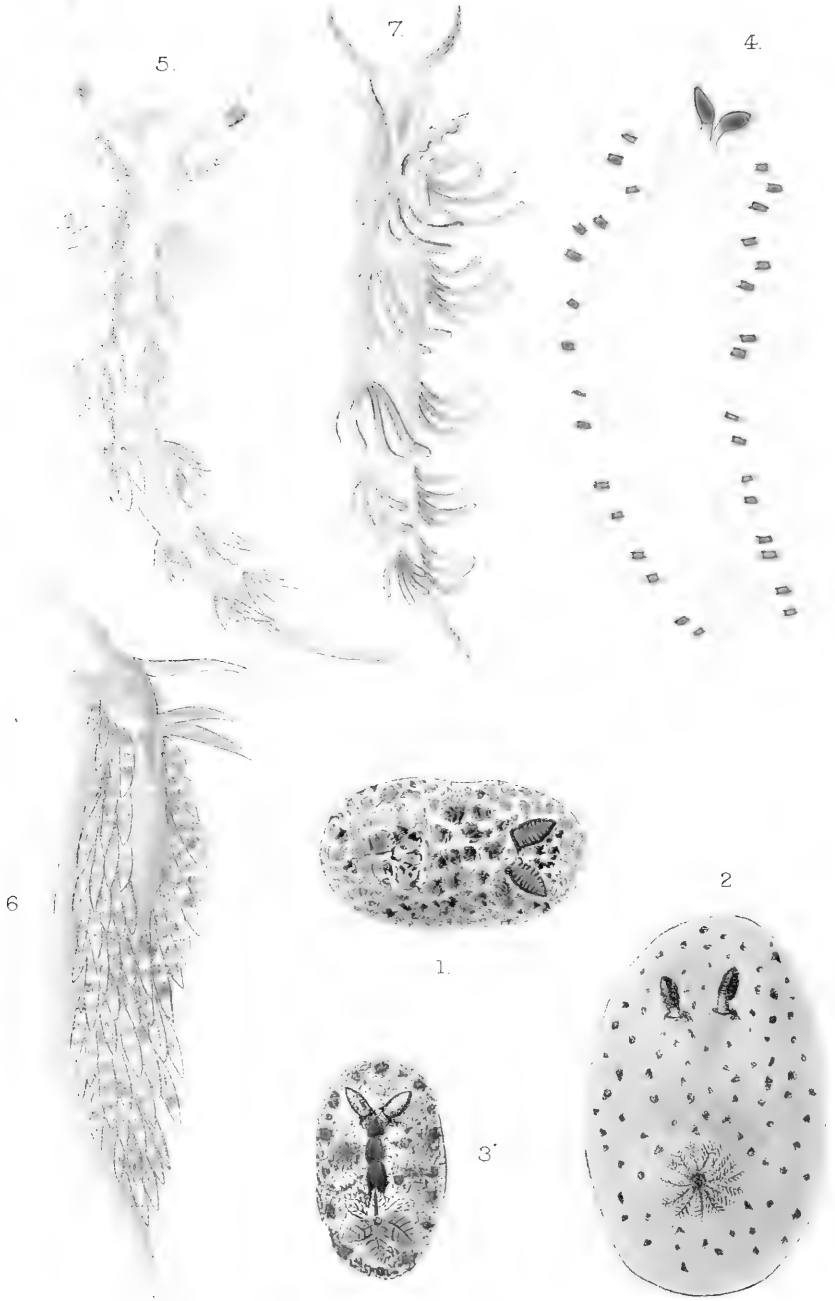


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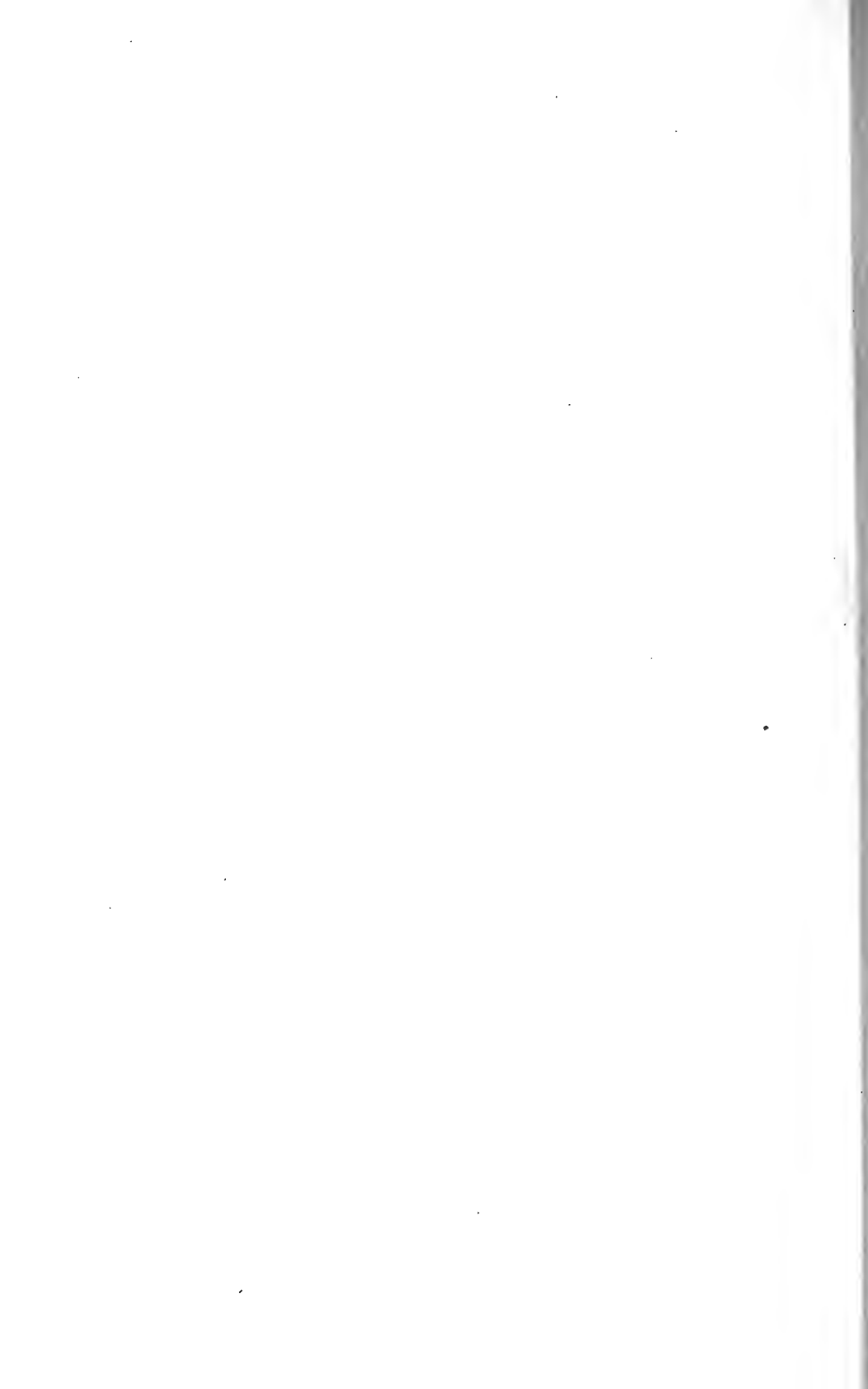


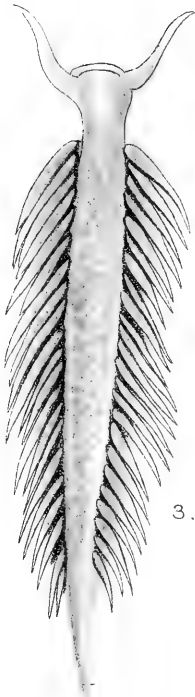
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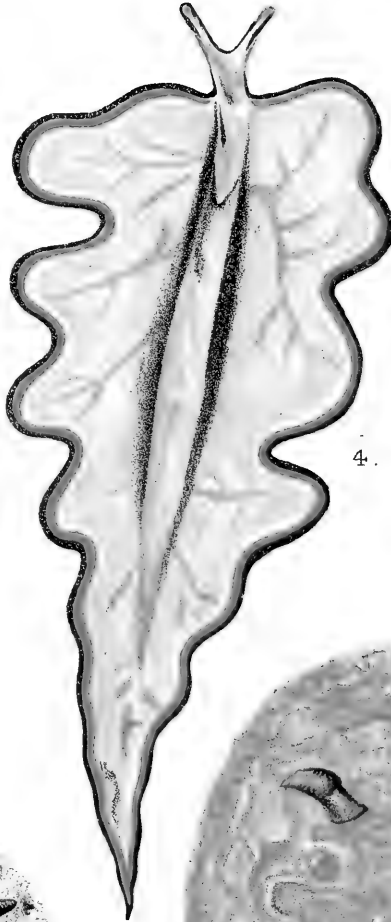


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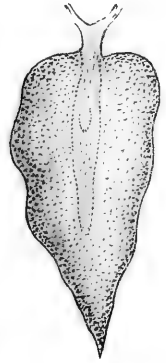




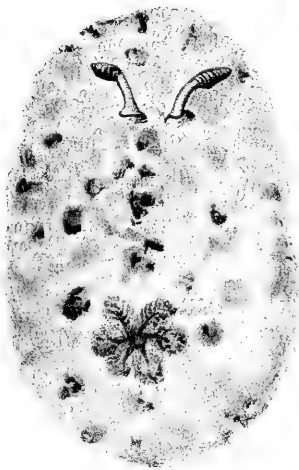
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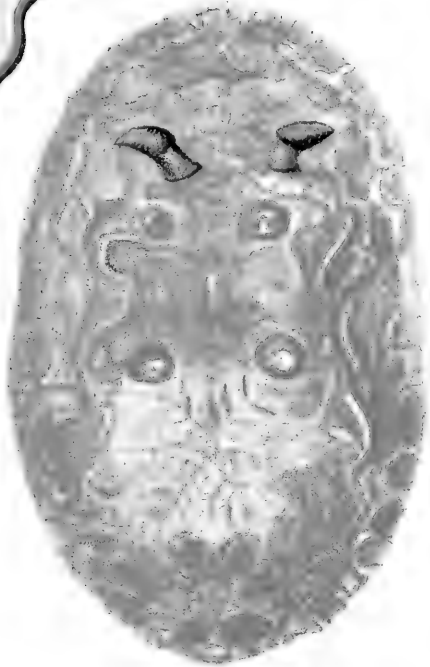
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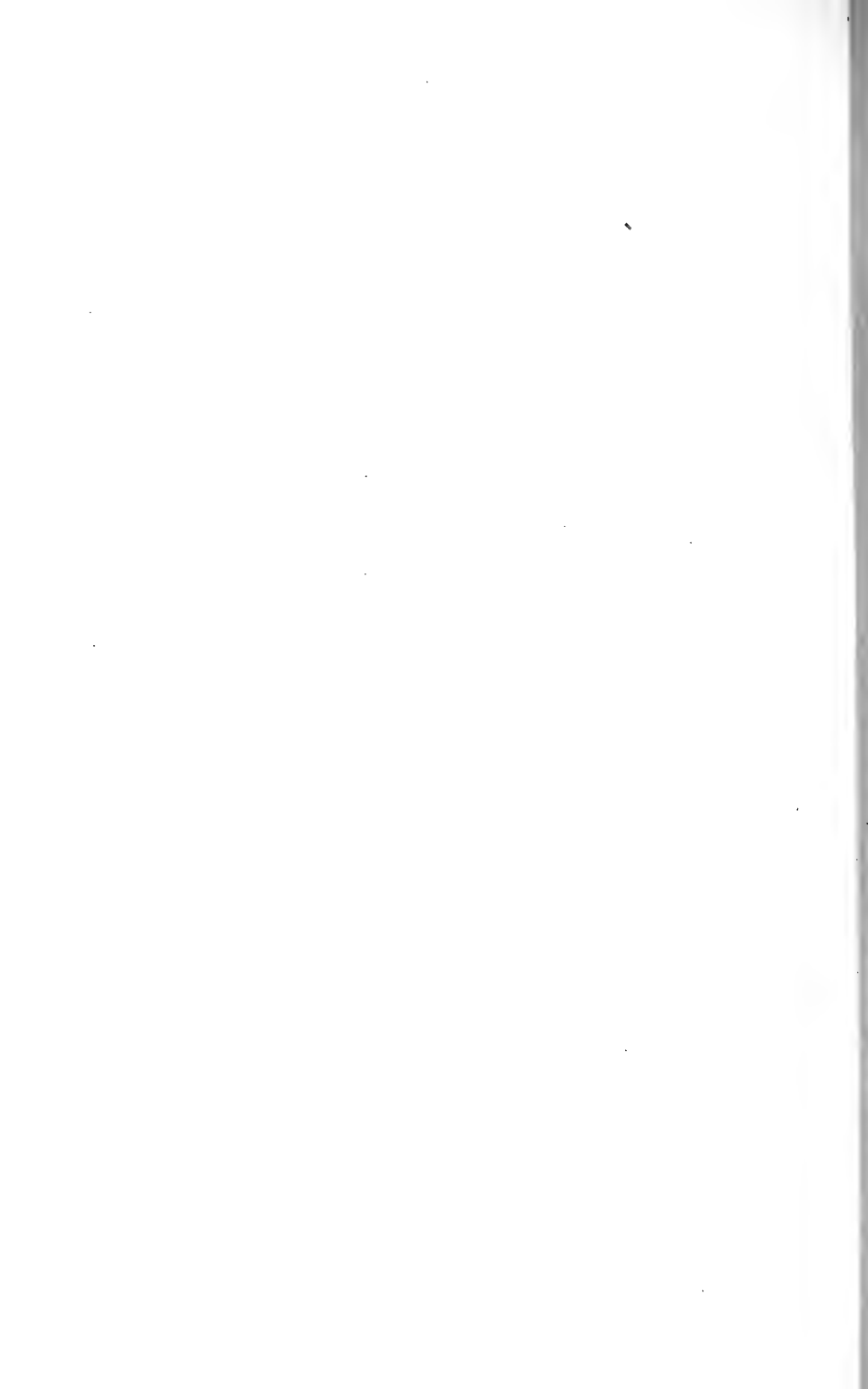


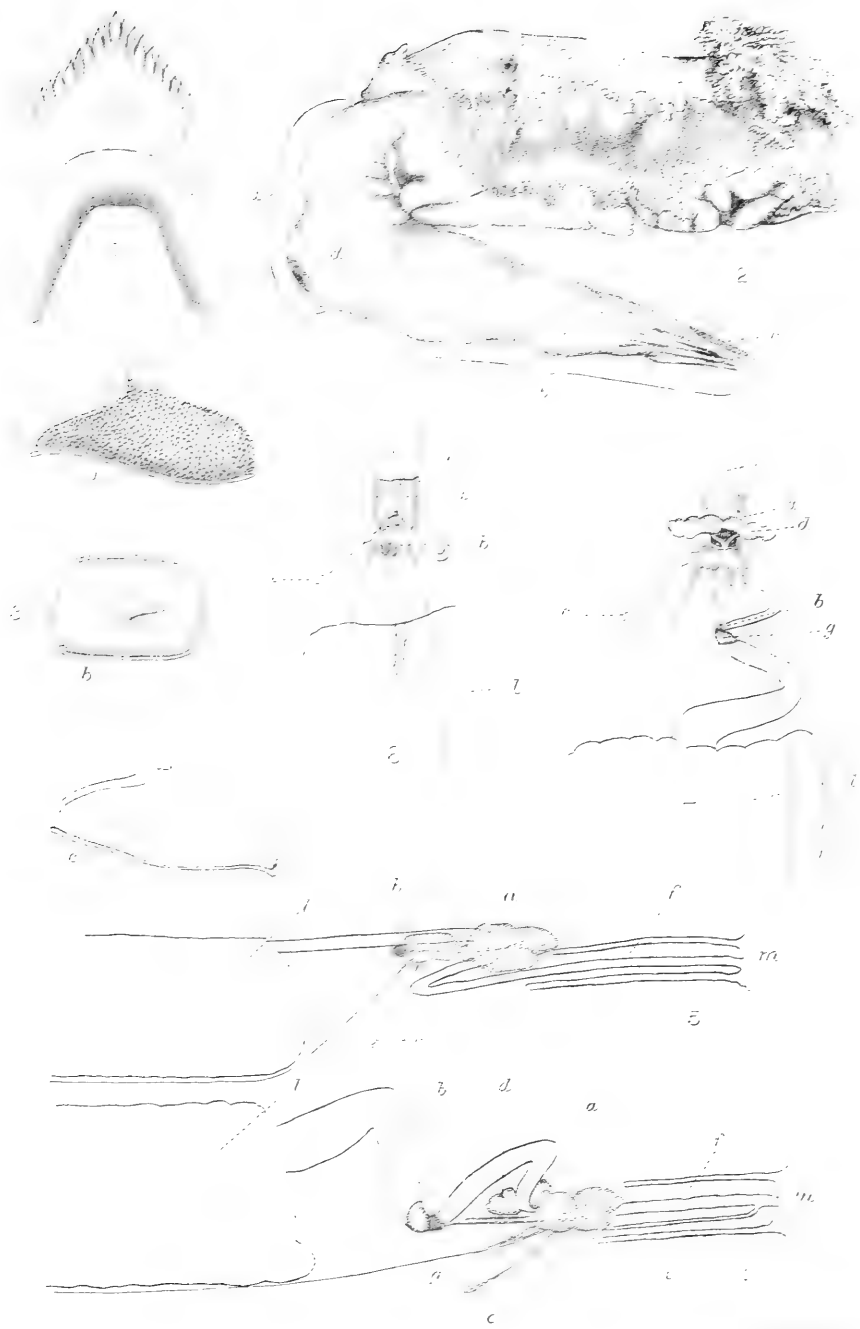
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BRADY 1882

NUDIBRANCHS OF S. INDIA AND CEYLON.



many are useless. Kelaart's specimens are marked as such, apparently in Hancock's writing, and generic and specific names are usually but not invariably appended.

(c) A collection designated by the label "Madras (or India) 1867. Sir Walter Elliot." This collection does not appear to have been sorted or named by Alder and Hancock. Besides Nudibranchs, it contains Tectibranchs, Pulmonates, Lamellariidæ, and Echinoderms.

The drawings consist of figures of about 55 species of Nudibranchs made from life by Kelaart in Ceylon. Thirty-five of these figures are now reproduced. The rest have been left aside, in most cases because other figures of the animals which they represent have been published, but in a few cases because they add nothing to the printed description. The poorly executed figure of *Doris cerisa*, for example, adds nothing to Kelaart's statement that it is a small *Doris* of a cherry-red colour.

It may be asked whether it is worth while to publish these old drawings. Bergh seems inclined to think that it would be better to leave aside all inadequate descriptions of Nudibranchs and pay no attention to them. This would be convenient if it were practically possible, and little would be lost. But is it practically possible? Bergh's own lists contain a selection of Kelaart's names, and yet I think he has sometimes redescribed Kelaart's species under other names, which he would hardly have done if he had seen the drawings. Further, there is a great practical advantage in giving animals old names, because they are less liable to alteration. If a nudibranch bears a name given by Kelaart, it need not be rebaptized if it is found to be identical with species imperfectly described by Pease, Angas, Abraham, and others.

Apart from this, Kelaart is by no means an authority to be despised, though he has not found favour with many of his critics. He totally ignored anatomy, and his descriptions of external characters have not that wealth and precision of detail which might be desired. But he is exact in recording localities and seasons, and he adds many notes on the habits of the animals, particularly on their spawn. His papers are of little service to the student of preserved specimens, but, taken together with his drawings, they will probably enable a naturalist in Ceylon to identify most of his species. They appear to have been published three times:—

- (a) As a pamphlet (pp. 1-64), dated "Trincomalie. 1st November, 1857." I have a copy of this pamphlet, which I have used in preparing the present paper.
- (b) In the Journal of the Ceylon Branch of the Royal Asiatic Society in 1858.
- (c) In the Annals and Magazine of Natural History, 1859, in three separate papers:—

I.	Ann. & Mag.	1859,	vol. iii.	pp. 291-304.
II.	"	"	vol. iii.	pp. 388-496.
III.	"	"	vol. iv.	pp. 267-270.

The references in the present paper are made to the 'Annals & Magazine' as being more accessible than the other publications, and the three papers are cited as Kelaart, l. c. I., II., and III. Similar abbreviated references are:—

- A. & H. l. c. = Alder and Hancock, "Notice of a Collection of Nudibranchiate Mollusca made in India by Walter Elliot, Esq.," in Trans. Zool. Soc. 1864.
 Farran, l. c. = Report on the Pearl-Oyster Fisheries of the Gulf of Manaar: Royal Society, 1905. Supplementary Report, xxi., "On the Opisthobranchiate Mollusca," by G. P. Farran.
 Bergh, Siboga = Siboga-Expeditie. L. Opisthobranchia. R. Bergh. 1905.

The three editions of Kelaart's paper do not appear to contain any differences of importance, but the pamphlet opens with a preface which gives little scientific information, but emphasises the fact mentioned from time to time in his descriptions, that he studied Nudibranchs by keeping them "in a glass vivarium," often for considerable periods. He also quotes a long passage from the 'English Cyclopædia' respecting the structure of Nudibranchs.

Besides these papers, Kelaart published a description and figure of *Trevelyana ceylonica* under the title "Description of a new Ceylonese Nudibranch," in the Ann. & Mag. Nat. Hist. 1858, vol. i. p. 257.

My examination of these collections and drawings (supplemented in a few cases by other material) results in notes on 64 species. Of the identifications suggested, I think the following may be regarded as more or less certain:—

1. *Hexabranchus marginatus* Q. & G. 1832 = *Doris gloriosa* Kelaart.
2. *Chromodoris diardii* (Kelaart) = *Chr. semperi* Bergh, of which *Chr. nigrostriata* Eliot and *Chr. tenuilinearis* Farran are varieties.
3. *Casella maccarthyi* (Kelaart) = *C. cincta* Bergh.
4. *Kentrodoris maculosa* (Cuv.) = *K. annuligera* Bergh = *Doris funebris* Kelaart.
5. *Discodoris concinna* (A. & H.) = *Disc. concinniformis* Bergh.
6. *Archidoris violacea* Bergh = *Arch. africana* Eliot.
7. *Thordisa villosa* (A. & H.) = *Th. maculigera* Bergh.
8. *Trippa luteola* (Kelaart) = *Thordisa* ? *caudata* Farran.
9. *Trevelyana ceylonica* Kelaart = *T. rubromaculata* Bergh.
10. *Bornella digitata* Ad. & Reeve = *Bornella hancockana* Kelaart.
11. *Samla bicolor* (Kelaart) = *Samla annuligera* Bergh.
12. *Elysia cærulea* Kelaart = *Elysia lineolata* Bergh.
13. *Elysia punctata* Kelaart = *Elysia nigropunctata* (Pease).

The following identifications are probable, but cannot be regarded as certain until further specimens are examined :—

1. *Chromodoris fidelis* (Kelaart) = *Chr. flammulata* Bergh.
2. *Hoplodoris desmoparypha* Bergh = *Platydoris papillata* Eliot.
3. *Asteronotus hemprichi* Ehrenberg = *Doris exanthemata* Kelaart.
4. *Thordisa crosslandi* Eliot 1904 = *Diabulula* (?) *gigantea* Bergh 1905.
5. *Doris intacta* Kelaart = *Trippa ornata* Bergh.
6. *Doris leoparda* Kelaart = *Tr. monsoni* Eliot.
7. *Doridopsis tuberculosa* (Q. & G.) var. = *Doris carbunculosa* Kelaart.
8. *Diphyllidia marmorata* Kelaart = *Linguella cinerea* Farran.
9. *Phyllobranchus orientalis* (Kelaart)
= { *Ph. prasinus* Bergh.
 Ph. rubicundus Bergh.

In both these lists the first name has priority if the identity is established.

The following references to genera are certain or probable :—

1. *Chromodoris glenici* (Kelaart).
2. *Chr. ? amabilis* (Kelaart).
3. *Chr. tennentiana* (Kelaart).
4. *Platydoris ellioti* (A. & H.); not *Discodoris ellioti*.
5. *Halgerda ? apiculata* (A. & H.).
6. *Staurodoris rusticata* (A. & H.).
7. *Doriopsilla miniata* (A. & H.).
8. *Stiliger ? viridis* (Kelaart).

A specimen marked "*Doris osseosa*, Ceylon, Dr. Kelaart," appears to be the animal described by me as *Sclerodoris osseosa* (Kelaart) in Proc. Zool. Soc. 1903, ii. p. 380.

No one who attempts to determine the species of tropical Nudibranchs can fail to be struck with the great variability of their external characters. Probably no group of animals offers more striking illustrations of how species arise out of varieties. Even land-slugs show how susceptible the soft molluscan skin is to changes of colour when it is not protected by a shell; and in the Nudibranchiata, the watery habitat of which favours the growth of processes and appendages, variations of form also are frequent. Again, form, as well as colour, is liable to be distorted by the ordinary methods of preservation, and it may happen that two descriptions of the same animal—one treating of the external characters during life, and the other chiefly concerned with the anatomy of a dead specimen—have nothing in common and are not recognised as referring to the same species. The principal types of structure in the group are now fairly well known; but it

is much to be desired that some naturalist in the tropics may follow the example of Kelaart with his vivarium, and by observing the living animals throw more light on their development, variation, and habits.

My best thanks are due to the Council of the Hancock Museum at Newcastle-on-Tyne for the loan of drawings and collections, and to Mr. T. J. Evans, Lecturer in the University of Sheffield, for assistance, especially in the preparation and examination of sections.

HEXABRANCHUS MARGINATUS Q. & G.

= *D. gloriosa* Kelaart.

(Kelaart, l. c. I. p. 291.)

Whatever limits be assigned to species and varieties within this genus, Kelaart's plate leaves little doubt that his *D. gloriosa* is the form called *D. marginata* by Quoy & Gaimard.

CHROMODORIS A. & H.

(Eliot, Journal of Malacology, 1905, Oct., p. 36;
and Proc. Zool. Soc. 1904, i. pp. 382-6.)

Bergh in his 'System' (p. 1104) gives a list of 105 species. Of these, *Chr. elizabethina* is probably the *Doris quadricolor* of Rüppell and Leuckart, and, as shown below, *Chr. semperi* is probably the *Doris diardii* of Kelaart. *Chr. nigrostriata* Eliot and *Chr. tenuilinearis* Farran are both varieties of *Chr. semperi* (v. Eliot, l. c.), and therefore should be classed under *Chr. diardii*. *Chr. petechialis* (Gould) is probably the same as *Chr. tumulifera* Collingwood. *Chr. macCarthyi* is certainly a *Casella* and should be omitted from the list, to which the following species may be added:—

105. *Chr. agassizii* Bergh.
106. *Chr. porterae* Cockerell.
107. *Chr. macfarlandi* Cockerell.
108. *Chr. epicurea* Basedow & Hedley.
109. *Chr. sykesi* Eliot.
110. *Chr. annulata* Eliot.
111. *Chr. splendens* Eliot.
112. *Chr. vicina* Eliot.
113. *Chr. inconspicua* Eliot.
114. *Chr. ? flava* Eliot.
115. *Chr. tasmaniensis* Bergh.
116. *Chr. figurata* Bergh.
117. *Chr. aegialia* Bergh.
118. *Chr. atopa* Bergh.
119. *Chr. tennentana* (Kelaart).
120. *Chr. gleniei* (Kelaart).
121. *Chr. ? amabilis* (Kelaart).
122. *Chr. flammulata* Bergh.
 ? = *Chr. fidelis* (Kelaart).

- | | |
|-------------------------------------|--|
| 123. <i>Chr. marpessa</i> Bergh. | } All from the 'Siboga'
Expedition. |
| 124. <i>Chr. venusta</i> Bergh. | |
| 125. <i>Chr. ophthalmica</i> Bergh. | |
| 126. <i>Chr. nodulosa</i> Bergh. | |
| 127. <i>Chr. pantherina</i> Bergh. | |
| 128. <i>Chr. papulosa</i> Bergh. | |
| 129. <i>Chr. siboga</i> Bergh. | |
| 130. <i>Chr. inopinata</i> Bergh. | |
| 131. <i>Chr. lactea</i> Bergh. | |
| 132. <i>Chr. bimaensis</i> Bergh. | |
| 133. <i>Chr. virgata</i> Bergh. | |

Basedow and Hedley have described *Chr. epicurea* under the name of *Hypselodoris* (Trans. Roy. Soc. South Australia, vol. xxix. 1905, pp. 141 & 153), and wish to substitute this generic name (Stimpson, Proc. Ac. Nat. Sci. Philadelphia, vii. 1855, p. 388) for *Chromodoris*. It would be a pity to drop an accepted and widely used name like *Chromodoris* in favour of one which has never been in use and which was only tentatively proposed for an imperfectly described animal. But in any case Stimpson's name (1855) cannot claim priority, for Ehrenberg's *Glossodoris*, *Pterodoris*, and *Actinodoris* (1831) are admittedly Chromodorids, though for the sake of convenience the names have not been revived (see Bergh, "Kritische Untersuchung der Ehrenberg'schen Doriden," Jahrb. d. d. malakozool. Ges. iv. 1877, pp. 45-76).

The list of 133 Chromodorids will no doubt be found to contain many synonyms. Many of the tropical species are known only by their external coloration, and when it is possible to examine many specimens the coloration generally proves to be variable. Very often different colours become predominant in different individuals. *Chr. diardii* var. *nigrostriata* is generally bluish grey with faint blotches of pale yellow, but sometimes the yellow is developed at the expense of the blue and the whole animal appears to be lemon-colour. *Chr. quadricolor* sometimes looks as if it were light-coloured with black bands, and sometimes as if it were black with light bands. A difference of intensity oftens produces a difference of colour: thus, red becoming paler may fade into orange, deep yellow, light yellow, and yellowish white, or becoming darker it may be intensified into reddish brown or lake, purple, purplish black, and black. In pale specimens markings, especially borders, have a tendency to disappear; in full-coloured specimens they tend to multiply, and scattered dots may collect and fuse so as to form blotches. Lines sometimes break up into a row of dots, but on the whole the distinction between the spotted and striped forms seems more persistent than others. Though these variations of tint and pattern show that we must not expect uniformity in a species, it is also clear that unless the resemblance in colour is striking and detailed, it is by no means safe to conclude that similar forms are specifically

identical, for, though the variations may be within specific limits, it is equally possible that two dissimilar forms, both varying, may roughly coincide. For the determination of species the most important internal characters are the radula and labial armature, the other organs not varying much in the genus. Good external characters are often furnished by the greater or less development of the dorsal margin, which in several species bears small knobs underneath. In a few species the back bears tubercles or even papillæ (*Chr. papulosa* B., *Chr. ? roseopicta* Verrill). The precise number of branchiæ is not a character of importance, but the species seem divisible into those where the plumes are few (3-7), moderately numerous (8-12), and many (12-20 or more). In some species the plumes have a strong tendency to develop accessory branches and become bipinnate.

CHROMODORIS (?) AMABILIS (Kelaart). (Plate XLII. fig. 1.)

(Kelaart, l. c. I. pp. 294-5.)

This form is perhaps a *Chromodoris*, though the bipinnate branchiæ create some doubt. It may even be *Chr. porcata* (Bergh in Semper's Reisen, xvi. 2, pp. 831-3), which is white or yellowish with purple spots on the back, yellow rhinophores, white foot and branchiæ. The gills are 8 and two of them subdivided. It is recorded from Mauritius.

CHROMODORIS FIDELIS (Kelaart). (Plate XLII. fig. 2.)

(Kelaart, l. c. I. p. 295. Bergh, System, p. 1106.)

Cf. Bergh, *Chr. flammulata* & *Chr. lactea* in Siboga-Expeditie: Opisthobranchia, pp. 151 & 159-160.)

This form, which is said to be common at Trincomalee, will probably be recognised by its striking coloration.

It is possibly identical with *Chr. flammulata* B., which has black gills and rhinophores, and is said to be red with a broad irregular white patch down the centre of the back. This is merely another way of regarding a pattern which Kelaart describes as a white surface, "the edge lined with red and irregular tooth-like transverse internal prolongations of the same colour." In other details, such as shape, number of branchiæ, and the anterior expansion of the foot, the two forms agree.

Chr. lactea B. appears to be a closely allied form. It is pure white with black branchiæ and rhinophores, and differs chiefly in not having the red border. The radula is much the same as that of *Chr. flammulata*, but there are some differences in the labial armature.

CHROMODORIS PRECIOSA (Kelaart). (Plate XLII. fig. 3.)

(Kelaart, l. c. II. p. 295. Bergh, System, p. 1106.)

This form appears to belong to the group of Chromodorids which are somewhat flat and have an ample mantle overhanging the foot all round.

The coloration is not uncommon, and it is quite possible that the species has been described again with a fresh name, but I cannot identify it with any other form.

CHROMODORIS TENNENTANA (Kelaart). (Plate XLIII. fig. 1.)

(Kelaart, l. c. III. p. 268.)

This appears to be another *Chromodoris* with an ample mantle-margin. In colour it offers analogies to *Chr. obsoleta* (Rüppell & Leuck.), *Chr. imperialis* (Pse.), and *Chr. aureopurpurata* Collingwood, but does not agree completely with any of them.

CHROMODORIS DIARDII (Kelaart). (Plate XLIII. fig. 2.)

(Kelaart, l. c. III. p. 267.)

= *Chr. semperi* Bergh in Semper's Reisen, Heft xi. pp. 482-484.)

The resemblance in coloration seems to me sufficiently strong to justify the identification of these two forms. *Chr. runcinata* is nearly allied, but neither Kelaart's description nor his figure gives a hint of the conspicuous spherical glands beneath the mantle-edge.

I regret to substitute Kelaart's name for that given by Bergh, but follow the precedent of the latter authority, who has changed his *Chromodoris elizabethina* into *Chr. quadricolor* (Rüppell & Leuckart). See Bergh in Semper's Reisen, Theil vi. Lieferung ii. p. 68.

CHROMODORIS GLENIEI (Kelaart). (Plate XLIV. fig. 1.)

(Kelaart, l. c. I. pp. 294-5.)

This form appears to be clearly a *Chromodoris* in virtue of its general shape and simply pinnate branchiæ. It is said to be found "in the Inner Harbour (Trincomalee), as also at Cottiar opposite Fort Frederick," and will probably be identified without difficulty on account of its striking coloration. Kelaart's picture has probably faded, for he describes the back as bearing "a deep golden-coloured patch, bordered and spotted with purplish red," whereas in the plate the patch is reddish brown with a margin of spots of the same colour but darker. The mantle appears to be ample; and the animal probably belongs to the same group as *Chr. reticulata*, *Chr. sykesi*, *Chr. cavæ*, &c., and may even be identical with the last of them, in which case the name *glenieii* has priority. *Chr. alderi* (Collingwood, Trans. Linn. Soc. ser. 2, Zool. vol. ii. 1878, p. 132) also presents resemblances.

CHROMODORIS INOPINATA Bergh.

(Bergh, Siboga-Expeditie, Opisthobranchia, 1905, pp. 157-9.)

This species is allied to *Chr. sykesi* Eliot (Proc. Zool. Soc. 1904, i. pp. 387-8). It has the same shape and a similar though not

identical gorgeous coloration. But there are differences of detail in the buccal parts, and the branchiæ of *Chr. sykesi* have not been observed to be subdivided like those of *Chr. inopinata* or to be so long.

CASELLA.

This genus, though offering hardly any structural differences from *Chromodoris*, is easily recognisable by its undulated dorsal margin, which is generally marked by a conspicuous border.

Casella rubra Bergh, 1905, seems to be a distinct species, but it may be doubted whether the other specific names cover more than one species which appears in several colour varieties.

CASELLA MACCARTHYI (Kelaart).

Doris maccarthyi Kelaart.

Chromodoris maccarthyi (Kelaart).

Casella cincta Bergh.

? *Casella atromarginata* (Cuv.).

(Kelaart, l. c. I. p. 292. Bergh in Semper's Reisen, xi. pp. 462-3; xvi. 2, pp. 831-37; xvii. pp. 941-4.)

Two drawings are preserved and also a specimen from Ceylon. The drawings represent a pinkish-grey *Casella* with the characteristic strongly undulated margin. There are no spots or mottlings of any kind, but the mantle is bordered with bright blue, the upper part of the rhinophores is blue, and there are indications of blue on the stems of the branchiæ. The preserved specimen corresponds with the drawing. The colour is of a uniform greyish yellow without a trace of spots. The mantle-edge is marked by a purplish-brown border, with traces of an accompanying white border particularly on the under side. The length is about 28 mm. and the maximum breadth nearly 20 mm. The mantle-margin is strongly undulated, but narrow, particularly behind. The rhinophore-sheaths are distinctly raised, but the margins of the branchial pocket are not elevated. The branchiæ are retracted. The buccal mass has been removed.

There can be but little doubt that this is the *Casella cincta* of Bergh. It has all the characters, except that the back is not spotted and the foot is not bordered with blue. The branchiæ are given as fewer (15 as against 22), but the difference is not important, and it is very likely that the smaller branchiæ were not visible outside the pocket. The preserved specimen was not opened in order to preserve the appearance.

I think that *Casella cincta* and *Casella atromarginata* are merely varieties of one species which shade into one another through various shades of blue, purple, and black. If this is so, the species must be called *C. atromarginata* (Cuv.) and the blue-bordered form var. *maccarthyi*. If thought advisable, the term var. *cincta* can be used for forms with a blue border and a spotted back.

HALGERDA Bergh.

(See Eliot on *Dictyodoris tessellata*, in Proc. Malac. Soc. vol. vi. pt. 4, 1905, p. 229.)

The *Doris apiculata* of Alder & Hancock probably belongs to this genus, which in my opinion is not separable from *Dictyodoris*. Several new species have been described lately, of which *Halgerda graphica* Basedow & Hedley is closely allied to *H. willeyi* Eliot if not a synonym. The genus may be tabulated as follows:—

1. *H. formosa* Bergh.
2. *H. ? apiculata* (A. & H.).
3. *H. (Dictyodoris) tessellata* (Bergh).
- { 4. *H. wasinensis* Eliot.
- { 5. *H. (Dictyodoris) maculata* Eliot; probably
the young of *H. wasinensis*.
6. *H. punctata* Farran.
- { 7. *H. willeyi* Eliot.
- { 8. *H. graphica* Basedow & Hedley.
9. *H. elegans* Bergh.
10. *H. rubra* Bergh.
11. *H. inornata* Bergh.

HALGERDA APICULATA (A. & H.).

(A. & H. l. c. p. 122.)

The type specimen is preserved at Newcastle, but the buccal parts have been extracted and the remains are so dry and hardened that nothing can be added to Alder and Hancock's description. That description, however, which includes the radula, makes it eminently probable that the animal is referable to *Halgerda*, and the filaments which surmount the tubercles should render it easy of recognition.

PLATYDORIS.

To the list of 27 species belonging to this genus given by me in the 'Journal of Conchology,' vol. ii. Oct. 1905, pp. 252-3, may be added two more from the 'Siboga' Collection:—

28. *Pl. flammulata* Bergh.
29. *Pl. sanguinea* Bergh.

Several of the species described are probably colour varieties. It is remarkable that the 'Siboga' obtained a form undistinguishable from the Mediterranean *Pl. argo* in the Malay Archipelago.

The chief characters of the genus are the hard and leathery consistency, the flat shape, and the armature of the reproductive organs. The efferent ducts are very thick and strong. The lining is raised into lumps and folds, generally yellow in colour, and in the male branch these lumps are in most species further developed into hard scales bearing hooks. These hooks, however, have not been found in *Pl. striata* and *Pl. flammulata*.

Through the kindness of Prof. Herdman I have been allowed

to examine the specimen from Ceylon described by Farran as *Platydorís? spinulosa*, but doubt if it is referable to this genus.

PLATYDORIS FORMOSA (A. & H.). (Plate XLVII. fig. 3.)

(*Doris formosa* A. & H. l. c. p. 116.

Eliot, Proc. Zool. Soc. 1903, ii. p. 376.)

Two specimens* are preserved, one about 60, the other about 40 mm. long. They agree with Alder and Hancock's description and plate.

The back is smooth, and the minute granulations are visible only with difficulty even under a lens. But scattered over the larger specimen quite irregularly are a number of hard white tubercles which look like parasitic growths or accretions. They are not detachable, and there are none on the smaller specimens. The lobes of the branchial and rhinophorial pockets are very distinct. The foot is grooved and deeply notched in front. The oral tentacles are rather large, and so distinctly grooved on the outer side as to be almost ear-shaped.

The tissues of the radula have decayed, but the teeth are well preserved. They are hamate, with moderately stout bases and rather slender elegant shafts which often have a distinct ridge or wing at the side. They differ considerably in size and somewhat in shape, some being more strongly hooked than others, but it is not now possible to assign them to their respective places in the radula. Alder and Hancock say they decrease in size towards the centre. It is noticeable that no denticulate or degraded teeth are to be found, so that the hamate form is probably retained to the extreme end of the rows and does not degenerate, as so often happens in *Platydorís*.

The genitalia are much hardened, but it is still plain that the large efferent ducts of both branches are extremely strong and muscular. One tube (probably the vas deferens) is thickly set with large round granulated scales, bearing short strong spines (Pl. XLVII. fig. 3). The other tube (probably the female branch) is lined with very conspicuous folds and lumps.

This handsome species appears to be characterised by its coloration, its distinctly grooved tentacles, and the armature of the genitalia, particularly the granulated appearance of the discs.

The East African form referred by me (*l. c.*) to this species with a query does not agree with the type specimen, and is more likely to be *Pl. sanguinea* Bergh (Siboga, p. 139).

PLATYDORIS SCABRA (Cuv.).

= *Doris celestis* Kelaart.

(Quoy & Gaimard, Voyage de l'Astrolabe, Zoologie, tome ii. p. 258. Eliot, Proc. Zool. Soc. 1903, ii. p. 375. Kelaart, l. c. I. p. 293.)

The *Doris celestis* of Kelaart seems to be clearly the older

* These and all the specimens described by A. & H. in Trans. Zool. Soc. 1864 are carefully labelled by Hancock, so that there is no doubt of their identity.

Doris scabra, referable to the genus *Platydoris*. The drawing, which is not reproduced, leaves but little doubt of this.

PLATYDORIS STRIATA (Kelaart).

Kelaart, l. c. I. p. 302.

(A. & H. l. c. p. 117.)

A single specimen is preserved in bad condition, having apparently been allowed to dry before being put in fresh spirits.

As preserved, it suggests that the colour was lighter than in Alder and Hancock's plates, and the fine brown lines, though distinct, much fewer.

The buccal mass had apparently been extracted, but a few scattered teeth were found among the internal organs. They are hamate and rather slender.

Little could be made out of the genitalia, which were small and hardened. A tube lined with the characteristic yellow folds and lumps was found, but no scales or hooks. It is very probable that they are really present, but Bergh ('Siboga,' p. 138) reports that in *Pl. flammulata* the male organs are provided with a "Längsfalten bildenden Cuticula mit spitzen und gerundeten Höckern versehen aber ohne die gewöhnlichen Dorntragenden Scheiben." It is therefore possible that they may be absent in this species too.

PLATYDORIS ELLIOTI (A. & H.).

(A. & H. l. c. p. 116. *Discodoris ellioti* Bergh, Siboga, p. 102.)

Three of Alder and Hancock's type specimens are preserved. One is quite hard, and was probably dried before it was put into spirits. Nothing could be made of it.

The other two are soft and somewhat decayed. The texture is not that usual in *Platydoris*, but the present flaccid condition may be due to decomposition. The buccal parts had been removed from one specimen but remained in the other. No labial armature was found, but a number of yellowish hamate rather slender teeth, set in no apparent order, the ribbon of the radula being decomposed.

The armature of the genitalia is very distinct. The efferent duct is thickly covered with discs bearing spines of the form typical of the genus. The spines are mostly stout and straight; some are a little inclined, but not bent. There is no doubt of the existence of this characteristic armature, but owing to bad preservation it is hard to say if it is on the vas deferens or the vagina, but probably the former.

Bergh originally placed this species under *Platydoris* (Syst. d. Nud. Gast. p. 1102), but subsequently (*l. c.*) identified it with a *Discodoris* obtained by the 'Siboga' from Makassar. It would appear, however, that the earlier classification was correct, for the genitalia are armed as in *Platydoris* and there is no labial armature. The absence of the latter is confirmed by Alder and Hancock's description, for under *D. ellioti* they say "Tongue as in

D. tuberculata," and under *D. pardalis*, the species described next, "Tongue as in the last species, with the addition of a prehensile collar."

The animal obtained by the 'Siboga' should perhaps be known as *Disc. berghi*.

PLATYDORIS PAPILLATA Eliot.

? = *Hoplodoris desmoparypha* B. var.

(Eliot, Proc. Zool. Soc. 1903, ii. pp. 379-380. Bergh, in Semper's Reisen, Suppl.-Heft i. p. 51; Siboga, p. 113.)

In making an examination of further specimens of this animal, I have found a spine in the accessory gland attached to the female genitalia. The structure of the gland seems to be as described by Bergh for *Hoplodoris*, but the spine is straighter. I cannot help thinking that the species is *Hoplodoris desmoparypha*, or at least very closely allied to it; but I have not been able to find a labial armature as described by Bergh. In one specimen there seemed to be something like a plate or girdle on the labial cuticle, but it was formed of fibres or filaments and not of the rods found in *Discodoris* and other genera. As a labial armature is generally unmistakable and easily found, I do not think its presence can have been overlooked. On the other hand, it is often developed in very different degrees in different individuals of the same species, and may perhaps disappear. In his first description (S. R. l. c. p. 53, note) Bergh seems to imply that it was vestigial or imperfectly preserved.

In my specimens the buccal cavity is black or brown. The teeth are as previously described by me (*l. c.*), but the outermost are sometimes slightly and irregularly serrulate*. The formula of the radula is about $40 \times 80.0.80$. There is a large sausage-shaped prostate.

The external characteristics correspond in most respects with the descriptions of *Hop. desmoparypha*, but the dorsal papillæ are far more developed and sometimes become branched processes 5 mm. long; but there is much variety in this respect, as also in colour. The spots and borders on the under side are particularly variable. The gill-pocket is sometimes distinctly stellate, and sometimes merely irregularly jagged or undulated. The tentacles are in all specimens large but flat. The anterior margin of the foot is deeply grooved and notched, and the upper lamina overhangs the lower.

The animal has been observed to bury itself in sand, and the dorsal papillæ resemble bits of sand when it is alive.

It may be doubted whether *Hoplodoris* is best regarded as a separate genus or a section of *Platydoris*. Most of the characters agree with that genus, and I do not think that the presence of either an accessory gland and spine or of a labial armature

* Proc. Zool. Soc. 1903, ii. p. 379, fourth line from the bottom: "innermost" is a misprint for "outermost."

(even if proved to be the rule) can exclude it from the genus. *Pl. variegata* Bergh has a labial armature. On the other hand, the dorsal papillæ are a marked point of difference. In any case, the form seems to be intermediate between *Platydoris* and *Asteronotus*, and to have little affinity to *Discodoris*.

DORIS EXANTHEMATA Kelaart.

(Kelaart, l. c. I. p. 300.)

? = *Asteronotus hemprichi* Ehrenberg.

Hancock has written on Kelaart's drawing "*D. mauritiana* Q. & G.?" This latter species is identified with *Asteronotus cespitosus*, and Kelaart's drawing, more than his description, supports the idea that the animal is the common *Asteronotus* of the Indo-Pacific. Whether there is really more than one species is doubtful. If there is only one, the name *A. hemprichi* Ehrenberg has priority. Kelaart's statement that *D. exanthemata* is "semi-gelatinous and . . . when dead rapidly dissolves and cannot be preserved in spirits" is against this identification. *Asteronotus* may perhaps be compared to a stiff solid jelly, but it can be preserved without difficulty.

The statement that the spawn is of a beautiful red colour is interesting. I have found this red spawn and *Asteronotus* in the same locality at Zanzibar, but cannot prove by observation the connection between the two.

Kelaart had a strange dislike of this animal, which he thinks "gives one more the idea of a horrid disease than the charms of a sea-nymph." But *Asteronotus*, though not particularly beautiful either in shape or colour, is not a revolting object. Very fair representations of it are given by Bergh (Siboga, pl. i. fig. 5, and Notes from the Leyden Museum, 1887, pl. vi. fig. 9) and Eliot (Proc. Zool. Soc. 1903, ii. pl. xxxiv. fig. 5).

KENTRODORIS Bergh.

The Kentrodorids are perhaps nearly related to *Jorunna*. They are also, especially *K. maculosa (annuligera)*, allied to *Thordisa* and *Dianthula*, from which they differ chiefly in having the verge armed with a spine. Only three species have been described, all from the Indian Ocean:—

1. *K. rubescens* B.
2. *K. gigas* B.
3. *K. maculosa* (Cuv.)
= *K. annuligera* B.

KENTRODORIS MACULOSA (Cuv.).

(Cuvier, Ann. du Mus. iv. 1804, p. 466-7. Quoy & Gaimard, Astrolabe, 1832, Zoologie, tome ii. p. 249.

= *Doris funebris* Kelaart, Ann. Nat. Hist. 3rd series, vol. iii. 1859, p. 293; and A. & H. l. c. p. 122.

= *Kentrodoris annuligera* Bergh.)

One specimen is preserved in Walter Elliot's collection, and two others were found at Newcastle marked as having been sent from Ceylon by Kelaart.

The largest specimen is 38.5 mm. long, 18 broad, and 15 high. The external characters of all are much the same. The colour is dull yellow-ochre, with black ring-like spots of irregular outline, the largest about 6 mm. broad. These spots are not as a rule simple ocelli, but areas surrounded by a ring and containing a considerable number (as many as 50) of smaller spots. The black pigment is almost entirely on the papillæ, and not on the dorsal skin. Besides these rings there are black spots without a light centre on the margins of the mantle and foot. The number of spots on the under surface is very variable.

The whole back is covered with thick-set minute papillæ, which can be scraped off. They are soft, but contain straight colourless spicules*. The rhinophore-pockets are large but not raised. The perfoliations of the rhinophores are black, but the base and tip of the column are white. The branchial pocket is a conspicuous transverse slit, 10 mm. long and 2.5 broad. Though it has not raised edges, the region all round it is distinctly elevated. The branchiæ are six, large, quadripinnate, yellow with a black rhachis. The anal papilla is subcentral, large, yellow with a black crenulated margin. The oral tentacles are long, digitate, yellow with black tips. The anterior margin of the foot is very deeply grooved. The upper lamina is divided in the middle and forms an ample flap on either side.

The buccal parts had been removed from two specimens, but the teeth were found in the third, though the ribbons of the radula had entirely decayed and it was not possible to state their arrangement with certainty. The formula may have been about $25 \times 20.0.20$. The specimen was small. Some of the teeth are like Bergh's figures of the first lateral of *K. annuligera*, but their position is no longer plain. The other teeth also agree with Bergh's figures.

In two specimens the penis terminates in a transparent colourless stylet about two-thirds of a millimetre long. The end is blunt and not pointed—a shape which is also indicated in Bergh's figures (Semper's Reisen, Heft x. pl. xii. fig. 16).

These specimens are undoubtedly identical with *Kentrodoris annuligera*, described by Bergh in Semper's Reisen (*l. c.* and xvii. 1890, p. 921). In his description of the Mollusca collected by Kükenthal at Ternate (Abhand. der Seckenberg. Gesellsch. Band xxiv. Heft i. p. 99) he expresses the opinion that his *Kentrodoris annuligera* is the *Doris funebris* of Kelaart and also the *D. maculosa* of Cuvier and of Quoy & Gaimard. As the examination of Kelaart's specimens shows, the first of these identifications is correct. The others are perhaps less certain. Cuvier (*l. c.*) described his *D. maculosa* as "presque aussi plat

* They correspond with Bergh's description in Semper's Reisen, xvii. p. 922.

que le *scabra* et encore plus rude," which suggests a flat rough *Platydorid*. But the identification may be allowed to stand, for it cannot be disproved, and it would be a pity to change the nomenclature established by Bergh.

Neither do I feel sure that Quoy and Gaimard's animal from Vanikoro is really identical with either Cuvier's species or *K. annuligera*. They say it is "à dos très bombé, de consistance assez molle," which does not agree with Cuvier's account given above. The figure of the under side (*l. c.* pl. xvi. fig. 4) does not indicate that the anterior margin of the foot is developed into lappets; the tentacles are expressly said to be yellow at the tips and the mantle has a white border. These are no doubt small points, but they may indicate real differences.

At least one other Dorid, *Platydorid townsendi* (Eliot, "Nudibr. from the Indo-Pacific," *Journal of Conch.*, Oct. 1905, p. 253), has the same coloration and superficial appearance as the species here described; and there may be others, for instance *Diarylula sandiegensis*, which is velvety, yellowish, with dark brown or black rings.

From the various descriptions and plates, it would appear that the colour of the living *K. maculosa* varies from pale yellow-green or grey to white. Kelaart represents hardly any spots on the under side. Alder and Hancock's figure (*l. c.* pl. xxx. figs. 9, 10) is much more elongated than those of other authors. It no doubt represents the animal as fully extended and moving.

DISCODORIS.

Three forms described by Alder and Hancock seem referable to this genus, and the types of all three are preserved at Newcastle, but in indifferent condition. The specimen of *D. pardalis* corresponds with Alder and Hancock's description of the external characters, but the buccal parts have been removed. The texture is soft.

DISCODORIS CONCINNA (A. & H.).

(*Cf. Disc. concinniformis* Bergh, *Mal. Unt. in Semper's Reisen*, xvi. 1, pp. 807-811, and xvii. pp. 900-902. *Id.*, *Siboga*, pp. 100-102.)

Four specimens labelled in Hancock's writing "Nos. 14, 23, 82, 115. *Doris concinna*. Madras. Mr. W. Elliot." There is also a note to the effect that the specimens were found partly dried up in 1902. They are now in spirit; but their hard and stiff texture is probably the result of their desiccation.

So far as one can judge from such old material, Alder and Hancock's description and plate are quite accurate. The colour of the under side and the foot appears to be variable, being in some specimens pale and spotted, in others darker and livid (*cf.* the varieties of *D. concinniformis* Bergh). The shape and elevation

of the branchial opening are also variable. In one specimen it is nearly closed; in another it is almost stellate. But in its natural condition it seems to be broad and circular. The foot is broad, grooved, and notched in front. The oral tentacles are long, digitate, and pointed. The most distinct external character is that the back is studded with small tubercles of varying size and of a lighter tint than the ground-colour. The peculiar effect which this produces in the appearance of the animal is well rendered in Alder and Hancock's plate. The tubercles are of somewhat irregular outline, and often have a long pointed tip. Though they are numerous, they are separated from one another by distinct intervals.

Though the tissues of the buccal organs are decayed, the hard parts are still recognisable. The labial armature is formed of longish, bent, transversely striated rods. The teeth are yellowish, hamate, moderately stout, and of a somewhat wavy outline. They are very like Bergh's plates in the 'Siboga' Expedition (*l. c.* pl. xiv. fig. 4). The genitalia are decayed, but no armature was found.

Bergh, in describing various specimens of his *Discodoris concinniformis*, has indicated its probable identity with this species. There is no divergence in the buccal parts; but it is curious that Bergh, while describing *D. concinniformis* as bearing light-coloured spots, does not state definitely that the tubercles are lighter than the dorsal surface, which is the cause of the peculiar coloration of *D. concinna*.

DISCODORIS FRAGILIS (A. & H.).

(A. & H. *l. c.* pp. 118-119.)

The remains of two specimens are preserved, but in so fragmentary a condition (the result probably of self-mutilation, not of dissection) that nothing can be profitably described except the dorsal surface. No buccal parts were found.

The ribbon-like strips, of which the remains mostly consist, are soft and slimy, but rather stiffer on the upper surface. This is covered with round, blunt, white tubercles, contrasting with the ground-colour, which is brown of different shades. The general appearance, however, is not like *Disc. concinna*. Towards the mantle-edge the tubercles become harder, and the edge itself seems to be marked in places by a continuous calcareous deposit. The integuments are not visibly spiculous, though they contain numerous spicula. These are as described by Alder and Hancock: small rods of rather irregular outline, often bent in the middle and with blunt or broad extremities.

STAURODORIS RUSTICATA? (A. & H.).

(A. & H. *l. c.* p. 120.)

Four smallish specimens labelled "Madras from Sir W. Elliot" are probably *Doris rusticata* A. & H., though there is no name

on the label. They are all covered in places with some hard reddish substance like sealing-wax, which seems to be adventitious and to have no natural connection with them. They are yellowish in colour and plump and convex in shape. The largest is 17 mm. long and 7 broad.

The dorsal surface is rather sparsely studded with large, almost clavate warts, between which are smaller ones. Near the margin all the warts are smaller and more crowded. The integuments are full of very long, thin, straight, colourless tubercles arranged in stellate patterns. The rhizophorial pockets are closed by two tubercles, the branchial pockets by 8-10, apparently set in more than one row. The branchiæ are entirely retracted, small, and badly preserved. Perhaps there are 5, in any case not many more. The head seems to be prolonged on each side into a short, blunt, tentacular process. The foot is broad without markings; the lateral margins are thin and expanded; the anterior margin grooved, but the upper lamina apparently entire.

The internal organs are too much hardened for examination, but a large free stomach was found. No labial armature was found. The radula is broken up, but perhaps the formula is about $40 \times 50.0.50$. The teeth are hamate, rather strongly bent, and with long bases. They seem shorter and thicker near the rhachis. No denticulate teeth were seen.

This form seems clearly referable to the section *Staurodoris*, of which it has all the characteristics, except that the branchiæ are not simply pinnate as in the typical species. *St. pustulata* Abraham (see especially Basedow & Hedley, Trans. Royal Soc. South Austr. vol. xxix. 1905, p. 151) from Australia seems allied, but is probably specifically distinct.

As I have indicated elsewhere, I think that both *Staurodoris* and *Archidoris* should be regarded as subgenera of the old Linnæan genus *Doris*.

ARCHIDORIS VIOLACEA Bergh.

(Bergh in Semper's Reisen, Bd. ix. Th. vi. Lief. i., January 1904. Cf. Eliot, on *Archidoris africana*, Proc. Zool. Soc. 1903, ii. p. 361: published April 1, 1904.)

Through the kindness of Mr. Suter, I have been able to examine some specimens of this form from Auckland, and think they are identical with my *A. africana*, the description of which was published a few months later. The difference of habitat is considerable, but the nudibranchiate fauna of New Zealand includes tropical elements like *Chromodoris* and *Doridopsis*.

The chief differences between the African and New Zealand specimens are that the former have large tentacles and a number of small tubercles (probably glandular) scattered over the under side of the mantle-margin. Similar tubercles are found in other East-African forms, and are perhaps not a specific character.

THORADISA Bergh.

The following species have been referred to this genus:—

1. *Th. villosa* (A. & H.).
2. *Th. maculigera* Bergh.
3. *Th. stellata* Eliot.
4. *Th. tristis* Bergh.
5. *Th. hilaris* Bergh.
6. *Th.?* *maculosa* Bergh.
7. *Th.?* *carinata* Bergh.
8. *Th. clandestina* Bergh.
9. *Th. ladislavii* (von Jher.).
10. *Th.?* *millegrana* (A. & H.).
11. *Th. crosslandi* Eliot.
12. *Th.?* *dubia* Bergh.
13. *Th.?* *pallida* Bergh.
14. *Th.?* *caudata* Farran.

The queries are due to the authors who have created the species or referred them to this genus.

Bergh's original diagnosis of the genus (Semper's Reisen, Heft xii. 1877) is:—"Forma corporis fere ut in *Discodoridibus*, dorso fere villosa. Armatura labialis nulla. Lingua ut in *Discodoridibus*, dentes extimi denticulati. Penis inermis." In his most recent work (The Opisthobranchs of the 'Siboga' Expedition, 1905) he returns to this definition and says:—"Die Gattung . . . zeichnet sich im Äusseren besonders durch die villöse Beschaffenheit des Rückens aus. Die äusseren pleuralen Zahnplatten sind sehr schwächig und kammförmig entwickelt." Meantime, however, several forms have been referred to the genus which have neither a villous back nor pectiniform external teeth.

The points emphasised by Bergh in the passages quoted above seem to characterise the genus with fair distinctness. The animals are externally not unlike *Discodoris*, but the dorsal surface, instead of being granulate or tuberculate, bears soft elongated processes of moderate length. A labial armature is absent, at least in the typical forms. The rhachis of the radula is bare and the side teeth are simply hamate, but towards the end of the row they become thin and have a tendency to split up into hair-like denticles. If, however, these denticles are not developed, I do not think that their absence is sufficient to exclude a form from the genus. It is admitted that in *Platydoris*, *Halgerda*, and *Staurodoris* such denticles may be present or absent, and they should not be used too rigidly as a generic character. On the other hand, it may be justly said that in such genera as *Thordisa*, *Platydoris*, and *Halgerda* the outermost teeth show a strong tendency to split and develop denticles; whereas in *Archidoris*, *Discodoris*, and other genera they have a tendency to diminish in size but to remain entire.

Bergh says (Siboga, l. c.) that only *Th. maculigera*, *Th. carinata*, *Th. tristis*, and *Th. hilaris* can be included in the genus with certainty, though it is noticeable that he originally (Semper's Reisen, xvii. 1890, p. 913) marked *Th. carinata* with a query. *Th. dubia* and *Th. pallida* seem to conform fairly well to the generic diagnosis, though in the descriptions of the dorsal surface it is very difficult to know exactly what is meant by Zotten, Knötchen, and similar terms.

Th. ? clandestina B. is smooth and the external teeth are not denticulate. *Th. ladislavii* was described by von Ihering ("Nudib. der brasil. Küste," in Mal. Jahrb. xiii. 1866, p. 234) as *Etidoris*, but Bergh in his 'System' regarded this genus as a synonym of *Thordisa*. The validity of the genus *Etidoris* may be doubted, but, as von Ihering remarks, the animal described by him comes near to *Archidoris*. It is tuberculate; the tentacles are thick and grooved, and the rhachis of the radula bears thickenings. It differs from *Archidoris* only in having the outermost teeth denticulate. *Doris millegrana* was described briefly by Alder and Hancock (Monogr. pt. vii., Appendix, p. i). Von Ihering (l. c. p. 238) created for it the genus *Aporodoris*, regarded by Bergh in his 'System' (p. 1098) as a synonym of *Thordisa*, but in the Opisthobranchia of the 'Siboga' Expedition (p. 94) recognised again as a separate genus and provided with a second species, *Aporodoris ? rubra*. The genus remains very doubtful, but, so far as the descriptions permit one to judge, seems allied to *Archidoris*. Alder and Hancock do not hint at any affinity between their *Doris millegrana* and their *Doris (Thordisa) villosa*. *Thordisa caudata* Farran has not a villous back, and is perhaps referable to *Trippa*. See below under *Trippa luteola*. *Th. crosslandi* is discussed below.

The remarkable *Doris lanuginosa** of Kelaart, which is "green and covered with short downy hair," is perhaps a *Thordisa* or *Diaulula*.

THORDISA VILLOSA (A. & H.).

(A. & H. l. c. p. 119. Eliot, Proc. Zool. Soc. 1903, ii. p. 367-8.

Cf. *Thordisa maculigera* Bergh, in Semper's Reisen, Heft xii. p. 540. Id., Danish Exped. to Siam: Opisthobranchia, p. 182.)

Two specimens, labelled *Doris villosa*, are preserved in fair condition. They differ somewhat in appearance. One is larger and more leathery than the other, and its dorsal tubercles are hard and warty. The smaller specimen is softer and the back villous rather than warty, the dorsal tubercles bearing soft filaments. It still resembles Alder and Hancock's plate (l. c. pl. xxxiii. fig. 1), and I also have but little hesitation in referring it to the same species as the specimens from Zanzibar described by me (l. c.) as *Thordisa villosa*.

Further, it seems to me almost certain that the species, as

* No drawing of this species was found.

surmised by Bergh, is identical with *Th. maculigera*. Unfortunately the buccal parts have been taken out of both the Newcastle specimens, and we must be content with Alder and Hancock's statement:—"Tongue as in *D. tuberculata*: no collar." This, of course, ought to mean that all the teeth are simply hamate and smooth, whereas in Bergh's *Th. maculigera* and in my specimen from Zanzibar the outermost teeth bear hair-like denticles. It is probable that there is some variation in this respect, for the shape of the teeth is not exactly similar in my specimen and in Bergh's. Also, after examining Alder and Hancock's two specimens, I am inclined to think that the animal described by me (*l. c.* p. 368) as *Th. stellata* is merely a variety of this species. It differs from the typical form in its harder consistency, stellate branchial pocket, and in that the outermost teeth of the radula are entire.

The outermost teeth are found to vary within the limits of the same species in *Platydoris argo* and *Halgerda formosa*, being sometimes smooth and sometimes denticulate.

THORDISA CROSSLANDI Eliot.

(Eliot, Proc. Zool. Soc. 1903, ii. p. 368. Cf. Bergh on *Diarulula? gigantea* in Siboga-Expeditie, Opisthobranchia, 1905, p. 119.)

After re-examining my specimens, I think this species is identical with the *Diarulula gigantea* of Bergh. The two descriptions are in general agreement and there are some remarkable coincidences in details. In both the nervous system is much concentrated; there is a large prostate, and the penis has a curiously twisted shape, somewhat as in *Phialodoris*. The dimensions and coloration also agree. There are two points of difference, which perhaps admit of explanation. Firstly, in *Th. crosslandi* there is a minute, but quite distinct, labial armature. I have found it in all the specimens which I have examined, but it may easily escape notice and may possibly really disappear in some individuals. Bergh found 70 rows of teeth in the radula, and "in den Reihen schienen 150-200 Platten vorzukommen." If this means 150-200 teeth on each side of the rhachis, the radulae in my specimens were smaller and do not exceed $50 \times 110.0.110$ as a maximum. Secondly, Bergh describes the dorsal surface as "überall fein und dicht granulirt, die Nöppchen gerundet, hier und da auch Kegelförmig." An inspection of my specimens, confirmed by notes in the living animal (*v. Eliot, l. c.*), shows that the back is covered with elongate pointed papillae, sometimes bearing filaments at their tips. But when preserved in alcohol they often become round owing to contraction and accidental pressure, and sometimes disappear entirely, although in life they are 2-3 mm. long.

The distinction between the genera *Diarulula* and *Thordisa* is perhaps not very clear. Bergh's diagnosis of the former is "Notaeum holosericeum [explained as "sammetartig"]. Dentes

pleurales hamati. Prostata magna." There is perhaps not much essential difference between a velvety surface and one which is covered with elongate soft papillæ (*Thordisa*), but, so far as the two can be distinguished, the form under consideration belongs decidedly to *Thordisa*. In *Thordisa* the outermost teeth are typically pectinate or denticulate, which is not the case in *Diaulula*. But, as explained above, I do not think that this is a safe generic characteristic. *Diaulula* has a large prostate, but the organ is also reported as present in *Th. maculigera* (Bergh, Danish Expedition to Siam, *Opisthob.* p. 184), *Th. dubia*, and *Th. pallida*.

It is not impossible that this form should be referred to *Phialodoris*, which has a penis of similar shape and a prostate. The radula presents no essential differences. But in *Phialodoris* the nervous system is not concentrated. The dorsal surface is crammed with spicules, which seem to be set in a stellate pattern, and is described as granulate. Its appearance in life, however, may have been different.

On the whole, it appears to me safest to leave the present form provisionally in *Thordisa* until a further examination of *Phialodoris podotria* (described from one alcoholic specimen) has been made. The specific name *crosslandi* has priority over *gigantea*.

Kelaart's *Doris marmorata* is not improbably *Phialodoris podotria*. It is "hard and granular," and the six branchial plumes are united at the base. Cf. Brock's figure reproduced by Bergh, in Semper's Reisen, Heft xvii. pl. lxxxv. figs. 5 & 6.

TRIPPA.

This genus, in which Bergh has incorporated *Phlegmodoris*, is characterised externally by a rather soft consistency and compound tubercles of irregular shape. Between the tubercles there are often deep pits rendered conspicuous by their black colour. There is no labial armature, and the radula, which is generally rather short, consists of hamate teeth which sometimes bear a few denticles. Ptyaline glands as well as salivary glands are present. There is no armature in the genitalia and a prostate seems not to be recorded.

The following forms are perhaps referable to the genus:—

1. *T. ornata* Bergh.
(?= *Doris intacta* Kelaart.)
2. *T. areolata* (A. & H.).
3. *T. spongiosa* (Kelaart).
(= *T. mephitica* Bergh.)
4. *T. monsoni* Eliot.
(?= *D. leoparda* Kelaart.)
5. *T. hispida* Bergh.
6. *T. affinis* Bergh.
7. *T. luteola* (Kelaart).
(= *Thordisa caudata* Farran.)

T. anceps Bergh (Bull. of Museum of Comparative Zoology, Harvard, 1890, p. 169) is a doubtful form omitted by Bergh in subsequent lists of the genus, and perhaps akin to *Atagama*. *T. hispida* is also regarded by Bergh as doubtful, but, so far as one can judge from the plates (Opisth. der Sammlung Plate, p. 527, pls. xxx. & xxxi.), seems to possess most of the characters of the genus.

It is sometimes difficult to distinguish the external characters of *Thordisa* and *Trippa* verbally, for some species of *Thordisa* have soft tubercles which bear secondary papillæ or filaments. But whereas the typical *Thordisa* is rather flat and covered with soft, elongate papillæ, the typical *Trippa* is spongy, though often full of spicules, and bears large, irregularly compound tubercles, with pits between them.

TRIPPA ORNATA Bergh.

(Bergh in Semper's Reisen, Heft xii. p. 543, and Heft xvii. p. 905. Id., Siboga-Expeditie, Opisthobr. p. 129.

Cf. Kelaart, *Doris intecta*, l. c. I. p. 302.)

The original specimen described by Bergh in 1877 was reddish-brown with a yellowish median longitudinal band. In another specimen (1890) he found a white longitudinal band (not, however, marked in the figure, Semper's Reisen, Heft xvii. pl. lxxxiv. fig. 7), and suggested that the animal might be Kelaart's *Doris intecta*. This suggestion is rendered even more probable by the description and figures in the 'Siboga' Expedition volume.

Kelaart's figure represents a reddish-brown, tuberculate Dorid with a white line extending from the branchiæ to the rhinophores. The only objection to identifying it with *Trippa ornata* is that it is said to have long oral tentacles, whereas the accounts of the preserved specimens suggest that the tentacles are rudimentary. As *Doris intecta* is said to be very common at Trincomalee in low water during September and October, the identity may perhaps be decided by an examination of further specimens.

TRIPPA LUTEOLA (Kelaart). (Plate XLII. fig. 4.)

(*Thordisa caudata* Farran, l. c. p. 341. *Doris luteola* Kelaart, l. c. I. p. 299.)

Two specimens from the reef at Tamatave, Madagascar, given me by Prof. Völtzkow. A note with the specimens says: "Saum citronen galb. Fühler schwarz. Kieme schwarz." Through the kindness of Prof. Herdman, I have also been able to examine the single type specimen of *Thordisa caudata* in the Museum of Liverpool University. All three specimens undoubtedly belong to the same species.

The specimens from Madagascar are much bent, but if straightened out would be 35-40 mm. long and 20-25 broad. The colour is a rather dirty white. The back is in most parts covered with flat tubercles of various sizes, generally bearing secondary

excrescences, from which spicules project here and there. But in all three specimens there are several bald spaces on either side, not connected, but arranged in a more or less continuous line from the rhinophores to the branchial pocket. The integuments are stiff, but not harsh to the touch. They are full of rod-like spicules, straight or slightly curved but not branched, set in an irregular stellate pattern which is not conspicuous. They form columns under the tubercles. The rhinophores are dark grey. The pockets open in hillocks covered with tubercles like the rest of the back, but not protected by special valves. The branchiæ are also grey, five or six in number and mostly bipinnate, but tripinnate in places. The margin of the pocket is hardly raised, undulated, but not stellate and not protected by tubercles. The mantle-margin is fairly wide. The anterior margin of the foot has a shallow groove and a rather distinct notch in the middle. The oral tentacles are white, digitate, and tapering; small, but quite distinct.

The blood-gland is flocculent and pinkish. The central nervous system is enclosed in a strong capsule and is granulate. The ganglia touch one another. The pedal ganglia are round; the cerebro-pleural are separated into two divisions with moderate distinctness. Under the œsophagus passes the strong, broad, short, common commissure. Mr. Farran found both salivary and ptyaline glands on the buccal mass, and I also found at least two sets of glandular organs. Two glands open into the œsophagus close to the central nervous system; they are band-like and granulate, with long thin ducts. Two other glands, apparently connected with the buccal mass, are large, white, opaque, flocculent, but compact. I could not discover where they open. Close to the mouth I found a gland-like bladder containing irregularly-shaped spicules. No labial armature was found.

The yellow radula consists of 38 rows, two of which are undeveloped and shadowy. The lateral teeth are 39, as in Mr. Farran's specimen, and the number seems remarkably constant. The 10 innermost are smaller than the rest, rather straight, and bear a single minute denticle, sometimes connected with a ridge, on the outer side. In the middle of the half row the teeth are larger and more distinctly hamate. The two or three outermost are small and bear hair-like denticles.

The stomach is rather large and not enclosed in the liver; under it lies a rather large, white, pear-shaped gall-bladder. The liver is greenish internally; externally it is covered by a thick white layer of the hermaphrodite gland. The genitalia are unarmed. Both the spermathecas are pinkish and globular, but one is three times as large as the other.

Generically this form seems to me referable to *Trippa* rather than to *Thordisa*. Both Mr. Farran and myself found ptyaline glands, which are regarded as characteristic of the genus. The back is covered with prominences which are often compound. The bald patches perhaps correspond to the pits found in other

species. The comparatively short radula and small inner teeth are also characters of *Trippa*, and the denticulation, though rare in the genus, is found in *Trippa monsoni*.

Specifically, I think the form may be identified with Kelaart's *Doris luteola*. His drawing is not very good and his description slight, though not inaccurate. Mr. Farran's type specimen of *Thordisa caudata* was found in Ceylon, and the remarkable coloration, supported by this identity of habitat, seems a sufficient reason for regarding the forms as the same.

TRIPPA SPONGIOSA (Kelaart). (Plate XLIV. fig. 2.)

(Kelaart, l. c. I. p. 302. Cf. *Doris areolata*, A. & H. l. c. p. 119. *Phlegmodoris mephitica* Bergh in Semper's Reisen, Heft xiii. p. 594.)

Kelaart's figure and description seem sufficient to identify this species with *Phlegmodoris mephitica* B. The coloration, consistency, rhinophore-sheaths, and branchiæ are all points of agreement. Kelaart was apparently unable to find the oral tentacles, which is not inconsistent with Bergh's account of them as folds on either side of the mouth.

André ("Mollusques d'Amboine," in *Revue Suisse de Zoologie*, tome iv. 1896, p. 401) suggests that *T. spongiosa* is the same as *Trippa (Doris) areolata* A. & H. He apparently had before him specimens from Amboina, but unfortunately gives no description. The identity is not improbable, for the only certain distinction between the forms is that there are several black pits in the dorsal surface of *T. areolata*, whereas in *T. spongiosa* the black pigment is wanting, though the back is said to be "deeply pitted." But without a further comparison of specimens it is impossible to decide whether the two forms are colour varieties or distinct species.

For some account of *T. areolata*, see my paper on "Nudibranchs from East Africa and Zanzibar," in *Proc. Zool. Soc.* 1903, ii. p. 369.

TRIPPA MONSONI Eliot. (Plate XLV. fig. 1.)

(Eliot, *Proc. Zool. Soc.* 1903, ii. p. 371. Cf. Kelaart, *Doris leoparda*, l. c. I. p. 294.)

These two forms are probably identical. They agree in size and in a somewhat remarkable coloration, composed of greyish or purplish spots separated by white reticulations. The rhinophores and branchiæ are yellowish or greenish. Kelaart, however, does not mention any pits such as are found on the back of *T. monsoni*.

An examination of specimens from Ceylon would probably decide the question of identity. If it is established, the animal will be *Trippa leoparda*.

DORIDOPSISÆ.

The works of Bergh and Vayssièrè contain much valuable information about this family, but Hancock, "On the Anatomy of

Doridopsis" (Trans. Linn. Soc. 1865, xxv. 2, pp. 189-207), is still well worth reading.

The family is divided into two genera, *Doriopsilla* and *Doridopsis*. *Doriopsilla*, which is discussed below, contains at present about six species.

(*Doriopsilla granulosa* (Pease) is doubtful.)

1. *Doriopsilla areolata* Bergh.
2. *D. pelseneeri* Olivier.
3. *D. miniata* (A. & H.).
4. *D. pallida* Bergh.
5. *D. lævis* Bergh.
6. *D. reticulata* Cockerell & Eliot.

Species 3, 4, and 5 are perhaps very closely related.

In a paper by Prof. Cockerell and myself (Journ. of Malac. 1905, vol. xii. pt. 3) Bergh's list of the species of *Doridopsis* given in his 'System' was brought up to date, and 64 species were indicated. Of these, *D. miniata* and *D. reticulata* are now shown to be *Doriopsillæ*, but the following additions from Bergh's Opisthobranchs of the 'Siboga' may be made:—

63. *D. erubescens* Bergh.
64. *D. amœna* Bergh.
65. *D. flaccida* Bergh.
66. *D. weberi* Bergh.

These sixty-six species probably include many synonyms, and many of them, particularly those described by D'Orbigny, Crosse, and Pease, are only doubtfully referable to the genus. Neither the buccal parts nor the genitalia supply specific characters in the majority of cases, and the external appearance is even more variable than in *Chromodoris*. One of the best known species, *D. nigra*, is protean in its transformations. It not only ranges from black to white, with or without coloured borders and spots, but is sometimes smooth and sometimes tuberculate. As a rule, however, the smooth and tuberculate forms appear to be distinct.

DORIDOPSIS TUBERCULOSA (Quoy & Gaim.) var.

(*Doris carbunculosa* Kelaart, l. c. I. p. 301 ; Bergh in Semper's Reisen, xvi. 2, p. 845.)

Alder and Hancock (*l. c.* p. 128) pointed out that Kelaart's *D. carbunculosa* is probably the same as Quoy and Gaimard's *D. tuberculosa*, though it differs in not having white spots on the under side. These white spots are very conspicuous in the living animal and remain in alcoholic specimens. Bergh, however (*l. c.*), has described a variety from Mauritius in which the white spots are absent, and which agrees with *D. carbunculosa* in several details. It is very soft, and the under side of the mantle is "mit feinen Längsfurchen," corresponding to Kelaart's statement that it is veined.

As Bergh observes, it is somewhat doubtful if this is merely a variety of *Doridopsis tuberculosa* or a new species. I have a specimen captured by Mr. Gardiner at Rotuma, which is of a uniform brownish yellow without a trace of spots, but in other respects apparently a typical *Doridopsis tuberculosa*.

DORIDOPSIS DENISONI (Angas).

(*Doridopsis denisoni* Angas, "Descrip. d'espèces nouv. de Moll. nud.," J. de Conchyl. 3 sér. iv. 1, 1864, p. 45. *Doridopsis denisoni* Bergh in Semper's Reisen, xv. p. 694, ff. *Doridopsis gemmacea* A. & H. l. c. p. 126, and Hancock, "Anatomy of *Doridopsis*.")

According to Bergh, Angas's name has a few months' priority over Alder and Hancock's *D. gemmacea*.

The three specimens are not very well preserved, but appear to agree with Alder and Hancock's two descriptions cited above both externally and internally.

The mouth-gland is large and consists of many finely divided lobes. The liver is flattish, much lobed, and deeply cleft behind. No hooks or spines could be found in the male genitalia, although they are no doubt really present. The vas deferens is extremely long and elaborately coiled.

DORIDOPSIS ATROMACULATA A. & H.

(A. & H. l. c. p. 129; and Hancock, "Anatomy of *Doridopsis*," p. 193.)

One specimen, rather well preserved. It is as described by Alder and Hancock, though the structure of the mouth-parts is obscured owing to this portion of the body having been opened. Superficially the back appears to be white with black tubercles, but on a closer examination it is seen that the whole surface is studded with groups of tubercles, or with compound tubercles, which are in some places white and in others black. Even in the black regions the tips of the tubercles are whitish.

The structure of the branchia is remarkable. The plumes arise from a large common ring which, as preserved, projects considerably above the edge of the branchial pocket. Three of them are tripinnate, elongate, but not very ample; in position they are right, left, and posterior. The anterior part of the ring bears a number of small inconspicuous bipinnate plumes, and there are a few more between the left and the posterior plumes. The right and posterior plumes are close together, the arrangement not being quite symmetrical. The large anal papilla lies somewhat to the left of the centre of the ring.

Doridopsis punctata has also only three branchiæ, but the arrangement is different, the plumes being tripinnate and fairly ample, without intermediate smaller tufts.

Hancock's statement that "the proboscis is quite slender and tapers imperceptibly into the crop" raises a doubt if the animal may not really be a *Doriopsisilla* (see below).

DORIDOPSIS CLAVULATA A. & H.

(A. & H. l. c. p. 127. Eliot, Proc. Zool. Soc. 1904, ii. p. 278.)

Three specimens in a fair state of preservation. Though the animal has a general resemblance to *Doridopsis denisoni*, it would seem to be easily distinguishable from it externally. The margin of the branchial pocket is much more distinctly tuberculate, and the large dark green areas on the back are very plain.

There also seem to be differences in the genitalia. They are much hardened, but it is clear that the vas deferens is much shorter than in *D. denisoni* and not so elaborately coiled. The lower part of the vas deferens and the penis are thickly covered with small, slightly bent, yellowish spines.

The arrangement of the alimentary canal, so far as it can be still ascertained, is as in *D. denisoni*. A large double mouth-gland lies beneath the buccal mass and opens into it by a single duct. There is a constriction after the proboscis, and another about halfway between the proboscis and liver.

DORIDOPSIS (?) GRISEA (Kelaart).

(Kelaart, l. c. p. 297.)

The statement that the "mouth is surrounded with a white veil" makes it probable that this species is a *Doridopsis*. Kelaart uses a similar expression concerning *D. carbunculosa*; and it is evidently an attempt to describe the two small tentacles characteristic of the genus which are often attached for the greater part of their length and inclined towards one another above the poriform mouth.

D. grisea is possibly the same as the animal figured by Bergh in the Opisthobranchia of the 'Siboga' Expedition, plate v. fig. 19, as "*Doriopsis*?"

DORIOPSISILLA Bergh.

(See Bergh, Jahrb. d. Deutsch. malak. Gesell. 1880, pp. 20-30; id., Zool. Jahrb., Abth. für Syst., Jena, 1896, Band ix. Heft iii. pp. 454-8; and Vayssière on *Doriopsisilla areolata* in 'Talisman' Opisthobranches, 1902, pp. 235-7, and Opist. de Marseille, iii. 1901, pp. 50-52.)

In *Doriopsisilla* the dorsal surface is granulate and harder than in *Doridopsis*; but the chief difference between the two genera is that whereas in *Doriopsisilla* the buccal ganglia beneath the alimentary tube lie immediately behind the main body of the central nervous system, in *Doridopsis* they lie at some distance behind it on a constriction of the alimentary tube, and are united to the nerve-collar by rather long connectives.

The difference may seem slight, but is of considerable structural importance, as will perhaps be understood by an inspection of figs. 4-7, Pl. XLVII., which give comparative views taken from beneath and from the side of the central nervous system and

alimentary tube in *Doriopsilla miniata* and *Doridopsis nigra* respectively. It should be remembered, however, that these forms may not be typical in all their details, and that other species may show minor variations.

In *Doriopsilla miniata* the tube which issues from the proboscis describes a curve below the nerve-collar (*cf.* Vayssière, *l. c.* 1901 : "Il [le tube] décrit un cercle complet en avant du collier nerveux, puis traverse celui-ci), and then passes through the collar and above the buccal ganglia which touch the collar to the liver. Its diameter is uniform, and its course behind the collar fairly straight. In *Doridopsis nigra* the nerve-collar lies immediately behind the proboscis. A straight narrow tube runs through it without making any curves until it has passed through the main body of the nervous system. It then makes two conspicuous bends to the right before entering the liver. In the angle between these two bends the tube is constricted, and here are situated two small salivary glands and the buccal ganglia, which latter are united to the nerve-collar by a pair of connectives which run straight and do not follow the bends of the tube. Behind the buccal ganglia the tube dilates and makes another bend to the right before it enters the liver.

It looks as if the arrangement in *Doriopsilla miniata* were the more primitive. It is much the same as that found in an ordinary Dorid, except that the radula with its pouch and the whole buccal mass have disappeared, leaving in their place a curved suctorial tube. But in *Doridopsis nigra* this curved tube has been pulled backwards through the nerve-collar, and the buccal ganglia have moved with it, and if, as it is reasonable to suppose, the buccal ganglia mark the commencement of the œsophagus, that organ has very different dimensions in the two genera. Though nothing is known about the food of the Doridopsidæ, it is clear that their alimentary organs form an exsertile proboscis and a powerful suctorial apparatus; and perhaps the arrangement found in *Doridopsis nigra* (which seems to be by far the most usual in the family) allows this apparatus, which probably expands and contracts when taking nutrition, to move more freely.

Doridopsis nigra (Pl. XLVII. figs. 5 & 7) has not only the two small salivary glands already mentioned, but also a large bilobed gland (Pl. XLVII. figs. 5 *d* & 7 *d*) discharging by a single duct, which enters the wall of the proboscis rather far back, runs forward as a thin tube (Pl. XLVII. fig. 5 *e*) in the lower wall of the proboscis, and opens close to the mouth. It is generally known as the ptyaline gland, but, as Hancock suggests, it may supply a secretion which can pierce or benumb the animal's prey. Neither salivary nor ptyaline glands could be found in my specimens of *Doriopsilla miniata*, and if present at all they must be small. Bergh reports their presence in *Doriopsilla areolata* and *D. pallida*, but could not find them in *D. levis* (Siboga, p. 179), which offers many analogies to *D. miniata*. The large development of the ptyaline gland in *Doridopsis* would doubtless be

an additional reason for pulling the alimentary tube back to give more room.

A further examination by sections of *Doridopsis reticulata* (Cockerell & Eliot, J. of Mal. xii. 1905, p. 41) indicates that this species also is a *Doriopsilla*. The real buccal ganglia are not, as stated, 4 mm. behind the central nervous system, but close to it and united by short connectives to the part that seems to correspond to the pleural ganglia. The alimentary tube differs somewhat from that of *D. reticulata*. The part in front of the nerve-collar is broad and pouch-like: just under the collar (as preserved) is a valvular apparatus separating this anterior dilated portion from the long narrow posterior portion. Before entering the liver the alimentary tube dilates again into a pouch divided by a constriction. Under the buccal parts is a large bilobed gland, probably, but not demonstrably, connected with the proboscis.

DORIOPSILLA MINIATA (A. & H.). (Plate XLVII, figs. 4 & 6.)

(A. & H. l. c. p. 130.)

Four specimens are preserved, hardened and in bad condition, but quite recognisable. The following notes are the result of examining recent specimens from Karachi, which I have no hesitation in identifying with this form.

The animal was described by me in the 'Journal of Conchology,' vol. ii, no. 8, Oct. 1905, as *Doridopsis miniata*, and stated to have long buccal connectives. Subsequent examination by sections has shown that this is incorrect. The portion of the alimentary canal lying between the central nervous system and the liver is supported by several strong filaments, and some of these were mistaken for connectives running between the buccal ganglia and the central nervous system.

The sections show clearly that the ganglia are arranged in the manner characteristic of *Doriopsilla*. The main mass (*a*) is of somewhat irregular shape and surrounds the œsophagus. Immediately behind it and touching it, but below the œsophagus, are the two buccal ganglia close to one another. Not far from the buccal ganglia a short connective runs to the right and terminates in a small ganglion near the penis, which apparently innervates the genitalia. The anterior portion of the alimentary canal is a thin tube, which preserves a uniform diameter until it enters the liver. On issuing from the proboscis it describes a Z-shaped figure. The lower curve of this figure is free and lies below the nerve-collar, which surrounds the upper loop. On reaching the liver the tube runs for some distance just below the surface before descending into the interior. In spite of a careful examination, the presence of ptyaline or salivary glands could not be demonstrated. It seemed certain that the wall of the proboscis does not contain a long duct coming from the ptyaline gland as in *Doridopsis nigra*.

Hancock's observations on *D. miniata* ("Anatomy of *Doridopsis*," p. 193) agree on the whole with mine. He says nothing about salivary or ptyaline glands.

The following Dorids, described and figured by Kelaart, cannot be referred with certainty to any of the modern genera, but if rediscovered will perhaps be recognisable:—

Doris elizabethina (Kelaart, l. c. II. p. 267) (Pl. XLIII. fig. 3) has the appearance of a *Chromodoris* in most respects, but the fairly wide bipinnate branchiæ would be abnormal in the genus.

Doris papillosa (Kelaart, l. c. I. p. 297) (Pl. XLV. fig. 3) is coriaceous and bears large papillæ. The back is covered with reddish spots and markings, but the rhinophores are green or blue. The three anterior branchiæ are white, the three posterior reddish. In the plate the anterior plumes are hardly visible.

Doris corrugata (Kelaart, l. c. I. p. 303). The very poor drawing, which is not worth reproduction, represents a flat greenish-grey tuberculate dorid, with no spots. The erect, simply pinnate branchiæ are conspicuous. It may be either a *Sphaerodoris* or a *Staurodoris*, and it will perhaps be possible to identify it by the greenish coloration of the upper surface and the black spots on the lower.

Doris lockyerana (Kelaart, l. c. II. p. 268) (Pl. XLVI. fig. 1). This "splendid species" looks as if it might be an *Asteronotus*, but has evidently no resemblance to the *D. exanthemata* which Kelaart disliked so much. It may be an *Orodoris*.

Doris viperina. } These large handsome species are probably
Doris picta, } Platydorids or Discodorids. The drawings of
Doris bellicosa. } the under sides are not reproduced.

D. viperina (Kel. l. c. I. p. 299) (Pl. XLVI. fig. 2) is "coriaceous . . . covered with short spinous tubercles." The drawing of the under side represents the oral tentacles as very large. Both the foot and the under side of the mantle are white and spotted with reddish brown.

D. picta (Kel. l. c. I. p. 303) (Pl. XLIV. fig. 4) is said to be "coriaceous . . . granular . . . sheaths of rhinophores large, granular." The drawing of the under side represents the oral tentacles as moderately large; the foot as white; the mantle-edge as white with a broad red border round the foot.

D. bellicosa (Kel. l. c. I. p. 303) (Pl. XLIV. fig. 3) is "coriaceous . . . granular, and covered with small spines." The figure of the under surface represents the oral tentacles as white and moderately large; the foot of a deep brick-red; the mantle white, but largely covered with brick-red spots and blotches, especially near the foot.

Doris variabilis (Kelaart, l. c. I. p. 300). The drawing is very

poor and adds nothing to Kelaart's description, but the animal may perhaps be identified, as it is said to be "found in great abundance on rocks in Dutch Bay at low-water mark." Kelaart associates it with *Doris atrata* (= *Doridopsis nigra*); so it may perhaps be a *Doridopsis*. Allowing for variations, *Doridopsis tristis* B. and *Doridopsis indaca* Tapp.-Can. have a somewhat similar coloration.

Doris rufopunctata (Kelaart, l. c. I. p. 297) (Pl. XLII. fig. 5). There are not sufficient data for assigning this form to any genus. It is expressly said that it is coriaceous and stiff; so it may prove to be a *Platydoris*.

Doris constantia (Kelaart, l. c. I. p. 298) (Pl. XLII. figs. 8 & 9). Both the description and the drawing seem to characterise the animal sufficiently externally, but it is impossible to say to what genus it belongs.

Doris castanea (Kelaart, l. c. I. p. 303) (Pl. XLII. figs. 6 & 7). This is possibly the animal described by me as *Sclerodoris* (= *Peronodoris*) *tuberculata* (Proc. Zool. Soc. 1903, ii. p. 381), but the identity cannot be proved from the materials supplied by Kelaart.

Doris aripona (Kelaart, l. c. II. p. 269) (Pl. XLV. fig. 2). It is impossible even to guess to what genus this species should be referred, but it looks recognisable.

DORIS NIVEA (Kelaart).

(Kelaart, l. c. I. p. 296.)

It may be doubted if Kelaart is right in suggesting that this is the *Doris* (*Chromodoris*) *pallida* of Rüppell & Leuckart. His alternative suggestion that it is akin to *Doris* (*Cadlina*) *repanda* is more probable, but in *Cadlina* the oral tentacles are generally flat and grooved, not linear. It may belong to the Doridopsidae. *Doridopsis bataviensis* and *Doriopsilla pallida* are whitish. No drawing of the species has been found.

TREVELYANA.

This genus was founded by Kelaart for *T. ceylonica* in the Ann. & Mag. Nat. Hist. ser. 3, 1858, vol. i. p. 257. Perhaps the *Gymnodoris* of Stimpson (1855) is a synonym. If so, the name has priority, but Stimpson's description is inadequate.

Trevelyana and *Nembrotha* form a small group within the Polyceridae, characterised by the entire absence of frontal and dorsal appendages. The dorsal margin and frontal veil are vestigial or entirely absent. The rhinophores are retractile, the branchiae non-retractile. There are no jaws. The penis is armed with spines. The oral tentacles are small. The foot is narrow and the general shape limaciform. *Greilada* somewhat resembles this group in external characters, but has frontal appendages, and the buccal parts are as in *Polycera*.

The two genera are clearly distinguished. Externally the chief difference is that *Trevelyana* has numerous small branchiæ and *Nembrotha* a few (3-5) large branchiæ. In *Trevelyana* the radula is fairly wide; the rhachis bare; the teeth are awl-shaped or slightly hamate, and though the innermost is generally distinguished from the rest, it is not of an essentially different shape. In *Nembrotha*, on the other hand, the radula is narrow; there is a rhachidian tooth; the first lateral is large and falciform, the rest are mere plates. Also, whereas in *Nembrotha* the hermaphrodite gland is spread over the liver, as is usual in the Dorididæ, in *Trevelyana* it is quite separate from the liver and forms two globular masses in front of it.

This arrangement is very rare in the Dorididæ and is characteristic of such forms as *Scyllæa*, *Bornella*, &c. It might be supposed that it would not occur in a Doridiform animal without being accompanied by other profound structural modifications; but it is found not only in *Bathydoris*, but also in *Alloiodoris*, which, but for this peculiarity, seems to be a perfectly ordinary Dorid.

It will thus be clear that it is not easy to see how *Trevelyana* can be derived from *Nembrotha* or *vice versa*. *Nembrotha* may be regarded as an animal analogous to *Triopa* which has lost its appendages, though the dentition is not exactly the same. But *Trevelyana* cannot be so explained. In its dentition, though not in other respects, it shows greater resemblance to *Notodoris*.

About nine species of *Trevelyana* seem fairly certain:—

1. *T. ceylonica* Kelaart.
 = *T. rubromaculata* Bergh.
 = *T. picta* Pse.
 ? = *Doris impudica* Rüpp. & Leuck.
2. *T. bicolor* A. & H.
3. *T. citrina* B.
4. *T. alba* B.
5. *T. inornata* B.
6. *T. plebeia* B.
7. *T. crocea* B.
- { 8. *T. coccinea* Eliot.
- { 9. *T. rubropapulosa* B.

Bergh in his 'System,' p. 1144, includes in his list *Trev. ? rubra* Pease, but in the Opisthobranchs of the 'Siboga' has inadvertently registered a form under the same name as a new species. The specimen was, however, small, and its state of preservation rendered a full description impossible. It may be the same as *T. rubra* Pse., which is very incompletely described. *T. concinna* Abraham, of which nothing is known except the external features of an alcoholic specimen, does not seem to me sufficiently characterised.

The remarkable *Tr. ? defensa* described by Bergh (Siboga, pp. 192-3) must, I think, be regarded as a new genus if not a

monstrosity, and can bear the name *Thimna*, as suggested by Bergh.

About thirteen species of *Nembrotha* are fairly well characterised. The dentition of *N. rubro-ocellata* B. (Siboga, pp. 201-2) is unknown, and it does not seem to me that the animal is sufficiently distinguished externally from other forms such as *N. rubropapulosa* :—

- | | |
|---|---|
| { | 1. <i>N. nigerrima</i> B. |
| | 2. <i>N. cristata</i> B. |
| | (See Eliot, Proc. Zool. Soc. 1904, ii. p. 90,
and Bergh, Siboga, 1905, p. 195.) |
| | 3. <i>N. kubaryana</i> B. |
| | 4. <i>N. cœrulea</i> Eliot. |
| { | 5. <i>N. lineolata</i> B. |
| | 6. <i>N. amitina</i> B. |
| { | 7. <i>N. morosa</i> B. |
| | 8. <i>N. diaphana</i> B. |
| { | 9. <i>N. gratiosa</i> B. |
| | 10. <i>N. affinis</i> Eliot. |
| { | 11. <i>N. verconis</i> Hedley & Basedow.
(Trans. Roy. Soc. S. Austr. 1905, vol. xxix. p. 158.) |
| | 12. <i>N. gracilis</i> B. |
| { | 13. <i>N. rubropapulosa</i> B. |

The brackets merely mean that the species are allied, and do not necessarily imply probable identity. It is possible, however, that some of the species are only colour varieties. Nos. 1 to 4 are dark, with a comparatively wide radula containing about 12 teeth on each side of the rhachis. *N. lineolata* is yellowish with fine brown lines and 8 teeth on either side of the rhachis. In the remaining species the radula is narrow and there are only 3 or 4 teeth on either side. Nos. 6 and 7 are dark; nos. 8 and 9 present a brilliant combination of colours in which bright yellow and dark blue are prominent. *N. gracilis* and *N. rubropapulosa* both have a tricuspid rhachidian tooth and a similar coloration of black and red.

TREVELYANA CEYLONICA Kelaart.

(Kelaart, Ann. & Mag. Nat. Hist. April 1858, vol. i. no. 4, p. 257, and pl. x. B. Eliot, Proc. Zool. Soc. 1904, ii. pp. 86-7.

Cf. *Trev. rubromaculata* Bergh, Siboga, pp. 189-191.)

There can be but little doubt that Bergh's *T. rubromaculata* is the same as the earlier *T. ceylonica*, for the agreement in characters, both external and internal, is almost complete. The radula in Bergh's specimen seems to have been somewhat larger than in mine (from East Africa), though it is not quite clear whether there were 16 or 32 teeth on each side of the rhachis.

The species can be recognised externally by the colour and by

the large branchiæ. Pease's *T. picta* (Amer. Journ. of Conch. 1871, vol. vi. p. 301) is perhaps a synonym, since it has a similar coloration and the "branchial star large . . . wider than the body." Perhaps also Rüppell & Leuckart's *Doris impudica* (1828) is the same species. If this can be proved, the specific name has priority.

The Newcastle collection contains a good coloured drawing by Kelaart, which is not reproduced here since it has already been published in black and white in the Ann. & Mag. of Nat. Hist. (*l. c.*). See also the coloured edition of H. & A. Adams's 'Genera of Recent Mollusca,' pl. cxxxvii. fig. 14.

KALINGA A. & H.

This remarkable genus was regarded by its discoverers, Alder and Hancock, as intermediate between *Euplocamus* and *Plocamopherus*, but it does not possess the characteristic conformation of the radula and prostate which distinguishes those genera. There can be no doubt, however, that it belongs to the Polyceridæ. Externally it differs from most members of the family in its somewhat doridiform shape, the absence of a tail, and in having its branchiæ entirely separate from one another, much as in *Hexabranchnus** and *Bathydoris*. In the Dorididæ phanerobranchiatæ, where the gills are not retractile, the complete isolation of the separate plumes does not necessarily imply any considerable structural change, but it may be a survival of an arrangement which is more primitive than the symmetrical circuit of united branchiæ.

The genitalia, so far as they are known, seem to be of the type found in *Polycera* and its allies, but the shape of the glans penis is unusual and resembles that of *Phialodoris*. The radula differs from those of all known nudibranchs. It is very broad and composed of very numerous tricuspid teeth. The specimens here examined indicate that the buccal organs are of extraordinary size and strength, though it is hard to say what may be their natural position and *modus operandi*.

KALINGA ORNATA A. & H. (Plate XLVII. fig. 2.)

(A. & H. *l. c.* pp. 134-6. Bergh in Semper's Reisen, xvii. pp. 959-962. Farran, *l. c.* p. 347.)

The Newcastle collection contains three poorly preserved specimens, which are the types used by Alder and Hancock for their description published in 1864, and also a very large specimen, relatively well preserved, and labelled "Sir W. Elliot, Madras,

* The descriptions of the gills of *Hexabranchnus* are often most misleading, for they state that the organs are retractile into separate cavities or pockets, the natural meaning of which is that each branchia has a separate permanent cavity into which it can be retracted. But in reality there are no such cavities. The plumes are contractile separately, and when they contract, the skin, being soft, forms a temporary hollow at their bases. But they do not disappear into a pocket, and when they spread out again the hollow vanishes.

1867." It appears to be specifically the same as the smaller specimens.

It is rather rectangular in outline and measures 106 mm. in length, 49 in breadth, and 41 in height. The coloration is brown of various shades; the dorsal surface and most of the branchiæ are dark brown; the sides of the body, the foot, the exerted proboscis, the rhinophores, all the dorsal processes and in places the tips of the branchiæ are light yellowish brown.

The back is flat; the margin does not project, but is clearly marked by a line of ramose processes extending at least as far back as the branchiæ. Of these processes, eight on each side are taller than the others, and the largest are about 6 mm. high and 5 mm. broad. They are branched three or four times, but as preserved suggest not so much branches as aggregations of tubercles. There are ten similar but rather smaller processes on the oral veil, varying from 2 to 5 mm. in length. Besides these marginal appendages, both the back and the sides of the body are irregularly sprinkled with processes of all shapes and sizes, varying from a height of 2 mm. to microscopic dimensions. The larger are distinctly ramose, the smaller apparently simple.

The rhinophore-pockets are not much raised and the margins are studded with small processes like the rest of the back. The rhinophores are completely retractile, smooth below, but bearing about 40 perfoliations on the top part, which is bent backwards. The large branchiæ cover the posterior third of the back. They are quadri- or even quinque-pinnate and consist of four groups:—

- (a) Left posterior. An enormous plume, 30 mm. long and 35 broad, arising from a single stem, but dividing close to the base into two large and two smaller branches. There is a pocket-like hollow round the base, but the plume is by no means retractile and extends beyond the dorsal margin.
- (b) In front of this large plume and a little nearer the median line is a smaller group (14 mm. \times 16 mm.) with three main divisions. (c) Rather to the right of this and on the middle line of the back is another group of two plumes (about 20 mm. \times 12 mm.), which seem to rise from a common base.
- (d) On the right is another group, about the same size as the last, which seems to consist of two plumes arising from a common stalk, though it is hard to be certain of this as the back is much corrugated. There is no large plume on the right corresponding to (a), and the whole arrangement of branchiæ is asymmetrical. The anal papilla is on the median line just to the right of (a). Though the opening is very large, it is low and inconspicuous. In front of it lies another opening, probably the renal pore. On the right side of the body, about halfway down and 25 mm. from the frontal veil, is the genital opening—a large simple pit in the interior of which are the separate sexual orifices.

Just below the oral veil on either side are two flat folded lobes (4 mm. long by 3 broad) which appear to represent tentacles.

A huge proboscis, unlike anything which I have ever seen in the Nudibranchiata, is everted under the oral veil and folded under the body of the animal (Pl. XLVII. fig. 2 *b*). It is 98 mm. long, and 34 mm. broad at its base, but tapers towards the tip, where it is about 8 mm. broad. The radula, which was found at the point marked *c* on this proboscis, is torn into several longitudinal strips, and the rhachis and innermost teeth can no longer be distinguished. When perfect, the ribbon must have been very large, consisting of between 300 and 400 transverse rows, each containing at least 200 teeth on either side of the rhachis. All the teeth examined are as figured by Farran (*l. c.* plate iii. figs. 23, 24), tricuspid with long bases.

From this strange buccal apparatus a strong muscular tube, about 30 mm. long, 12 mm. wide, and nearly straight, runs to the liver, enters it and re-emerges as the intestine. Within the liver is a small stomach which seems to receive only one hepatic duct. The walls of the stomach and intestine are quite distinct within the liver. The liver itself is about 57 mm. long and 38 broad, tapering posteriorly. It is elongate-ovate in shape and greyish in colour. Its relations to the hermaphrodite gland are not clear.

The central nervous system is enclosed within a strong white capsule, but is itself rather dark grey. The general outline is as usual, suggesting the three pairs of ganglia, but no division into ganglia is traceable in its substance. It seems to be composed of a mass of large and small granules not set in groups.

The genitalia are not well preserved, but owing to their large size the principal features can still be ascertained. The ampulla of the hermaphrodite gland is much convoluted. It is about 3 mm. broad and, as coiled, 30 mm. long. At its end comes the bifurcation of the male and female branches. The first part of the male branch is enveloped in a large lobed organ, which is apparently the mucus-gland, and enters the female branch close to the bifurcation. When free from this gland, the male branch appears as a broadish tube (5 mm.) with rather thin walls. It dilates into an elliptical expansion (presumably a prostate) about 15 mm. long and 10 mm. broad, with thickish walls and empty inside. After this dilation it becomes a thin-walled free tube, 35 mm. long and 5 mm. broad, running to the penial pouch. The vas deferens within the pouch is straight and not convoluted. The lower part of the vas deferens bears an armature of numerous, minute, brownish spines of very various shapes and sizes—long, short, straight, wavy or hooked, but mostly with narrow bases. The glans penis is formed, as Bergh says, somewhat as in *Phialodoris*. There seem to be two elongate lateral folds of skin, and in the middle another fold surrounding a rather irregular opening. After the bifurcation the female branch is thin and constricted. It receives the ducts of the above-mentioned mucus-gland (?) and of the large hard albumen-gland. Then comes the

small pear-shaped spermatocyst (9 mm. \times 3 mm.) full of brownish matter. Below this is the roughly spherical spermatheca with a diameter of about 20 mm., sessile, or rather forming simply a dilatation of the tube. From the spermatheca runs a tube about 45 mm. long to the vestibulum genitale, and at the point where it enters it there is a much laminated body of glandular appearance which is probably the *Blase* of Bergh (*l. c.* p. 962). No other organs could be identified with certainty. A folliculate gland found detached among the genitalia may perhaps have been the blood-gland dragged out of place, and have had no real connection with them.

The eversion and protrusion of the buccal parts found in this specimen have also occurred in the three smaller specimens, but are less conspicuous owing to the relatively small size of the organs. In the specimen examined by Bergh the buccal parts had disappeared. No doubt they had been protruded and then accidentally torn off. In Farran's specimen, too, "the whole buccal mass had been everted through the mouth-opening, so that the radula lay along the under surface of the everted organ." It is therefore clear that the buccal parts are habitually protruded in preserved specimens; but it is impossible to say whether this protrusion is due to convulsive action at the moment of death, or whether the living animal can protrude its radula voluntarily. Information as to its feeding-habits is much to be desired, for whatever may be the cause of the protrusion, it is evident that the buccal organs are of unusual size and strength.

An inspection of the parts protruded in all Alder and Hancock's specimens, particularly of their musculature, suggests that the portion nearest to the body of the animal (Pl. XLVII. fig. 2 *a*) is everted, that is to say turned inside out, but that the distal portion (fig. 2 *b*) is in its natural condition and simply protruded. The smaller (but badly preserved) specimens entirely support this view, because, in them, if the protruded portion is straightened the radula is, or appears to have been, on the upper side. But in the large specimens and in Mr. Farran's specimen the radula lies on the under side; a position which it is difficult to explain, unless we suppose that the radula has been dragged round and is not in its normal place.

PHYLLIDIIDÆ.

Few recent additions have been made to this family, which, though abundant in the Indo-Pacific, has not hitherto proved numerous in species. It appears to me, however, that *Phyllidia zeylanica* Kelaart must be regarded as separate from *Ph. varicosa*, with which Bergh unites it. The beautiful animal described by Bergh as *Ph. celestis* (Siboga, pp. 182-3) is perhaps a distinct species; but its coloration, though lighter and brighter, is essentially that of *Ph. varicosa*. Many specimens at any rate of

this form are, when alive, glossy black with slate-blue ridges and orange tubercles on the back.

Bergh (Siboga, p. 180) observes that the genus *Ceratophyllidia* Eliot "ist wohl mit der *Phyllidiopsis* identisch." It is not denied that the mouth-parts are as in *Phyllidiopsis*, but the back is studded with papillæ which consist of soft globes mounted on flexible stalks which shake when the animal moves. They seem to me strikingly different from the flat hard tubercles of the other *Phyllidiidæ*, and to constitute a sufficient generic character.

PHYLLIDIA ZEYLANICA Kelaart. (Plate XLII. fig. 10.)

(Kelaart, l. c. II. p. 494.)

Bergh (System, p. 1120, and elsewhere) regards this species as equivalent to *Phyllidia varicosa*, but the identification offers many difficulties. The rhinophores and oral tentacles are said to be black, whereas in *Ph. varicosa* they are yellow. The foot is whitish, whereas in *Ph. varicosa* it is blackish or purplish with a deep black median line. Also the general arrangement of the dorsal pattern is not the same. It cannot be said that in *Ph. varicosa* "three continuous black lines run round the whole length" of the back. The form seems to have greater affinities to *Ph. rosans*, but here also differences of shape and colour present themselves, for among other points *Ph. zeylanica* is more distinctly tuberculate. It must, I think, be regarded provisionally as a separate species.

BORNELLA DIGITATA Ad. & Reeve.

(=*B. hancockiana* Kelaart, l. c. III. p. 269.)

Among the drawings are two labelled "*Bornella digitata*" and "*Dendronotus* vel *Bornella Hancockii*," both containing figures of the entire animal and of the rhinophores and papillæ separately. In both there are five pairs of papillæ behind the rhinophores, and no difference is discernible except that in *B. digitata* the rhinophoral papillæ have five branches and the others three, whereas all five are represented as having four branches in *B. hancockii*. But even this difference is not observed in the figures of the entire animals.

The two names are clearly synonyms.

SCYLLÆIDÆ.

The family contains two genera: *Scyllæa* L. and *Crosslandia* Eliot. The latter is closely allied to *Scyllæa* in structure but differs in appearance, since the dorsal margin instead of bearing two large papillæ on either side, is expanded into a single wing-like flap.

Like other genera of pelagic, or semipelagic, nudibranchs, such as *Glaucois*, *Phylliroë*, and *Hexabranchus*, *Scyllæa* presents numerous varieties differing in colour and external details, among which it is extremely hard to find valid specific characters. Also

some of the older species are very imperfectly known. Bergh recognises eight species altogether, and in the commonest, *Sc. pelagica*, four varieties besides the typical form. Basedow & Hedley (Trans. Roy. Soc. South Australia, vol. xxix. 1905, pp. 148-9, pl. ix. figs. 1 & 2) have recently figured some forms of very divergent appearance which they refer to this species. According to the structure of the radula the species fall into two groups. In *Sc. pelagica* the teeth are flat and bear only a few denticles: *Sc. marmorata* belongs to this group. In *Sc. elegantula* and *Sc. bicolor* the teeth are erect and bear more numerous (10-15) denticles.

Alder and Hancock (*l. c.*) described two species: *Sc. viridis* and *Sc. marmorata*. No specimen of the former is forthcoming, but the animal should be recognisable by its shape if found again. Notes on the specimens of *Sc. marmorata* are appended.

On Kelaart's drawing of the animal which he has called *Scyllæa* (?) *dracæna*, Hancock has written:—"Not a *Scyllæa*; belongs to the Bullidæ." The drawing suggests that it is a mutilated *Lobiger* with only three wings. But no shell is visible.

SCYLLÆA MARMORATA A. & H.

(A. & H. l. c. p. 136.)

Two specimens from Newcastle, preserved in alcohol. They are high and narrow, about 15 mm. long and 3 mm. broad. One has been dissected already, and two large globular masses of the hermaphrodite gland are very conspicuous.

So far as can be now seen, the external characters are as described by Alder and Hancock. The most remarkable features are the row of very distinct yellow tubercles on each side of the body, and the large size of the whitish branchiæ which are set inside the cerata and on the caudal crest. The largest tufts are 3 mm. wide and the branches 2.5 long.

The jaws are greyish, of the shape usual in the genus, with edges which are irregular in places, but not denticulate. The surface is covered with fine striations and with numerous very short rods, which look like minute spicules. In parts near the edge is developed a fine mosaic. On the labial cuticle are two grey triangular patches with a colourless triangle between them. They appear to be of the same substance as the jaws and exhibit the same short rods. This formation is perhaps analogous to the labial armature in *Bornella*.

The radula is, as usual, somewhat fragile and decayed, but consisted of at least 16 rows when complete, with at least 27 teeth in the longest rows. The teeth do not differ materially from those of *Scyllæa pelagica*. The central tooth has a strong, flat, elongate, rectangular base, but is not very broad. It bears four denticles on either side of the central cusp. The first laterals are similar to it, but narrower. The rest become gradually broader and bear as many as six longish denticles on either side.

The outer teeth approach the hamate shape, but all have the double row of denticles.

In the specimens already dissected by Alder and Hancock were found in the stomach (presumably the second stomach) twelve yellowish triangular plates of somewhat varying size. Other parts of this digestive tract are mottled with reddish-brown spots which bear papillæ.

The buccal mass was removed from the second specimen, which was not further dissected in order to preserve its external appearance.

PLEUROPHYLLIDIIDÆ.

The Oriental collections belonging to Alder and Hancock contain twelve specimens of this family referable to six species. This is an unusually large number. It is probable that the animals burrow in sand or mud and escape the notice of ordinary collectors, though when once discovered they may be found in considerable plenty and variety.

Four genera have been described—*Pleurophyllidia* Meckel, *Linguella* Blainville, *Camarga* Bergh, *Pleurophyllidiella* Eliot; and to them I think should be added *Pleuroleura* (= *Dermatobranchus*). Bergh and others make this last genus the type of a separate family, which differs from the Pleurophyllidiidæ only in having no gills or lamellæ under the mantle. But as the organisation of the two groups is the same and somewhat remarkably different from that of other Nudibranchiata, it seems better to recognise their affinities by uniting them in one family, just as has been done in the case of *Tethys* which has branchial tufts, and *Melibe* which has none.

In *Pleurophyllidia* the anterior dorsal margin forms a continuous fold behind the rhinophores, so that the space in front of the rhinophores is separated from the rest of the dorsal surface. In *Linguella*, on the other hand, the anterior fold is not continuous, and the dorsal surface passes between the rhinophores without interruption, and then spreads out into the area in front of the rhinophores. Though this character is clear and decisive in well-preserved specimens, it is often obscured by distortion, and most of the *Linguellæ* in the present collection have superficially the appearance of *Pleurophyllidia*, the real structure being visible only on careful examination. It would seem that when the animals are put into spirits the head is withdrawn and contracted, with the result that a fold is formed behind the rhinophores. This artificial fold may illustrate the manner in which the natural fold of *Pleurophyllidia* has arisen in the course of evolution. *Linguella* is probably the more primitive form, for in Nudibranchs the rhinophores generally rise out of the dorsal surface and it is the exception that they should be separated from it. But if the rhinophores come close together and the anterior parts are often retracted, there must be a natural tendency to form a fold as in *Pleurophyllidia*.

Bergh in his 'System' mentions 19 species of *Pleurophyllidia*. Of these I think that *P. marmorata* Kelaart is probably *Linguella cinerea* Farran, though the description is somewhat vague. *P. lugubris* Bergh seems to have been accidentally omitted from the list. Only two species appear to have been described since:—

20. *P. rosea* Bergh.
21. *P. stenidia* Bergh.

To the five species of *Linguella* enumerated by Bergh (*l. c.*) may be added:—

6. *L. variolosa* Bergh.
7. *L. cinerea* Farran.
(? = *Diphyllidia marmorata* Kelaart.)

Camarga, represented by one species, *C. marginata* (Oersted), from the Pacific Coast of Nicaragua, seems to have a ridge in front of the rhinophores connected with the mantle by a wide commissure*.

The genus *Pleurophyllidiella* was proposed by me (Proc. Zool. Soc. 1903, vol. i. p. 250) for a species, *P. horatii*, from East Africa, which appears to have no traces of branchiæ or a branchial cleft, though lateral lamellæ are present. The head parts appear to be as in *Linguella*. Bergh (Siboga, 1905, p. 208) suggests that the branchiæ may be so deeply retracted as to be invisible. I doubt if this is the case. If the branchiæ are merely obscured and not really absent, the more probable explanation is that they are so far from the body that they are undistinguishable from the lateral lamellæ, which is much the same as saying that they have disappeared if the conformation described exists in the living animal. While fully admitting that the preserving fluid may strangely distort external features, I see no particular reason to suspect this specimen †.

In several *Pleurophyllidias* (especially *P. pallida*, *P. compta*, and *P. stenidia*) the lateral lamellæ are greatly reduced: in *Pleuroleura* both branchiæ and lateral lamellæ are entirely absent. The radula of *Pleuroleura* is narrower than in the other genera, and in one species (*P. picteti*) there are only four laterals. The head parts seem to be as in *Linguella*, though the plates show some discrepancy in this respect, probably due to distortion in preserved specimens. Some of the species are quite small, and none seems to exceed about 3 centimetres in length. Probably the total absence of a specialised breathing-apparatus is unfavourable to the growth of large molluscs. It is hard to say whether the genus should be

* I am not sure that I clearly understand Bergh's diagnosis of this genus, and the figures in his Monograph on the Phyllidiadæ (pl. ix.) do not throw much light on the external characters. The diagnosis is:—"Corpus minus elongatum. Clypeus tentacularis latus, semilunaris, angulis productis; caruncula nuchalis humilis, lata, in pallium commissura latiore transiens; rhinophoria sejuncta. Sacci cnidogeni nulli."

† In my description, p. 252, *l. c.*, the statement that the first lateral tooth bears denticles "only on the internal side" is a misprint: read "external side."

regarded as more primitive than the forms which have developed branchiæ and lateral lamellæ, or as retrograde. Perhaps the latter hypothesis is more probable.

To the five species mentioned in Bergh's 'System' may be added:—

6. *Pl. walteri* Krause.
7. *Pl. picteti* André.
8. *Pl. alba* Eliot.
9. *Pl. pallida* Bergh.
10. *Pl. suluensis* Bergh.

The family, especially the genus *Pleurophyllidia*, is probably cosmopolitan, being at present recorded from Spitzbergen, the Northern Atlantic, the Mediterranean, Brazil, California, Valparaiso, Honolulu, Japan, China, the Persian Gulf, India, Ceylon, the Malay Archipelago, East Africa, and West Australia. *Linguella* seems confined to the Indo-Pacific, all the eight species being recorded from Indian, Chinese, and Japanese waters. *Pleuroleura* has much the same distribution, with the striking exception of *P. walteri* from Spitzbergen.

The coloration is usually sober, but some of the tropical species are rose-coloured, and *Pleurophyllidia tenuolata* is striped with purple and yellow.

In all the genera each species has a characteristic dentition, but it may be observed that in many species only a single individual or very few have been examined, so that the radulæ may show a wider range of variation than is at present known. The arrangement of the teeth is in all cases essentially the same. There is a rhachidian tooth bilaterally symmetrical and bearing several cusps, a somewhat clumsy first lateral which sometimes resembles half the rhachidian tooth, and a varying number (from 3 in *Pleuroleura picteti* to 180 in *Pleurophyllidia formosa*) of subsequent hamate laterals. The species differ chiefly in the amount of denticulation, and all degrees of it are found, from *Pleurophyllidia natalensis* and *P. cygnea*, in which all the teeth are smooth, to *Pleurophyllidia undulata*, in which they are all denticulate. The various transitional stages can be easily traced, but it is hard to say whether we should regard them as the gradual disappearance of denticles from denticulate teeth or the gradual splitting up and serrulation of smooth teeth. It may be noticed, however, that the radula of such forms as *P. cygnea* is very like that of *Tritonia*, and the jaws are similar in the two groups. The buccal parts might therefore be regarded as derived from those of *Tritonia*; but otherwise the Pleurophyllidiidæ occupy an isolated position, and their peculiar characteristics are probably correlated with burrowing habits, which are known to prevail in some species. It would be interesting to know if their resemblance to the Phyllidiidæ, which is merely external, can be explained by any similarity in their manner of life.

Of the Newcastle specimens, *Pleurophyllidia formosa* and

Linguella cinerea appear to have been presented by Kelaart, which is agreeable to the supposition that they represent his *Diphyllidia formosa* and *D. marmorata*.

PLEUROPHYLLIDIA FORMOSA (Kelaart). (Plate XLII. figs. 11, 12.)

(*Diphyllidia formosa* Kelaart, l. c. II. p. 494; Bergh, "Anatomische Untersuchung der *Pleurophyllidia formosa*," Verh. d. k.-k. zool.-bot. Gesellsch. in Wien, xix. 1869.)

One large specimen seems to be identical with both the animal described by Kelaart and that described by Bergh. It is unfortunately very badly preserved and the body has become soft and crumbly. It is 62 mm. long and 28 broad. The shape is linguiform. The colour is yellowish white, but the frontal shield is still faintly reddish, and the back bears traces of about 30 longitudinal stripes. The rhinophores have also preserved their pink and black coloration. The side-lamellæ are almost obliterated, but the branchiæ are distinct and set in a deep cleft. There is a longitudinal furrow in the posterior part of the foot. Of the internal organs only the hard buccal parts were sufficiently well preserved to be examined. They appear to be as described by Bergh. The jaws are large, brown, convex externally, bearing on the edges many denticles which can be seen with a hand-lens. The median tooth of the radula is very broad. It bears four denticles on each side of the central cusp, which is itself slightly denticulate. The first lateral is large and bears a few irregular indentations. The next few laterals are smooth; after that the rest are bifid, except the three or four outermost, which are again smooth.

One of Kelaart's drawings represents this species lying half buried in sand with the head and tail exposed. I have seen *P. californica* behave in the same way, and no doubt the habit is common in the genus. The sides of the mantle are held against the body so as to form a tube, through which a current of water is sent over the gills and side-lamellæ.

P. formosa is allied to *P. ceylanica*, which has a smaller radula and the outermost teeth serrulate, and also to *P. cygnea* and *P. natalensis*, in which all the teeth are quite smooth. The figure of *P. cygnea* given by Basedow and Hedley (Trans. Royal Soc. of South Australia, vol. xxix. 1905, p. 149, pl. x.) is remarkably like Kelaart's drawing, and differs chiefly in representing the frontal veil as colourless, not pink.

PLEUROPHYLLIDIA TENIOLATA Bergh.

(Bergh, Bidrag Monogr. Pleurophyllidierne, pp. 42-46.
Eliot, "Nudibranchs from the Indo-Pacific," Journ. of Conch. vol. ii. no. 8, Oct. 1905.)

One specimen of this fine species, which has hitherto been recorded from Mozambique and Maskat. Length if stretched

out about 60 mm., breadth about 27 mm. The pattern of yellow and purplish stripes is still very plain, though the colours have faded to white and black. The external and internal characters agree with previous descriptions. The formula of the radula is about $57 \times 65.1.1.1.65$ in the longest rows. The rhachidian tooth bears one denticle rather high up on either side of the central cusp and 5-6 rather low down. The first lateral is clumsy in shape, and bears 4-5 minute denticles on its outer edge. The remaining teeth are hamate, with projections behind the base. All except the 10-20 outermost have one or more denticles, often only one, but in this case the tooth never appears bifid.

LINGUELLA CINEREA FARRAN.

(Farran, l. c. p. 334.)

One specimen obtained from Kelaart appears referable to this species. Through the kindness of Prof. Herdman I have also had an opportunity of examining the type specimen preserved in the Museum of Liverpool University.

Kelaart's specimen is yellowish grey with darker shades here and there, and very flat and broad. Length 25 mm., breadth 21 mm., height 6 mm., breadth of foot 15 mm. The external characters are as described by Farran, but he does not allude to the narrowness of the branchial lamellæ, which is remarkable in both specimens. They are about 30 in number, and set on the under side of the mantle so as to form a narrow band 2 or 3 millimetres wide. This band is separated from the mantle-margin by a clear space, and from the side of the body by another clear space as wide as the band itself. These side-lamellæ run into the gills, which in places are hardly distinguishable from them. The true gills are about 25 in number and prolonged into a distinct cleft. On each side of the large round mouth there appears to be a process attached to the under side of the tentacular shield. There is a groove in the hinder part of the foot.

The jaws are yellow, long and narrow, with several rows of denticles, which are most developed on the masticatory process. In places there are at least eight rows of them, but they are often indistinct. The radula is decayed and very fragile, but there are at least 40 rows of teeth, and perhaps 50 teeth in each row on either side of the rhachis. The central tooth is strongly arched, with a moderately long median cusp and 6 or 7 lateral denticles, of which only the highest is on the side of the central cusp as a rule. The first lateral is lower and broader than the rest, and usually bears 8 rather distinct blunt denticles. The succeeding teeth are hamate, and become taller and slenderer in shape and bear more denticles. In the middle of the half row the number of denticles amounts to 18 or 20; then it somewhat decreases, and on the outer teeth the denticles are more minute and less distinct; but all the teeth, except the outermost of all, bear traces of serrulation. In the broken condition of the radula, however, it is difficult to be sure which are the outermost teeth. This

radula is essentially the same as in Farran's* specimen, but the median tooth is a little lower and broader and the side-teeth are more distinctly denticulate.

Kelaart's specimen is not accompanied by any name or note, but I strongly suspect that it is *Diphyllidia marmorata* †. His description is vague and the plate, which is very bad, adds nothing to it. But perhaps the living animal might be identified by its coloration. Kelaart says the body (*i. e.* the sides of the body under the mantle, as the plate shows) is white and spotted; the mantle yellowish brown and marbled with darker brown or greenish brown; the veil white, with a yellow margin. The colour of *L. civeera* in life is unknown.

LINGUELLA VARIOLOSA Bergh.

(Bergh, Malac. Unters. in Semper's Reisen, Theil vi. Lieferung i. 1904, pp. 21-24.)

Five specimens are perhaps referable to this species, which is recorded from China. They represent two well-marked varieties, which may possibly prove to be distinct species, and in all the radula differs slightly from Bergh's description. That description, however, was made from a single specimen, and the differences observed do not appear to exceed the variations possible within the limits of a species.

In two specimens (A) the external characters correspond closely with Bergh's description. In two others (B) the dorsal tubercles are much smaller and arranged in continuous ridges, which materially modify the general appearance. The fifth (C), however, stands midway between these groups, and suggests that they are both varieties depending on the size and arrangement of the tubercles. The buccal parts are essentially the same in all.

A. The larger of the two specimens is about 43 mm. long and 17 mm. broad. The conformation of the anterior part seems to be as in *Linguella*, but the portion before the rhinophores is much contracted and bears only a few minute tubercles. The colour is uniform brownish yellow. The back is studded with large and small tubercles, which towards the rhinophores show a tendency to arrange themselves in 5 longitudinal lines. The larger tubercles are as much as 1.5 mm. in diameter, and bear a dark spot or depression in the middle. The branchiæ and side-lamellæ are as described by Bergh, and behind the branchiæ is a globular or ovate body, apparently a modified lamella, measuring about 2.5 mm. by 1.5 mm. The foot is grooved in front and with small pointed

* Farran's description of the radula is liable to misinterpretation. He says: "The first lateral tooth with 9 denticulations on the outer edge. The teeth increase in length outwards, the number of denticulations decreasing." But the denticles do not decrease from 9 downwards. They attain the number of 18 or 20 before they begin to decrease.

† He expressly registers *Diphyllidia* and *Linguella* as synonyms under *D. formosa*.

corners, as in many Aeolids. The formula of the radula is $47 \times 20.1.20$, increasing in a few rows to $23.1.23$.

B. The larger of the two specimens is bent, but about 25 mm. long and 15 mm. wide, the margin being spread out. The colour is grey; the under surface, and especially the side-lamellæ, darker. Most of the external characters in both specimens are the same as in A: the globular body behind the branchiæ, the anterior groove and corners of the foot, and the parts in front of the rhinophores. But the dorsal surface appears very different, since it bears 15–20 ridges divided by smooth areas. These ridges are formed of tubercles more or less fused together. They are all small compared with those of A, but in one of the specimens they are larger than in the other, less fused together, and some bear spots as in A. The two specimens do not agree in details, showing that there is a considerable tendency to variation. The radula in the specimen opened is about $42 \times 16.1.16$ as a maximum, but many rows are shorter. I propose to call this form *L. variolosa*, var. *striata*.

C. One rather large specimen, yellowish with traces of red and brown here and there. Not so well preserved as the others and rather soft. Length about 60 mm., breadth about 27. The external characters are mostly the same as in the other specimens, but the organ behind the branchiæ is less globular and more clearly resembles a swollen lamella. The greater part of the back is covered with large and small tubercles as in A, the larger being pitted at the top and having a diameter of about 2 mm. But in the median part of the anterior half these tubercles give place to ridges like those found in B, composed of small prominences more or less fused together. The formula of the radula is $63 \times 25.1.25$. In a few rows there are 27 laterals.

The character of the dentition and jaws is the same in all the specimens. The median tooth is broad, and bears 8–9 denticulations and ridges on either side of the central cusp, which has itself one or two small denticulations. In specimen A this central cusp is lower than in the others. The first lateral bears about 8 denticles on the outer side. The second lateral also bears about 8 denticles, and has something of the clumsy shape shown in Bergh's plates (*l. c.* plate ii. figs. 17–20). The third lateral is more erect, and bears about 4 denticles (rarely 5–6) near the top, and often one or two more arranged irregularly lower down and sometimes quite near the base. The fourth lateral bears one or two denticles, rarely three. The remaining teeth are smooth and hamate. The jaws are large, strong, brownish yellow, and bear 5–6 rows of knob-like dentitions along the edge.

In Bergh's specimen only three laterals were denticulate, whereas in all which I examined the denticulation extended to the fourth tooth. This difference, however, hardly amounts to a specific character, unless it be found to persistently accompany other peculiarities. The proper description of the radula is probably: the first few laterals denticulate, the rest smooth.

LINGUELLA SARASINICA Bergh.

(Bergh, "Weitere Beitr. zur Kennt. der Pleuroph.", Verh. k.-k. zool.-bot. Gesells. Wien, 1890, pp. 10-12. Eliot, "Nudibr. from the Indo-Pacific," J. of Conch. ii. 8, 1905, pp. 240-1.)

A single specimen, which looks well-preserved but is very soft and crumbly. It is broad and flat, but rolled up. If stretched out, it would be about 60 mm. long and 40 wide. The colour is yellowish grey of various shades, with a white border round the mantle. The back is covered with tubercles of various sizes. The smaller are mostly pointed. The larger are flat roundish plates, as much as 2.5 mm. broad, and showing signs of a central peak which has perhaps been flattened by artificial pressure.

At first sight the conformation of the anterior part seems to be as in *Pleurophyllidia*, the mantle-margin being continuous behind the rhinophores. But the white border is interrupted, and a careful examination proves that the apparently continuous fold is due to contraction, and that the dorsal surface is prolonged uninterruptedly between and before the rhinophores. The surface in front of the rhinophores is studded with conical papillæ and flat tubercles like those of the back but rather smaller. The gills lie between the body and the mantle-edge, not in a cleft. They are only 30-40 in number, thin and of varying size, the largest being 7 mm. The side-lamellæ are much larger and thicker than the gills, but are not numerous (20-30). They are often interrupted and broken, so that it is hard to count them. The tail is short, and there is a deep furrow in the posterior part of the foot.

The yellow jaws are large, each being about 11 mm. long and 5 mm. broad. The middle part is very convex. The edge bears minute irregular lumps, but is not denticulate. On the inside of the masticatory process is a triangular membranous flap about 2 mm. long. The radula consists of 55 rows containing 120-130 teeth on each side of the rhachis. The rhachidian tooth is not very wide but arched, with a deep sinus behind. The central cusp is moderately prominent, and bears 2-3 denticles on its slope; below them are about 8 ridges terminating in denticles on either side of the tooth. The first lateral is hardly hamate, but squarish with a few (generally 4) denticles. The remaining teeth are hamate. The second and third bear 8-12 denticles. Then the number of denticles decreases, and after about five teeth the appearance is bifid, though accessory denticles beneath the bifurcation occur throughout the row. In general, the denticulation is irregular. Smooth teeth occur here and there throughout the outer half of the row, and the last ten are usually, though not invariably, smooth.

I think this form may be referred to *L. sarasinica*, recorded from Trincomalee and the Persian Gulf. The jaws, however, present differences, and are not denticulate as in the specimens previously examined. But the denticulations may wear off in the larger and older individuals.

LINGUELLA FALLAX (?) Bergh.

(Bergh, "Beitr. zur Kenntniss der japanischen Nudibranchien," Verh. k.-k. zool.-bot. Ges. in Wien, xxx, 1880, pp. 177-180.)

Three specimens are possibly referable to this form. Considering their age they are well preserved. The dorsal surface, gills, side-lamellæ, and foot are all brownish pink; the mantle, foot, and tentacular shield are bordered with yellow, and the rhinophores are tipped with the same colour; the dorsal surface bears 15-20 yellow longitudinal stripes, with indications that there were narrower stripes between them which have disappeared. Under the lens it is seen that some of the stripes are composed of a series of minute yellow rings. The largest specimen is about 40 mm. long (but much bent) and 16 broad.

The dorsal surface is smooth, except that some of the stripes are distinctly raised, and is continuous with the smooth tentacular shield, which is not very wide and not much produced at the ends. The central dorsal stripe passes between the rhinophores and beyond. The gill is a tightly-packed collection of lamellæ, which lie not in a cleft, but between the body-wall and the mantle-edge. Immediately behind the gill there is in all the specimens a large lobe (as much as 5 mm. \times 3 mm.), and in one there is a smaller accessory lobe on the left side. The side-lamellæ are numerous and thick, not so well preserved as the rest of the animal, but seemingly fan-shaped. The largest is 4 mm. long and 2 mm. broad at the tip, but narrower at the base. The penis projects in front of the gill. It is about 5 mm. long, cylindrical, slender, and unarmed. No cnidopores were found.

The jaws are yellow, not very strong, with 6-8 rows of mosaic-like denticles. In the two specimens opened, the radula consisted of 55 and 60 rows of teeth respectively. In the smaller radula the number of laterals did not exceed 17 or 18, in the larger it rose to 21. The rhachidian tooth is very broad, and bears 10 denticles on each side of the central cusp. The first lateral does not overlap it much, and is not very markedly different from the succeeding teeth, though stouter and more hamate. The first four laterals bear eight denticles. The rest are smooth and erect, but the fifth sometimes bears one or two denticles. After the fifth no denticles were seen.

In most of their external characters and in their buccal parts these specimens agree with *L. fallax*, described by Bergh from a single specimen found at Enosima, Japan. Bergh, however, mentions no dorsal stripes, and it is remarkable that they should have disappeared in a comparatively recent specimen and lasted so long in those kept at Newcastle. Also, although the radula is essentially the same as that described by Bergh, the central tooth is wider than in his figure. The identification must therefore remain somewhat doubtful until more Indian and Japanese specimens can be compared.

In general appearance the animal must be something like *Pleurophylidia formosa*, but is probably of a more uniform light rose-colour.

PHIDIANA UNILINEATA (A. & H.). (Plate XLVII. fig. 1.)

(A. & H. l. c. p. 143. Bergh, System, p. 1031.)

Six specimens are preserved, but have become completely dry and hard. No characters could be ascertained except the buccal parts, which were found in one specimen.

The jaws are rather long and narrow, somewhat decayed, but showing in places a row of large distinct denticles.

Twelve teeth were found. They are yellow and bear from 6 to 9 (Pl. XLVII. fig. 1) denticles on either side, the highest of which is on the central cusp. The number of denticles often appears to be only seven when it is really more, because the additional denticles are very small.

This form seems to be clearly a *Phidiana*.

SAMLA BICOLOR (Kelaart). (Plate XLV. fig. 4.)

= *Samla annuligera* Bergh.

(*Eolis bicolor* Kelaart, l. c. II. p. 490. Bergh, Schauinsland's Reise nach der Pacific: Die Opisthobranchier, pp. 236-9.)

If reliance can be placed on external characteristics, these two forms are undoubtedly identical as they agree both in shape and colour. Not only are the arrangement* and coloration of the cerata the same, but both have the oral tentacles strongly developed and rhinophores with a short stalk and perfoliate club. It only remains to ascertain that *Eolis bicolor* has a triseriate radula. It is said to be found among seaweed in Back Bay, Trincomalee, and will be easily recognisable.

The genus *Samla*, founded on a single specimen, differs from *Flabellina* only in having the corners of the foot rounded and no penial armature. It may be doubted if these characters are of more than subgeneric value.

EOLIS SMEDLEYI Kelaart. (Plate XLV. fig. 5.)

(Kelaart, l. c. II. p. 492.)

The ringed rhinophores and tentacular processes of the foot indicate that this is probably a *Facelina*, and the large oral tentacles and disposition of the cerata are in keeping with the supposition. But none of Kelaart's Aeolids (with the exception of *E. bicolor*) can be identified with known forms or referred to modern genera with any certainty. This is not the fault of his drawings (which are better than those of the Dorids), but is due to the fact that most tropical Aeolids have been described from preserved specimens. The external appearance in life is often wholly unknown, for they lose their colour and shape in alcohol even more completely than Dorids.

* Kelaart's statement that the anterior clusters are "composed of 34 or more branches, the others of two rarely of three," is clearly a misprint for "three, four, or more."

EOLIS HUSSEYI Kelaart. (Plate XLV. fig. 6.)

(Kelaart, l. c. II. p. 490.)

Though this species is described and figured with a distinctness which will probably be sufficient for recognition, it is not easy to assign it to any definite genus. It may be a *Cratena* or *Cuthona*. Several *Cratena* are recorded from the Indo-Pacific, and *Cuthona bicolor* from Japan. It is also not impossible that it may be a *Phestella*, as the form of the head cannot be distinctly seen.

EOLIS NODULOSA Kelaart. (Plate XLV. fig. 7.)

(Kelaart, l. c. II. p. 491.)

This species will perhaps be recognised by the character of the rhinophores. The plate, confirmed by the description, represents them as bearing three strong annulations, an unusually small number.

EOLIS EFFULGENS Kelaart. (Plate XLIII. fig. 4.)

(Kelaart, l. c. II. p. 491.)

This is perhaps a *Facelina*. The rhinophores are perfoliate, and a sketch of the lower surface (not reproduced) shows that the front of the foot is produced into distinct tentacular processes. The elongate shape of the body, large oral tentacles, and the general arrangement of the cerata agree with the generic characters.

The animal will probably be found again, as it is said to occur in great numbers in Dutch Bay and other parts of the sea near Fort Frederick.

The drawings of *Eolis paulinæ* (Pl. XLIII. fig. 6) and *Eolis tristis* (Pl. XLIII. fig. 5), which are reproduced, will probably enable any one who re-discovers the animals to recognise them, but in the absence of further details it is useless to speculate on their generic position.

STILIGER? VIRIDIS (Kelaart). (Plate XLVI. fig. 3.)

(*Pterochilus viridis* Kelaart, l. c. II. p. 492.)

Pterochilus is the original name of *Embletonia* A. & H., discarded because it was found to be already used in Entomology. The present animal is more probably allied to *Stiliger*. It can hardly be *Ercolania zanzibarica* Eliot (Proc. Zool. Soc. 1903, ii. pp. 256-7), which has club-shaped cerata, though the coloration is similar and both animals are found in seaweed. The "numerous, long, linear, acutely pointed cerata" somewhat resemble Trinchese's figure of *Placida tardyi*.

It is difficult to distinguish satisfactorily *Stiliger*, *Ercolania*, and *Placida* (*Laura*).

PHYLLOBRANCHUS ORIENTALIS (Kelaart).

(Kelaart, l. c. II. p. 492. Alder & Hancock, l. c. p. 145.

Cf. *Phyl. prasinus* Bergh in Semper's Reisen, Heft ii. pp. 52-87.)

Six specimens are preserved, much contracted and hardened,

and three of them have been already opened. Nearly all the papillæ have been detached, but are preserved separately.

The specimens are dark brownish green, from 15 to 20 mm. long, and from 5 to 7 mm. wide. The papillæ are greenish. The largest have a stalk about 2.5 mm. long, and the foliaceous expansion at the top measures about 6 mm. by 5 mm. The edge of the expanded part is symmetrically indented; from the funnel at its base radiate about five raised tuberculate lines, some of which bifurcate or trifurcate. The grooved and bifid rhinophores are still quite plain, as are also the grooved tentacles below them. From these tentacles runs down a ridge on either side, which seems to mark off the head from the rest of the body. The large tubular anal papilla is on the right side a little below the dorsal margin, and 4-5 mm. from the anterior end. The lateral margins of the foot are expanded; the anterior margin appears to be grooved. There is no trace of any transverse division of the sole, as in *Cyerce*.

The state of the internal organs rendered dissection impossible, but the long pinkish buccal crop was still discernible. The radula consists of 37 teeth, the number mentioned by Alder and Hancock, arranged in a spiral like that represented by Bergh (*l. c.* plate vii. figs. 2, 3). The outline of the teeth is as represented by Bergh (*ib.* fig. 4), and they bear 15-18 blunt, truncate denticles. The first four at the base of the spiral are mere plates; the rest are perfectly formed and increase rapidly in size.

According to both the statements and drawings of Alder & Hancock and Kelaart, the dorsal papillæ pass round the head and in front of the rhinophores, which they do not do in the other known species referred to *Phyllobranchus*. The preserved specimens do not throw much light on this point. None of them has any papillæ in front of the rhinophores, but it is impossible to say that such papillæ have not fallen off. On the other hand, a comparison with the specimens of *Phyl. prasinus* collected by me in Zanzibar suggests that the conformation of the head-parts is precisely the same. It is also noticeable that Alder and Hancock complain that the specimens were too hard and brittle for anatomical examination. This suggests that they were then in much the same condition that they are now, and that Alder and Hancock merely repeated Kelaart's statement as to the papillæ extending round the head. They no doubt extend up to the lappets connected with the oral tentacles, and, when the animal retracts its head and assumes a circular form, might appear to surround the rhinophores. But it is remarkable that both Kelaart and the Indian artist, whose drawings are certainly not copied from one another, agree in representing the papillæ as arising in front of the rhinophores. It is also probable that Kelaart referred the animal to *Proctonotus* because he thought that the papillæ passed round the head.

Nevertheless, I think it likely that this species is identical with *Phyl. prasinus* and *Phyl. rubicundus*, which do not appear to be differentiated by any marked characters. Kelaart's drawing is

much paler than Alder and Hancock's, but has a faint pink tinge in places, particularly on the rhinophores.

In any case, *Phyllobranchus orientalis* A. & H. is the type of the genus, and the points in doubt can probably be settled by an examination of specimens from Ceylon. *Phyl. viridis* B. from the West Indies, and *Phyl. borgnini* Trinchese, from Naples, seem to be distinct.

ELYSIIDÆ.

Though the genera *Elysia* and *Placobranchus* are clearly distinguished, it does not seem to me that the differences between the two groups called by Bergh Elysiidæ and Placobranchidæ are sufficient to constitute two families.

The whole family (comprising *Placobranchus*, *Elysia*, *Tridachia*, *Thuridilla*, *Elysiella*, and *Bosellia*) is nearly related to the Limapontiidæ, which differ in the reduction of the tentacles, the absence of lateral expansions of the body, and the slight ramifications of the liver. *Elysiella* and *Bosellia* seem to be connecting-links, but neither genus is well known. The genus *Thuridilla* is well characterised: there is a buccal crop, and the anal papilla is median and posterior as in *Alderia*. But the distinction between *Elysia* and *Tridachia* is less satisfactory. In the latter genus the wings are very ample with crinkled margins, and in the type species (*T. crispata*) united behind the head. But this connection between the two wings seems not to occur in the other species.

Bergh (Journ. Mus. Godeffroy, i. 1873, pp. 79-80) gives a list of twenty species of *Elysia*. Of these, the *Elysia* sp. Schramm may be omitted. It is almost certainly identical with one of the species created by Verrill, and, as it is nameless, has no claim to be maintained. *Elysia nigropunctata* (Pease) 1871 appears to be the same as the earlier *E. punctata* Kelaart 1859. I have not been able to identify the animal cited as *Elysia neapolitana* d'Ch. without a reference.

Since the publication of this list several species have been described, of which *E. lineolata* Bergh seems to be clearly a synonym of *E. cerulea* Kelaart. *E. hendersoni* Eliot is not characterised in sufficient detail. Other species are:—

19. *E. dubia* Eliot. East Africa.
20. *E. ornata* Verrill. Bermuda.
(There is a *Pterogastron ornatum* Pease, which may be an *Elysia* and have priority for the specific name.)
21. *E. subornata* Verr. Bermuda.
22. *E. flava* Verr. do.
23. *E. picta* Verr. do.
24. *E. papillosa* Verr. do.
25. *E. thysanopoda* Bergh. Malay Archipelago.
26. *E. haingsisiana* Bergh. do.
27. *E. crispa* Verr. Bermuda.

Several of these twenty-seven species are probably mere colour varieties. It is, for instance, clear that in both the tropical Pacific and tropical Atlantic there is found a greenish *Elysia* in which one or more coloured borders and spots of various colours may be present or absent. More distinct are the forms with a coloration offering vivid contrasts and often brilliant, such as *E. cærulea*, *E. picta*, and *E. haingsisiana*. Other good characters may perhaps be found in the shape and denticulation of the teeth, and in the conformation of the wings, tentacles, and pericardial prominence.

ELYSIA GRANDIFOLIA * Kelaart. (Plate XLVI. fig. 4.)

(Kelaart, l. c. II. p. 493.)

Two specimens preserved with the rest of Kelaart's molluscs are probably referable to this form, but have no label. They are of a uniform yellowish grey, much contorted, and so decayed and fragile that it is hardly possible to unroll them without breaking them. They are about 30 mm. long and 20 mm. broad. The wings are ample and the tail long and pointed. The rhinophores are well developed and auriculate. The mouth is ventral. The sole is not in any way marked off from the under side of the wings. Though the specimens are in such bad condition, it seems clear in both of them that the pericardial prominence is not a simple round lump, but that the pericardium or some accessory organ is prolonged posteriorly for about 10 mm. The projection is not even, but constricted several times. From either side of it spring about seven main trunks of prominent vein-like reticulations. Each is subdivided many times and the whole upper surface of wings is covered with an elaborate raised network.

The radula consists of 8 teeth in the ascending series, 12 in the descending, and about 20 in the heap. They are of the form usual in the genus, hollowed in the back and rather straight in outline. Under the highest power the lower edge appears minutely serrulate, but this serrulation is not visible under lower powers.

Kelaart's figure agrees fairly well with the specimens, but the head, as drawn, is rather small. The coloration resembles Bergh's figure of *Elysia ornata* (Siboga, pl. ii. fig. 20) and my figures of *Elysia marginata* (Proc. Zool. Soc. 1904, ii. pl. xvi. figs. 7, 8), but neither of these has the pointed tail and the elongate pericardial prominence. The latter feature appears in *E. dubia* Eliot (Proc. Zool. Soc. l. c. p. 297).

ELYSIA CÆRULEA Kelaart. (Plate XLIII. fig. 7.)

(Kelaart, l. c. II. p. 493. Cf. Bergh on *Elysia? lineolata*, in Siboga-Expeditie, Opisthobranchia, pp. 85-87.)

This can hardly be anything but the *Elysia lineolata* of Bergh,

* By an error Bergh has registered this animal in his lists as *E. grandiflora*, but Kelaart calls it *grandifolia* both in MS. and in print.

which has a similarly gorgeous coloration, though there are some differences of detail. For instance, in Kelaart's animal the rhinophores have not red tips, but a red ring below a black tip.

Elysia picta Verrill, from the Bermudas, has a somewhat similar brilliant coloration, and also the unnamed species noticed by Magarelli in his "Note biologiche sugli Opisthobranchi del Golfo di Napoli" (Atti della Soc. Ital. Milano, 1903, vol. xlii. p. 283).

It is possible that these forms are not true *Elysias*, but belong to *Thuridilla* or some allied genus.

ELYSIA PUNCTATA Kelaart. (Plate XLVI. fig. 5.)

(Kelaart, l. c. II. p. 493. Cf. *Elysia nigropunctata* Pease, Amer. Journal of Conchol. 1870-71, p. 304; and Bergh, Journal des Mus. Godeffroy, Heft ii. 1873, pp. 80-82.)

This species appears to be the same as *Elysia nigropunctata* Pease; and as the plate indicates that the rhinophores and the pericardium are bordered with red, it probably represents the var. *sanguinea* of Hedley (Mem. of Australian Mus. iii. 7, March 1897, p. 486).

The name *punctata* (1859) has priority over *nigropunctata* (1871).

EXPLANATION OF THE PLATES.

PLATE XLII.

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| <p>Fig. 1. <i>Chromodoris amabilis</i>, p. 642.
 2. <i>C. fidelis</i>, p. 642.
 3. <i>C. preciosa</i>, p. 642.
 4. <i>Trippa luteola</i>, p. 658.
 5. <i>Doris rufopunctata</i>, p. 667.
 6. <i>D. castanea</i>, p. 667.
 7. Do., underside.</p> | <p>Fig. 8. <i>Doris constantia</i>, p. 667.
 9. Do., underside.
 10. <i>Phyllidia zeylanica</i>, p. 674.
 11. <i>Pleurophyllidia formosa</i>, p. 679.
 12. Do., underside.</p> |
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PLATE XLIII.

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| <p>Fig. 1. <i>Chromodoris tennentana</i>, p. 643.
 2. <i>C. diardii</i>, p. 643.
 3. <i>Doris elizabethina</i>, p. 666.
 4. <i>Eolis effulgens</i>, p. 686.</p> | <p>Fig. 5. <i>Eolis tristis</i>, p. 686.
 6. <i>E. paulina</i>, p. 686.
 7. <i>Elysia cerulea</i>, p. 689.</p> |
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PLATE XLIV.

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| <p>Fig. 1. <i>Chromodoris gleniei</i>, p. 643.
 2. <i>Trippa spongiosa</i>, p. 660.</p> | <p>Fig. 3. <i>Doris bellicosa</i>, p. 666.
 4. <i>D. picta</i>, p. 666.</p> |
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PLATE XLV.

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| <p>Fig. 1. <i>Trippa monsoni</i>, p. 660.
 2. <i>Doris aripona</i>, p. 667.
 3. <i>D. papillosa</i>, p. 666.
 4. <i>Samla bicolor</i>, p. 685.</p> | <p>Fig. 5. <i>Eolis smedleyi</i>, p. 685.
 6. <i>E. husseyi</i>, p. 686.
 7. <i>E. nodulosa</i>, p. 686.</p> |
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PLATE XLVI.

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| <p>Fig. 1. <i>Doris lockyerana</i>, p. 666.
 2. <i>D. viperina</i>, p. 666.
 3. <i>Stiliger ? viridis</i>, p. 686.</p> | <p>Fig. 4. <i>Elysia grandifolia</i>, p. 689.
 5. <i>E. punctata</i>, p. 690.</p> |
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PLATE XLVII.

Fig. 1. *Phidiana unilineata*, tooth (p. 685).

2. *Kalinga ornata* (p. 670). *a*, the proximal; *b*, the distal region of the protruded buccal parts; *c*, the place where the radula was found; *d*, the mouth.
3. *Platydoris formosa* (p. 646). Scales from the reproductive organs. *a*, lateral view of a scale showing granulations; *b*, view of a scale from above; *c*, section through a scale.
4. *Doriopsisilla miniata* (p. 665). Nervous system and anterior part of alimentary canal, seen from the side.
5. *Doriopsis nigra* (p. 664). Do., do.
6. *Doriopsisilla miniata* (p. 665). Nervous system and alimentary canal, seen from below.
7. *Doriopsis nigra* (p. 664). Do., do.

In the last four figures the nervous system is drawn in red and the digestive tract in black, and the following lettering is used:—*a*, central nervous system; *b*, buccal ganglia; *c*, genital ganglion; *d*, ptyaline or mouth-gland; *e*, duct of do.; *f*, proboscis; *g*, salivary glands; *l*, liver; *m*, mouth.

2. Description of a new Zebra.

By the Hon. WALTER ROTHSCHILD, Ph.D., F.Z.S.

[Received June 19, 1906.]

EQUUS ANNECTENS, sp. nov.

This very distinct form of Zebra is at once distinguishable by the very narrow white stripes and broad black bands extending from behind the ears to the root of tail. The black bands extend from root of tail much further longitudinally towards the shoulder than in any other form, all being joined up with the transverse bands, and not broken up as in most forms of *E. burchelli*. It differs at first sight from *E. zebra* and most forms of *E. burchelli* by the entire absence of red on the face and muzzle, thus approaching *E. burchelli selousi*. Head, legs, and tail evenly banded with narrow white bands on an intense black ground. Ears strongly banded.

Skull.—This shows, from its less bombiform frontal and greater width across the palate, an intermediate character between the forms of *Equus burchelli* and *Equus zebra*; a very distinct feature is the great breadth and convexity of the malar and maxillary.

Habitat. Neighbourhood of Fort Jameson, N.E. Rhodesia.

3. Description of a new Bush-Buck.

By the Hon. WALTER ROTHSCHILD, Ph.D., F.Z.S.

[Received June 19, 1906.]

CEPHALOPHUS ROBERTSI, sp. nov. (Male type.)

This is nearest to *C. harveyi*, *C. castaneus*, *C. callipygus*, and *C. natalensis*, but differs from them all by being quite uniform in colour, of an orange-chestnut of a much paler, yellower, and brighter shade.

Colour of body, legs, and head orange-chestnut or pale Chinese-orange. Occiput, outside of ears, and a large patch above the nostrils, ash or mouse-grey. Chest and inner side of fore legs above knee more whitish. Crest between horns and on forehead dark rufous and very long and thick. Horns long, basal third ringed and rugose; much slenderer than in the four allied forms.

Length of horns 80 mm.

Habitat. Portuguese East Africa (Roberts Collection).

4. On the Entomostracan Fauna of the New Zealand Lakes.

By G. STEWARDSON BRADY, M.D., LL.D., D.Sc., F.R.S.,
C.M.Z.S.

[Received May 18, 1906.]

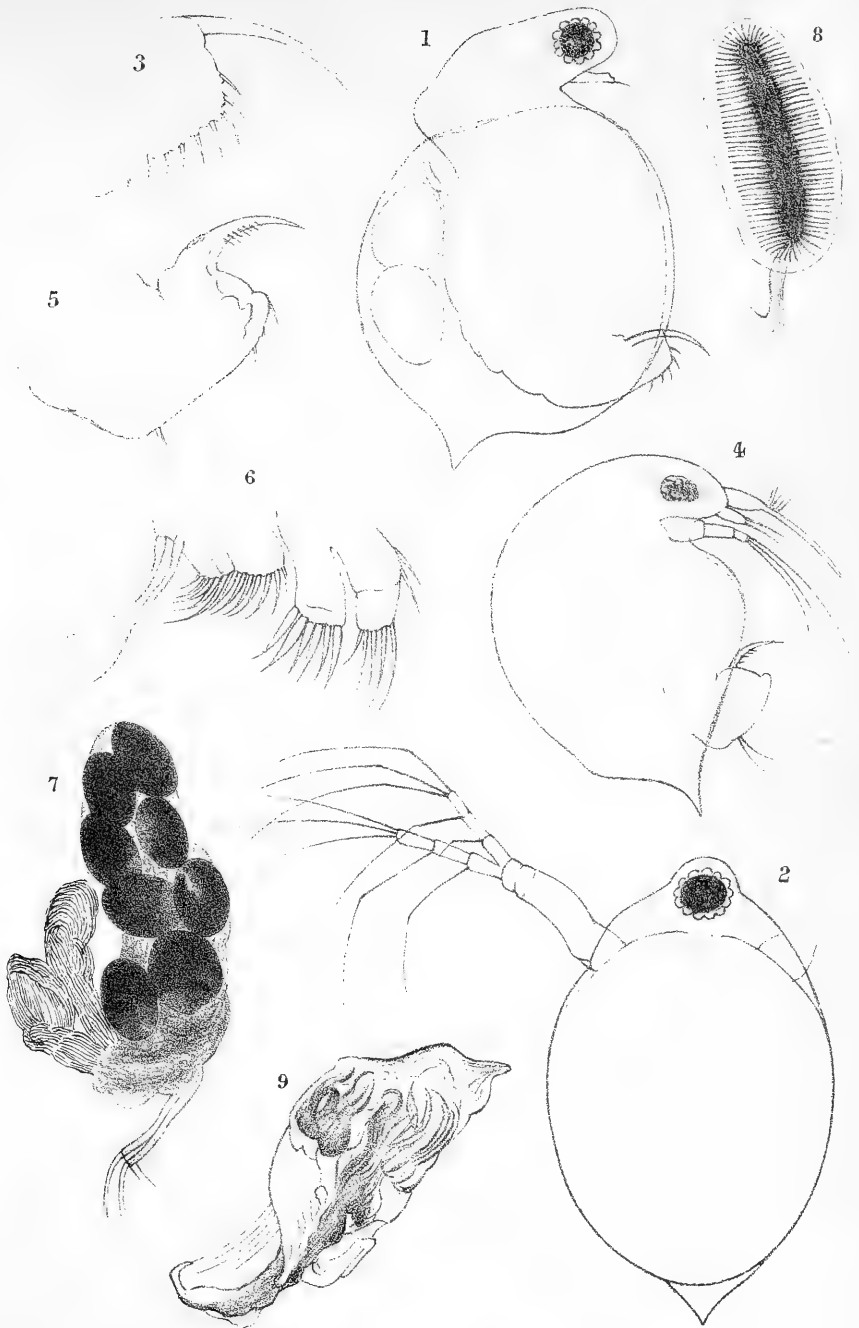
(Plates XLVIII.-LI.*)

I am indebted to my friends Messrs. Keith Lucas, M.A., and G. Hodgkin, M.A., for the opportunity of examining the very interesting Plankton collections made by them during their bathymetrical survey of the New Zealand Lakes. The present paper deals with the Entomostraca only.

The higher Crustacea—comparatively few in number—are reported upon by Professor C. Chilton of Canterbury College, Christchurch, in a separate paper (*infra*, p. 702). Besides the Crustacea, which constituted almost the whole bulk of the nettings, there were a few Hydrachnæ, a very few insect larvæ, and in some of the gatherings a considerable number of a rotifer belonging to, or closely resembling, the genus *Asplanchna*. Fragments of confervoid and unicellular Algæ were also abundant, and some very small fragments of a polyzoan were also noticed. Samples of about seventy nettings came under my review. These were taken from seven different lakes in depths varying from the shallow-water of the shore to an extreme depth of about 1450 feet. The proceeds were preserved in various solutions—picronitric, formalin, and alcoholic. The picronitric solution is objectionable, acting as a solvent on the calcic material of the shells, and formalin is liable in a less degree to the same objection. But, as a rule, the specimens were well preserved.

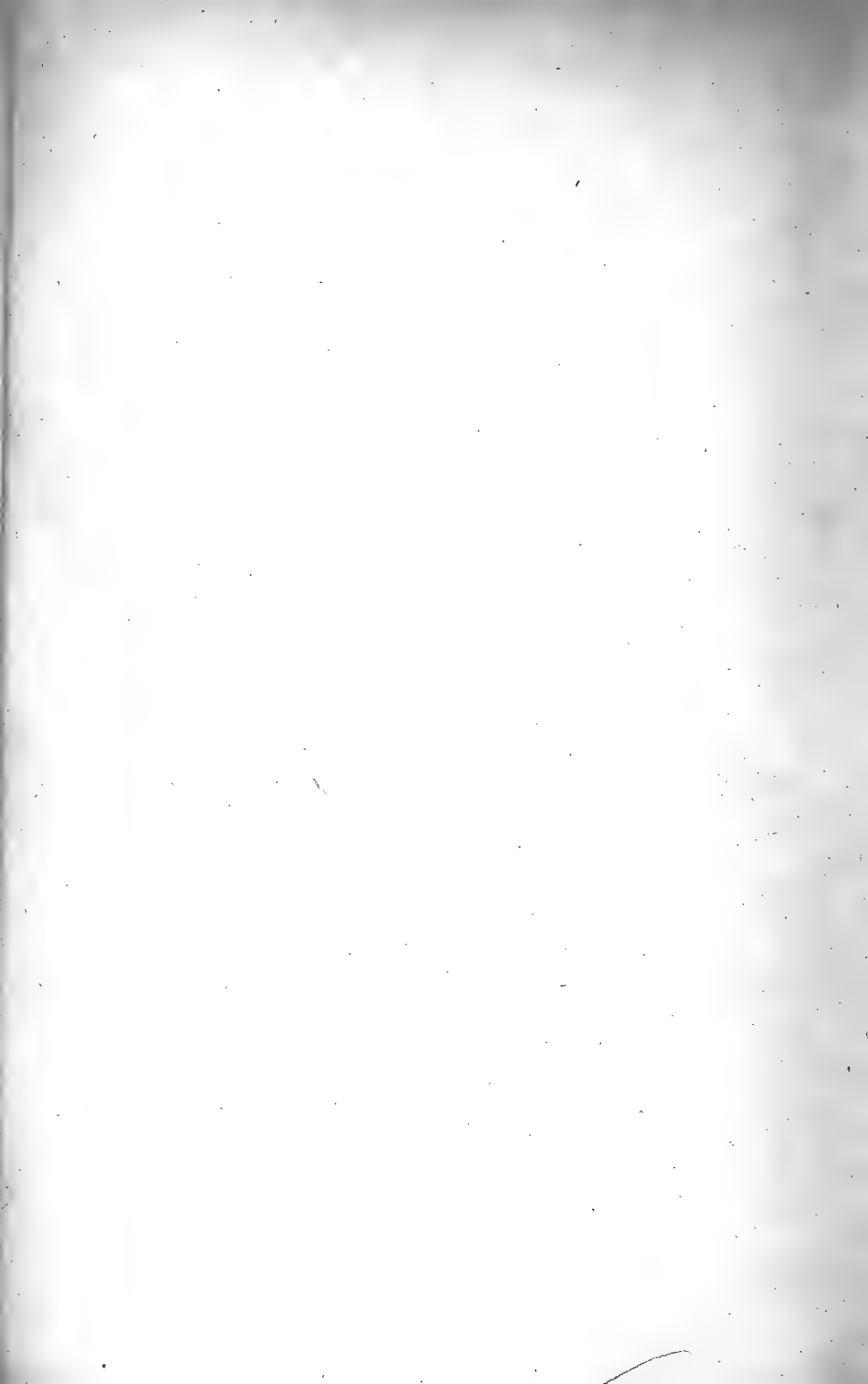
The most striking fact arising out of this research is the small number of species found in so extensive a series of nettings from so many different lakes. The climatic and physical conditions of these lakes may be taken as closely approximating to those of the English Lake-district of Cumberland and Westmoreland; and it is interesting to compare the results of the investigation of the two areas so far as is at present possible. The following table embraces those species which occur only in the lakes themselves,

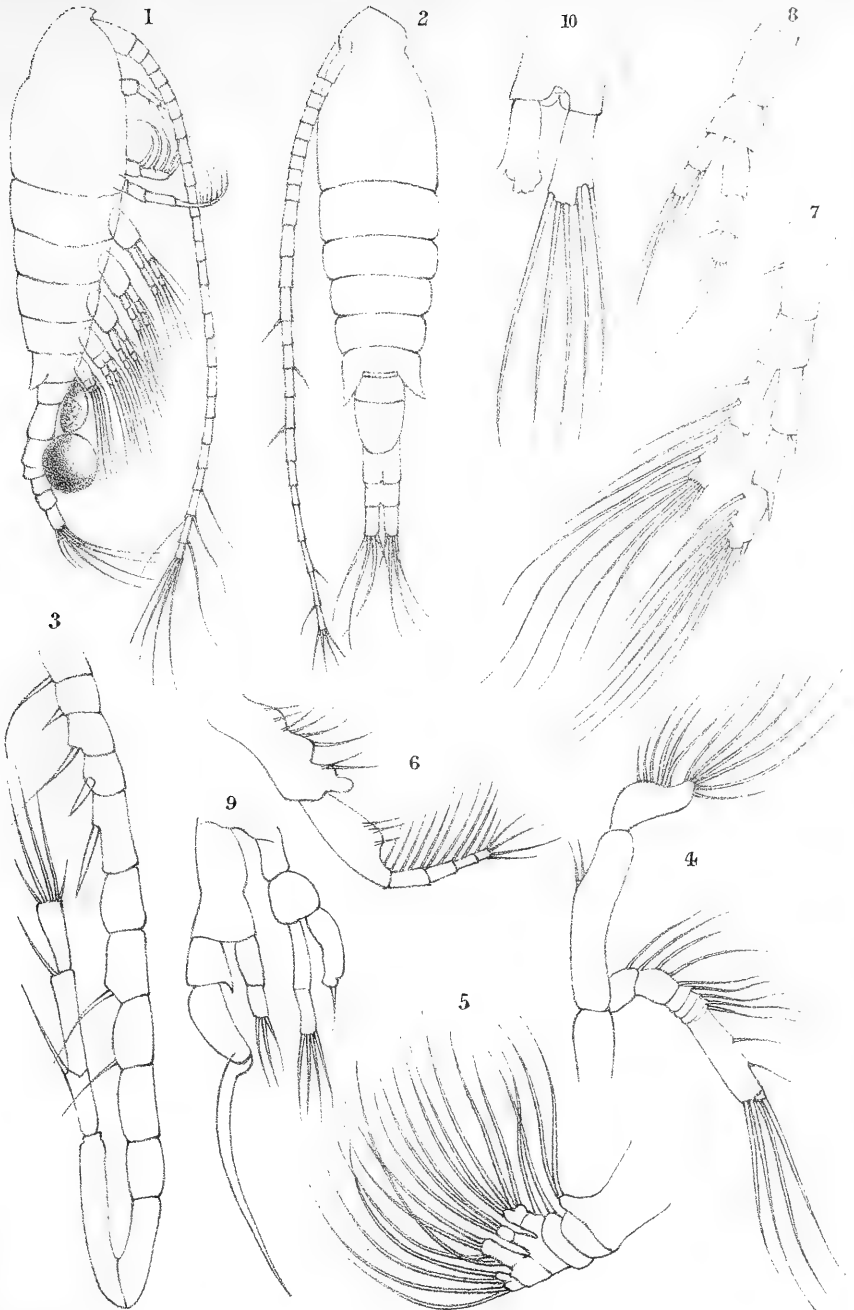
* For explanation of the Plates, see p. 701.



G.S.Brady del.

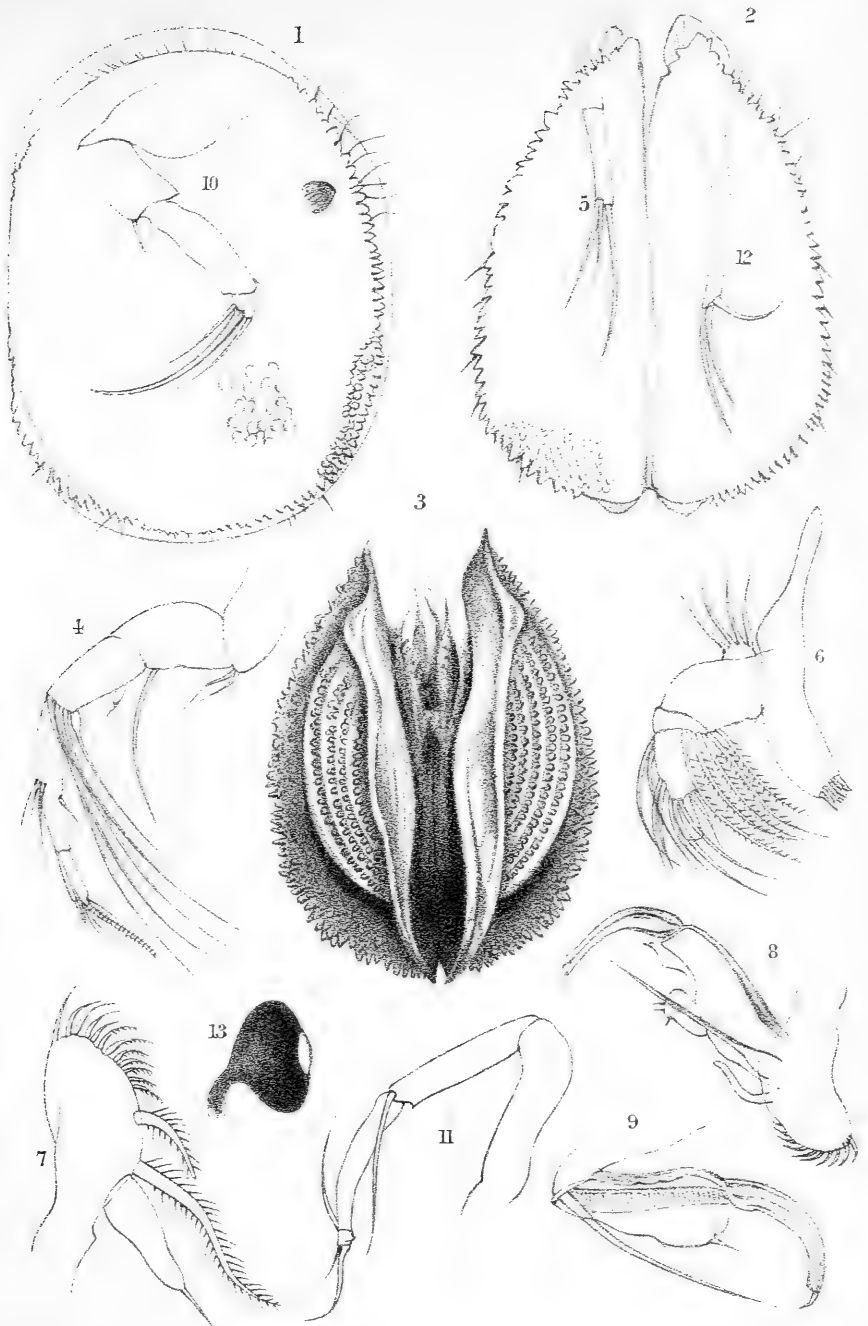
M P. Parker lith.
Parker & West imp.





G.S.Brady del.

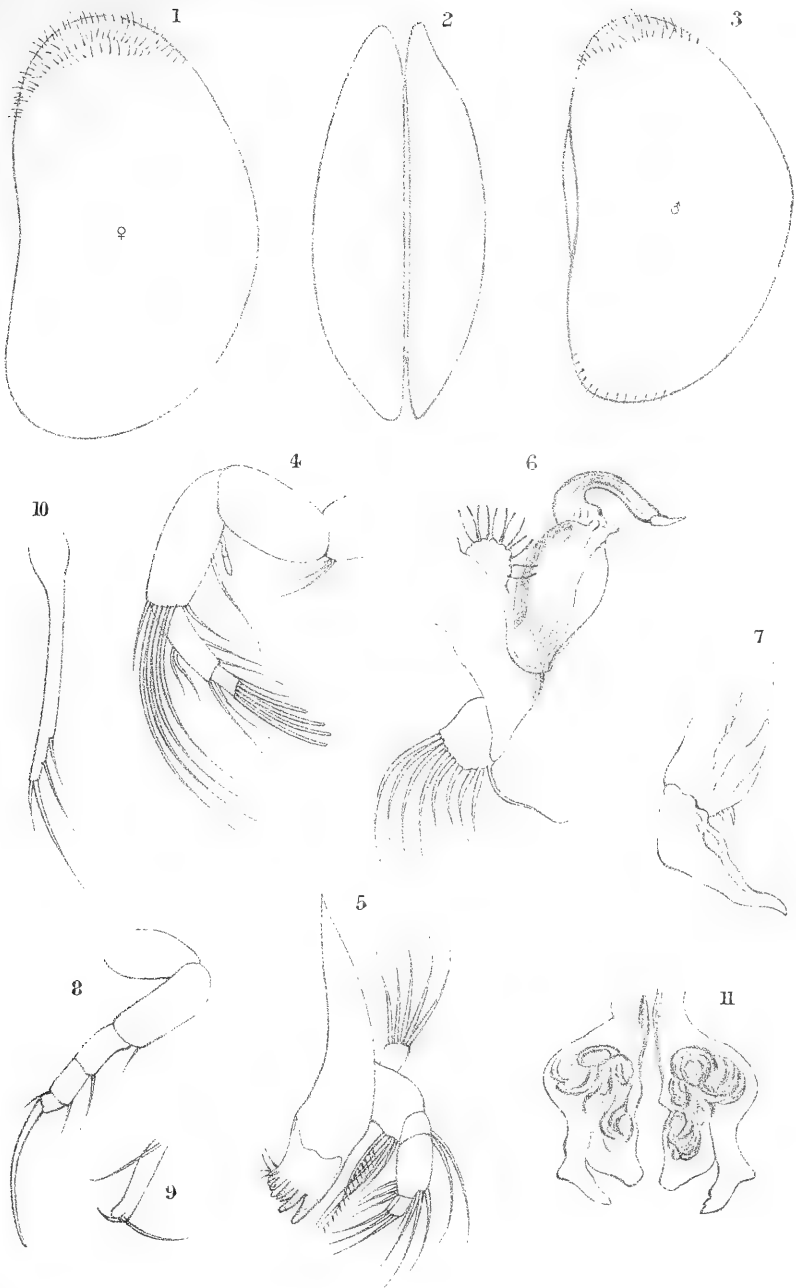
M P.Parker lith.
Parker & West imp.



G.S. Brady del.

M.P. Parker lith.
Parker & West imp.

ENTOMOSTRACA FROM NEW ZEALAND LAKES.



G.S. Brady del.

M P. Parker lith.
Parker & West imp.

—not those of nameless outlying pools. Had these latter been included the English list would have been much longer, but would have compared unfairly with that of New Zealand, where similar gatherings are not at present attainable.

The list represents as nearly as possible what one might expect to get in the English Lakes from a series of hauls such as those dealt with from New Zealand.

ENGLISH LAKES.

NEW ZEALAND LAKES.

CLADOCERA.

Sida crystallina O. F. Müller.
Diaphanosima brachyurum Lievén.
Latona setifera O. F. Müller.
Holopedium gibberum Zaddach.
Daphnia galeata G. O. Sars.
Hyalodaphnia jardinii Baird.
Simocephalus vetulus O. F. Müller.
Ceriodaphnia quadrangula? O. F. Müller.
Bosmina obtusirostris G. O. Sars.
Drepanothrix dentata Euren.
Camptocercus macrurus O. F. Müller.
Eurycercus lamellatus O. F. Müller.
Acroperus harpæ Baird.
Alanopsis elongata G. O. Sars.
Lynceus costatus G. O. Sars.
 „ *guttatus* G. O. Sars.
Graptoleberis testudinarius Fischer.
Alonella exigua Lilljeborg.
 „ *nana* Baird.
Peracantha truncata, O. F. Müller.
Pleuroxus uncinatus Baird.
Chydorus globosus Baird.
 „ *sphaericus* O. F. Müller.
 „ *barbatus* G. S. Brady.
Bythotrephes longimanus Leydig.
Polyphemus pediculus Linné.
Leptodora kindti Focke.

Simocephalus gibbosus G. O. Sars.
 „ *obtusatus* G. M. Thomson.
Ceriodaphnia globosa, sp. n.
Bosmina meridionalis, G. O. Sars.
Chydorus sphaericus Baird.
 „ *globosus*? Baird.

COPEPODA.

Diaptomus gracilis G. O. Sars.
Cyclops albidus Jurine.
 „ *bicolor* G. O. Sars.
 „ *fuscus* Jurine.
 „ *gigas* Claus.
 „ *leuckartii* Claus.
 „ *robustus* G. O. Sars.
 „ *serrulatus* Fischer.
 „ *strenuus* Fischer.
 „ *abyssorum* G. O. Sars.
 „ *vicinus*, Uljanin.

Boeckella triarticulata G. M. Thomson.
Calamœcia lucasi, gen. & sp. nov.
Cyclops distinctus Richard.
 „ *serrulatus* Fischer.

OSTRACODA.

Cyprina ophthalmica Jurine.
 „ *exsculpta* Fischer.
Cyclocypris lævis O. F. Müller.
 „ *serena* Koch.
Cypris fuscata Jurine.
 „ *obliqua* G. S. Brady.
Notodromas monachus O. F. Müller.
Herpetocypris reptans Baird.
Cypridopsis vidua O. F. Müller.
Candona candida O. F. Müller.

Newnhamia fenestrata King.
Cyprinotus sarsi, sp. n.

ISOPODA.

Asellus aquaticus *Linne*.*Paranthurus nigrofuscatus* *Lucas*.

AMPHIPODA.

Gammarus pulex *De Geer*.*Paracalliope fluviatilis* *G. M. Thomson*.
Paracorophium excavatum *G. M. Thomson*.

SCHIZOPODA.

Tenagomysis novæ-zealandiæ *G. M. Thomson*.

MACRURA.

Xiphocaris curvirostris *Heller*.

BRACHYURA.

Hymenosoma lacustris *Chilton*.

The foregoing list of British species might have been considerably enlarged, but of many I do not possess accurate records and have therefore omitted them altogether. The disproportion, however, between the numbers of British Lake species and of species inhabiting similar places in New Zealand—so far as our present knowledge extends—does not need to be further dwelt upon. The disproportion is not, perhaps, greater than that found among vertebrate animals, both aquatic and terrestrial. To name, for example, only aquatic animals, it may be noted that while New Zealand possesses only one native Amphibian, Great Britain has eight; and that while the freshwater fishes of Great Britain are very numerous, the number of New Zealand species is extremely small. It is not, therefore, at all surprising to find that the freshwater Crustacea of New Zealand, as at present known, number only about one-third or one-fourth of the British species, and it seems scarcely likely that further research will materially alter these proportions. But it is noticeable that the great preponderance of British species is confined to the Entomostraca; while of the higher Crustacea, which are very poorly represented in Great Britain, New Zealand possesses a considerable number.

The lakes explored by Messrs. Lucas and Hodgkin were Waikare, Taupo, Rotoiti, Roto Aira, Waikaremoana, Wakatipu, and Manapouri.

CLADOCERA.

SIMOCEPHALUS GIBBOSUS *G. O. Sars*.

Simocephalus gibbosus *Sars*, On Freshwater Entomostraca from the Neighbourhood of Sydney (1896), p. 15, pl. ii. figs. 4-6.

Numerous examples of this fine species were found in "nettings from among reeds at a depth of six feet," in Lakes Rotoiti and Waikare.

SIMOCEPHALUS OBTUSATUS (*Thomson*).

Daphnia obtusata *Thomson*, On New Zealand Entomostraca,

Trans. & Proc. New Zealand Institute, vol. xi. (1878) p. 261, pl. xi. fig. E, 2, *a-e*; G. O. Sars, Freshwater Entomostraca of New Zealand, 1894, p. 10, pl. ii.

A few specimens found in company with the preceding species in the Rotoiti gathering and in a similar netting from Waikare Lake.

CERIODAPHNIA GLOBOSA, sp. n. (Plate XLVIII. figs. 1-3.)

Female. Outline as seen laterally subquadrangular, rounded; the head separated from the rest of the body by a very deep cervical depression, much flattened in front and produced ventrally into a rounded lobe the extremity of which is almost filled by the large eye; hinder part of the body almost circular, with a large triangular, sharply pointed projection above the middle of the posterior margin (fig. 2); dorsal margin boldly arched, ventral also arched but less so than the dorsal; seen ventrally the outline is broadly elliptical (fig. 1), greatest width in the middle and equal to about two-thirds of the length, anterior extremity forming a rounded protuberance which is nearly filled by the eye, posterior produced into a sharp triangular spine. Shell devoid of marginal hairs, and showing no surface-markings except a uniform dotting. The antennæ and other appendages are of the usual form. Caudal lamina armed with a long, slender terminal claw (fig. 3), which is quite simple and destitute of marginal setæ or pectinations; posterior margin of the lamina bearing at the distal extremity a series of about eight slender spines.

Length .76 mm.

Habitat. Roto Aira, in vertical nettings to a depth of 50 feet, in Taupo Lake at 450 feet, and in a netting among reeds in Waikare Lake—abundant in all these gatherings.

It is interesting to note that all the three lakes in which this *Ceriodaphnia* occurs lie, as Mr. Lucas tells me, on a single river, the Waikato.

BOSMINA MERIDIONALIS G. O. Sars. (Plate XLVIII. figs. 4, 5.)

Bosmina meridionalis G. O. Sars, Pacifiche Plankton-Crustaceen (Zoolog. Jahrbüch. v. 1903) p. 631, Taf. 34. figs. 3 *a-c*.

Professor Sars's type specimens were taken in Wakatipu Lake, New Zealand, and it occurs in greater or less abundance in most of the lake gatherings. I have seen only females, nor did any males occur in the gatherings examined by Sars.

COPEPODA.

BOECKELLA TRIARTICULATA (G. M. Thomson).

Boeckia triarticulata Thomson, Trans. & Proc. New Zealand Institute, vol. xv. (1882) pl. vi. figs. 1-9.

Boeckella triarticulata G. O. Sars, Freshwater Entomostraca of New Zealand, p. 49, pls. vii. & viii.

Boeckella propinqua G. O. Sars, Pacifiche Plankton-Crustaceen (Zoologisch. Jahrbüch. v. 1903), p. 636, Taf. 35. figs. 10 a-h.

This species seems to be the commonest of all the lacustrine Copepoda of New Zealand. It occurs abundantly in almost all the gatherings submitted to me. It has been fully figured and described by Professor G. O. Sars (*loc. cit.*) and by Mr. G. M. Thomson. Mr. Thomson's specimens were found in a pond near Canterbury, and those described by Sars were raised artificially from mud collected in the same place. Those described by the latter author under the name "*propinqua*" differ only very slightly from the type species, chiefly in the greater length of the anterior antennæ and in the build of the fifth pair of feet, more particularly in the males. But specimens referable to both forms occur intermixed in various New Zealand gatherings, and I think can scarcely be looked upon as distinct one from the other. The *propinqua*-form is generally the longer and more deeply pigmented, and I am disposed to think is really the fully developed condition of *triarticulata*.

The types of *B. propinqua* were taken in a freshwater pond in D'Urville Island, New Zealand.

Genus CALAMÆCIA *, gen. nov.

Body slender and elongated; posterior angles of the metasome in the *female* produced sharply backwards; urosome of the *female* four-jointed, of the *male* five-jointed; caudal rami short and rather broad. Anterior antennæ of the *female* composed of twenty-four joints; posterior antennæ two-branched, the outer branch six- (or seven?) jointed and equal in length to the inner branch. Mouth-organs as in *Limnocalamus*, except that the anterior maxillipeds are destitute of strong terminal claws, being simply setiferous. Inner branches of the first four pairs of feet biarticulate, and, like the outer branches, bearing very long and delicate marginal setæ. Fifth pair of feet in both sexes two-branched; in the *female* the penultimate joint of the three-jointed outer branch is produced into a strong marginal spine, the inner branch is simply biarticulate: in the *male* (Plate XLIX. fig. 9) the terminal joint of the outer branch of the right foot forms a very long curved claw, the inner branch is simply biarticulate; the foot of the left side somewhat smaller, its outer branch short and club-shaped, inner branch elongated and composed of a single joint.

This is more nearly allied to *Limnocalamus* than to any other described genus, but differs as regards the two-jointed inner rami of the swimming-feet and in the build of the fifth pair of feet in the male.

CALAMÆCIA LUCASI, sp. n. (Plate XLIX. figs. 1-10.)

Female. Seen dorsally the outline is very narrow and elongated

* κάλαμος, a reed; ὀίχέω, I dwell.

(fig. 2), the greatest width of the cephalothorax scarcely equalling one-third of its length, a distinct cervical sinus in front; urosome very narrow, and, including the caudal rami, less than half the length of the cephalothorax; caudal rami short, scarcely longer than the last abdominal segment, about twice as long as broad (fig. 10). Anterior antennæ very long and slender (fig. 3), reaching as far as the extremities of the longest caudal setæ, very sparingly setiferous; the two branches of the posterior antennæ (fig. 4) nearly equal in length, the median joints of the outer branch very small and indistinctly separate, three (or perhaps four) in number. Mandibles and maxillæ of the usual calanoid type; anterior maxillipeds (fig. 5) very densely setiferous; basal joint of the posterior maxillipeds produced distally into a short, blunt, digitiform lobe; second joint swollen, its inner margin rather strongly arcuate (fig. 6). Swimming-feet long and slender, the basal portion much elongated. Fifth pair bearing on the second joint of the outer branch a strong marginal spine which reaches as far as the apex of the last joint, this joint bears one long terminal seta and two very short ones; the inner branch is biarticulate and bears terminal setæ similar to those of the outer branch (fig. 8). The ova are excessively large and very few in number—never more than four (fig. 1). Length, exclusive of tail-setæ, .85 mm.

Male. The anterior antennæ of the male (fig. 3) are geniculated, but none of the joints is excessively enlarged or tumid, neither are there any marginal serrations, though there are two not very conspicuous spines on the 13th and 14th joints. The foot of the fifth pair (fig. 9) on the right side has the outer branch ending in a very long flexuous spine, the inner branch short and simply biarticulate; the left foot has both branches simple and uni-articulate, the outer branch curved, emarginate near the apex and bearing a single terminal bristle, the inner branch much longer and simply setiferous at the apex.

Habitat. Abundant in a netting taken among reeds in Lake Waikare and in a "vertical netting" up to 120 feet, Lake Rotoiti.

I have much pleasure in naming this interesting species after Mr. Keith Lucas, to whom I am indebted for the opportunity of examining the proceeds of his painstaking investigation of the New Zealand Lakes.

Apart from its small size, this species proved unusually difficult of examination owing to the tenuity of its tissues and the very indistinct jointing of the various appendages, and I am by no means sure that the account I have given is in all cases entirely correct, as, for instance, in that of the swimming-feet, where some specimens seemed to show doubtful traces of three joints in the inner branches.

CYCLOPS DISTINCTUS Jules Richard.

Cyclops tenuicornis var. *distinctus* Richard, Liste des Cladocères et des Copépodes d'eau douce observés en France (1887).

Cyclops distinctus Lilljeborg, Synopsis specierum huc usque in Suecia observatarum generis Cyclopis (1901).

This species was found in most of the nettings. It is closely allied to *C. albidus* Jurine. So far as appears from Mr. Lucas's collections, it seems to be the prevailing form of *Cyclops* in the New Zealand Lakes.

CYCLOPS SERRULATUS Fischer.

This common Northern species occurred, though only sparingly, in several of the nettings; but the serrulation of the caudal stylets is seldom so distinctly marked as in European specimens.

O S T R A C O D A.

Genus NEWNHAMIA King.

Like *Notodromas*, except that the mandibular palp bears a small rudimentary branchial appendage the filaments of which are directed upwards, and that the posterior maxillæ have two branchial filaments attached directly to the limb and not arising from a distinct plate: the shell profusely tuberculated over the whole surface. (Mr. King's description of the genus is: "eyes two, distinct, pedunculated, with a corresponding tubercle on each valve: a boat-shaped plate on ventral margin.")

NEWNHAMIA FENESTRATA King*. (Plate XLVIII. figs. 6-9 and Plate L. figs. 1-13.)

Newnhamia fenestrata King, On Australian Entomostraca (Proc. Royal Soc. Van Diemen's Land, vol. iii. pl. ix A. 1-12; Vávra, Die Ostracoden vom Bismarck-Archipel (Archiv f. Naturgesch. 1901, p. 180, pl. viii. figs. 1-15).

Female. Shell seen laterally broadly elliptical; height equal to three-fourths of the length; extremities rounded, subtruncate, the anterior rather the narrower of the two; dorsal margin feebly arcuate, ventral rectilinear in the middle, rounded off toward each extremity: seen from above (Pl. L. fig. 2) the outline is ovate, broadly rounded behind, tapering evenly from the middle to the acuminate anterior extremity; greatest width equal to more than two-thirds of the length and situated behind the middle; the greater part of the ventral surface occupied by two broad, sinuous flanges on the contact margins of the two valves, and by broad crescentic flattened plates stretching from these flanges nearly as far as the lateral margins of the shell; the flanges are smooth and longitudinally sulcate, but each lateral plate is beautifully ornamented with four rows of concentric parallel rows of rounded tubercles (fig. 3); the general surface

* "On Australian Entomostraca," by the Rev. R. L. King, B.A. (Papers and Proceedings of the Royal Society of Van Diemen's Land, January 1855).

of the shell is covered with closely-set and irregularly shaped rounded or pointed tubercles (figs. 1, 2, 3): a prominent transparent tubercle in front of the middle and just within the dorsal margin, through which the darkly coloured eye is conspicuous. Colour dark grey. Length .77 mm.

Male. The shell of the male, seen dorsally (fig. 2), is more angular in outline, widest near the rounded, subtruncate, posterior extremity, abruptly tapered in front. The two pairs of antennæ are like those of *Notodromas monachus*, the posterior pair with very slender apical joints (fig. 5) and with swimming-setæ reaching beyond the apices of the terminal unguis; the second joint bears at its distal extremity a long hair with a delicately bulbous base; the terminal unguis in the male is minutely bipectinate. Mandible-palp (fig. 6) bearing a minute branchial process which has a few (4 or 5?) upward-pointing setæ. The first pair of maxillæ (Pl. XLVIII. fig. 6) of the usual type and provided with a large branchial plate; second maxilla in the *female* (Pl. L. fig. 7) consisting of an expanded club-shaped lamina which bears a fringe of plumose setæ at the distal extremity and a simple fusiform palp near the base, between which and the apical fringe are two stout plumose branchial filaments: in the *male* the maxillæ of the second pair form strong prehensile organs (figs. 8, 9), differing somewhat on the two sides and destitute of branchial setæ. The feet of the first pair are of the usual type (fig. 10), but have an unusually long apical claw; those of the second pair (fig. 11) bear two slender apical setæ, one of which (the longer) is reflexed. Caudal rami (fig. 12) slender, with three slender, closely approximated apical setæ. The male sexual apparatus is of the usual type (Pl. XLVIII. figs. 8, 9): a pair of simple, very prominent, subspherical, pedunculated eyes (Pl. L. fig. 13), which are deeply pigmented and have a colourless transparent cornea.

Habitat. About a dozen examples of this species were taken in a netting among reeds in Lake Waikare. Being preserved mostly in picric acid, the shells have lost their mineral substance and become very thin and flexible, so that the normal characters are not easily ascertained—especially the distinctive sexual characters. I have no doubt, however, that this is the species described by the Rev. R. L. King (*loc. cit.*); but his figures are scarcely adequate, and I have here given drawings, so far as my material would allow, of the more important parts. As regards the shell, some allowance must be made for the softened, membranous condition. The slight differences between this species and *Notodromas* seem, perhaps, scarcely to call for a separate generic name, but the term *Newhamia* having been already proposed by Mr. King it may very properly be retained, at any rate provisionally.

[Since writing the foregoing description, I find that *N. fenestrata* has been described and figured by Vávra in a paper—"Die Ostracoden vom Bismarck-Archipel" (Archiv f. Naturgesch. 1901). Vávra's specimens were taken in the Island of Neu-Pommern. Mr. King's specimens were from Tasmania.]

CYPRINOTUS SARSI, sp. n. (Plate LI. figs. 1-11.)

Shell of the *female*, seen laterally (fig. 1), subreniform, highest near the middle, height equal to more than half the length; anterior extremity narrower than the posterior, evenly rounded; posterior wider, rounded off below, sloping with a steep curve above; dorsal margin boldly arched, almost gibbous, highest in the middle, thence sloping rather steeply and almost in a right line toward the front and with a more gentle curve backwards; ventral margin slightly sinuated in the middle. Seen from above (fig. 2) the outline is elongate-ovate, more than twice as long as broad, the greatest width in the middle; lateral margins evenly curved, anterior extremity obtuse, posterior subacuminate. Surface of the shell smooth, rather densely clothed at the anterior extremity with very fine, silky hairs, very sparingly hairy behind; colour creamy buff, profusely blotched or almost covered with patches of dark brown. The valves of the two sides are equal or nearly equal in size, without any overlapping dorsally or at the extremities; the right valve is very feebly—almost imperceptibly—tuberculated round the postero-ventral angle. Length 1.4 mm. The swimming-setæ of the posterior antennæ (fig. 4) reach slightly beyond the apices of the claws; caudal rami (fig. 10) very slender, bearing one very long and one short apical seta and two posterior marginal setæ, both of which are closely approximated to the apex.

The shell of the *male* (fig. 3) is smaller and higher in proportion to length than that of the female. The maxillæ of both sides (figs. 6, 7) are strongly built, that of the right side bearing a very strong, falcate terminal claw, that of the left side a triangular plate which ends in a slightly hooked prominence; copulative organs (fig. 11) and ejaculatory duct of the usual type.

Habitat. Taupo Lake. About eight specimens divided evenly between the two sexes: taken by "netting on bottom in a depth of 5-25 feet—sandy, with patches of weeds."

So far as the soft parts of the animal are concerned, there is little or nothing to distinguish this species from *Cyprinotus dahli* G. O. Sars, but the characters of the shell differ in some important points. There is not the very steep posterior declivity of *C. dahli* nor the marked convexity of the ventral margin: moreover, the valves of the two sides are nearly equal and the right valve is not raised dorsally above the level of the left, neither is there any tuberculation of the margins except perhaps a very indistinct appearance of it at the anterior extremity of the right valve. The New Zealand shells, as they reached me, were very thin and membranous in structure, but this was probably a consequence of their having been preserved in picric acid. The specimens of *Cyprinotus dahli** on which Professor G. O. Sars founded the species were raised by him in his laboratory from

* G. O. Sars, "On some West-Australian Entomostraca raised from dried sand" (Archiv f. Mathem. og Naturvidenskab), 1896, p. 24, pl. iv. figs. 1-5.

dried Australian sand, and I am much indebted to him for having kindly sent me specimens for the purpose of comparison. I have pleasure in naming the species in honour of Professor Sars.

EXPLANATION OF THE PLATES.

PLATE XLVIII.

Ceriodaphnia globosa, p. 695.

- Fig. 1. Female seen ventrally. $\times 84$.
 2. Female seen from right side. $\times 84$.
 3. Extremity of post-abdomen. $\times 240$.

Bosmina meridionalis, p. 695.

4. Female seen from right side. $\times 90$.
 5. Post-abdomen. $\times 240$.

Newhamia fenestrata, p. 698.

6. Maxillar lobes. $\times 240$.
 7. Caudal rami with egg-masses and spermatic bundles. $\times 84$.
 8. Ejaculatory duct of male. $\times 100$.
 9. External copulatory organ of male. $\times 240$.

PLATE XLIX.

Calanecia lucasi, p. 696.

- Fig. 1. Female seen from right side. $\times 84$.
 2. Do. dorsally. $\times 84$.
 3. Anterior antenna of male, distal portion. $\times 240$.
 4. Posterior antenna. $\times 300$.
 5. Anterior foot-jaw. $\times 240$.
 6. Posterior foot-jaw. $\times 240$.
 7. One of the swimming-feet. $\times 240$.
 8. Foot of fifth pair of female. $\times 240$.
 9. Fifth pair of feet of male. $\times 240$.
 10. Furca. $\times 240$.

PLATE L.

Newhamia fenestrata, p. 698.

- Fig. 1. Outline of shell of male—from left side. $\times 85$.
 2. Do. do. from above. $\times 85$.
 3. Shell of female seen from below. $\times 84$.
 4. Posterior antenna of male. $\times 84$.
 5. Apical joint of posterior antenna; female. $\times 240$.
 6. Mandible and palp. $\times 240$.
 7. Second foot-jaw of female. $\times 240$.
 8, 9. Do. male, right and left. $\times 240$.
 10. Foot of first pair. $\times 200$.
 11. Do. second pair. $\times 200$.
 12. Caudal ramus. $\times 200$.
 13. Eye. $\times 140$.

PLATE LI.

Cyprinotus sarsi, p. 700.

- Fig. 1. Outline of shell of female, from left side. $\times 40$.
 2. Do. do. from above. $\times 40$.
 3. Do. of male, from left side. $\times 40$.
 4. Posterior antenna. $\times 84$.
 5. Mandible and palp. $\times 84$.
 6. Second maxilla of right side (male). $\times 200$.
 7. Do. prehensile portion, left side. $\times 200$.
 8. Foot of first pair. $\times 84$.
 9. Last joint of second foot. $\times 84$.
 10. Caudal ramus. $\times 84$.
 11. External copulatory organs. $\times 84$.

5. Note on some Crustacea from the Freshwater Lakes of New Zealand. By CHARLES CHILTON, M.A., D.Sc., F.L.S., Professor of Biology, Canterbury College, New Zealand.

[Received May 18, 1906.]

Dr. G. S. Brady has been good enough to submit to me the few Amphipoda and other higher Crustacea collected by Messrs. Lucas and Hodgkin during their recent investigation of the principal lakes of New Zealand*. The first specimens reached me in November 1905 and were at once reported upon; a few additional specimens were received in March 1906, and an examination of these has necessitated some alteration of the general remarks at first made. It will be seen from the following list that the collections of the higher Crustacea were rather meagre and that all the specimens secured belong to species already known.

For many years I have looked forward to making collections from the freshwater lakes of New Zealand in the hope of finding there Crustacea allied to the blind forms inhabiting the underground waters of the Canterbury Plains, just as forms closely allied to European subterranean species are found in the deep waters of the Swiss Lakes. The Crustacea first sent me by Dr. Brady were, however, disappointing from this point of view, but among those lately received there are two specimens of the blind species *Paraleptamphopus subterraneus* (Chilton), one specimen from Lake Wakatipu (depth not stated) in the South Island, and the other from Lake Taupo in the North Island, taken at a depth of 700 feet. This species is widely distributed in the underground waters of the Canterbury Plains, and has also been found in surface streams at Castle Hill in Canterbury and in the Longwood Range in Southland, and its occurrence in the two lakes named still further widens its area of distribution. It is closely allied to *Paraleptamphopus ceruleus* (G. M. Thomson), first described from a small stream at the top of the Old Man Range in Otago, at a height of about 3000 feet, but since found to be, like its underground representative, more widely distributed.

The next most interesting species is the little Isopod that I have identified as *Paranthura nigro-punctata* (Lucas). Though a surface form it is of particular interest, since it is the only known freshwater species of the Anthuridæ, and thus helps to throw some light on the origin of the subterranean species *Cruregens fontanus*, which belongs to the same family. Taken in connection with the recent discovery of a Caprellid in the Lake of Geneva, the occurrence of this Anthurid in freshwater leads us to hope that other unexpected finds may be looked for on a further examination of the lakes.

Two other species, *Tenagomysis novæ-zealandiæ* and *Para-*

* "A Bathymetrical Survey of the Lakes of New Zealand," by Keith Lucas. Geographical Journal, May & June 1904.

corophium excavatum, were previously known only from salt or brackish water on the sea-coast. The little crab *Hymenosoma lacustris* was previously known to occur in New Zealand only in a small freshwater lake near the coast, but it has also been recorded from streams in Victoria and in Norfolk Island.

In the following list I have given only the most important references under each species.

BRACHYURA.

HYMENOSOMA LACUSTRIS (Chilton).

Elamena (?) *lacustris* Chilton, Trans. N. Z. Inst. xiv. p. 172.

Hymenosoma lacustris Chilton, l. c. xv. p. 69, pl. i. fig. 2.

Hymenosoma lacustris Fulton & Grant, Proc. R. S. Vict. xv. (new series) p. 60, pl. viii.

One male and one female specimen from Lake Waikare, the male taken on the stony shore, the female in 5 feet of water.

These resemble the typical specimens from Lake Pupuke Auckland, except that the posterior tooth of the carapace is quite absent and the anterior one forms a slight projection of the outline of the carapace rather than a definite tooth.

This species has been found in freshwater streams in Norfolk Island and in Lake Colac in Victoria. A full account of the slight differences observed between the specimens from different localities will be found in the paper by Messrs. Fulton and Grant mentioned above.

MACRURA.

XIPHOCARIS CURVIROSTRIS (Heller).

Caridina curvirostris Heller, Voy. Novara, Crust. p. 105.

Xiphocaris fluviatilis G. M. Thomson, Trans. Linn. Soc. viii. p. 447, pl. xxix. figs. 2 to 13.

Numerous specimens from Lake Waikare, from nettings among reeds*.

This species is common in freshwater streams throughout the main islands of the Colony; I have specimens also from the Chatham Islands.

SCHIZOPODA.

TENAGOMYSIS NOVÆ-ZEALANDIÆ G. M. Thomson.

Tenagomysis novæ-zealandiæ G. M. Thomson, Journ. Linn. Soc. xxvii. p. 484, pl. xxxiii. figs. 6 to 8 & pl. xxxiv. figs. 9 to 17.

Six specimens from Lake Waikare, in a netting from among reeds.

This species has hitherto been known only from the sea-coast. Mr. Thomson records it from the Kaikorai lagoon (brackish water), estuary of Waikouaiti River, and rock-pools at Brighton—all

* In the tube with this specimen was a single example of a terrestrial Isopod, *Porcellio scaber* Latr., an introduced species which must have got among the collections from the lakes by some accident.

near Dunedin, and from the Bay of Islands, dredged in 8 fathoms. I have taken it near the mouth of a little stream at Brighton, in water which was at the time almost fresh to the taste, though close to the sea and affected by extra high tides.

AMPHIPODA.

PARACALLIOPE FLUVIATILIS (G. M. Thomson).

Calliope fluviatilis G. M. Thomson, Trans. N. Z. Inst. xi. p. 240.

Paracalliope fluviatilis Stebbing, Ann. & Mag. N. H. ser. 7, iv. p. 210.

Numerous specimens from Lake Waikare.

This species is very common in all freshwater streams in New Zealand; I have also taken it in perfectly salt-water in Dunedin Harbour and elsewhere.

PARALEPTAMPHOPUS SUBTERRANEUS (Chilton).

Calliope subterranea Chilton, Trans. N. Z. Inst. xiv. p. 177.

Calliopius subterraneus Chilton, Trans. Linn. Soc. ser. 2, Zool. vi. p. 234.

Paraleptamphopus subterraneus Stebbing, Ann. & Mag. Nat. Hist. ser. 7, iv. p. 210.

One imperfect specimen from Lake Wakatipu (no depth mentioned), and one from Lake Tapu, taken at a depth of 700 feet.

These are both blind, and do not differ appreciably from specimens from the underground waters of the Canterbury Plains. This same blind species has also been taken in surface streams at Castle Hill, Canterbury, at an elevation of 2000 feet above the sea; and more recently Mr. R. M. Laing has brought me specimens from the Longwood Range in Southland. The extension of its distribution as shown by its occurrence in Lakes Tapu and Wakatipu is very interesting.

PARACOROPHIUM EXCAVATUM (G. M. Thomson).

Corophium excavatum G. M. Thomson, Trans. N. Z. Inst. xvi. p. 236.

Paracorophium excavatum, Stebbing, Ann. & Mag. N. H. ser. 7, iii. pp. 241 & 350.

Several specimens from Lake Rotoiti, 5 fathoms, and Lake Waikare (netting among reeds).

This species was described by Mr. Thomson from specimens obtained from "Brighton Creek (salt-water)." I subsequently took it in Brighton Creek along with *Tenagomysis novæ-zealandiæ* when the water was almost fresh to the taste, and specimens lived in a small bottle of this water for some months. I have specimens also from brackish water at Napier.

It thus appears probable that the last three species are all capable of living in fresh or in salt water; and the occurrence of *Paracorophium excavatum* in freshwater lakes far from the sea.



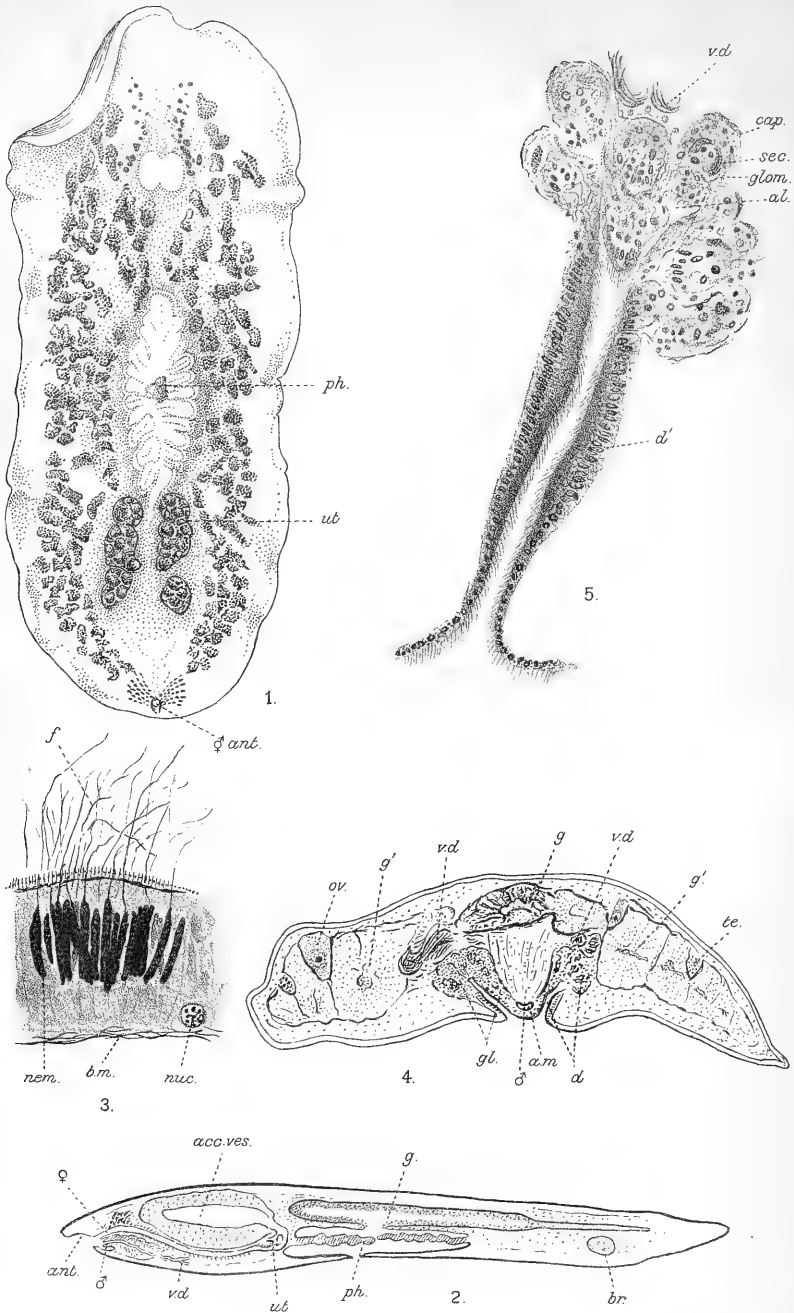


Fig. 1. C.G. Hewitt, del.

E. Wilson, Cambridge.

TURBELLARIA FROM CAPE VERDE ISLANDS.

is very interesting. I do not know of any other freshwater Corophiidae.

ISOPODA.

PARANTHURA NIGRO-PUNCTATA (Lucas).

Paranthura costana Thomson, Trans. N. Z. Inst. xiv. p. 230; Index Faunæ N. Z. p. 262.

Paranthura nigro-punctata Stebbing & Norman, Trans. Zool. Soc. xii. p. 129, pl. xxvi. fig. 11.

A small specimen, about 6 mm. long, from Waikare Lake, taken at a depth of 5 feet, must, I think, be referred to the species found on the New Zealand coast, which was long ago identified with this European species by Mr. Thomson. The specimen is immature, the seventh segment of the pereion being small and lacking appendages. It possesses large distinct black eyes, the colour is pale yellow with markings of black on the back, and it is evidently a surface form. Another specimen from the same locality was dissected and drawn by Dr. Brady, who kindly sent me the drawings he had made.

So far as I am aware, this is the only freshwater species of the Anthuridæ known, with the exception of the subterranean form *Cruregens fontanus* from the underground waters of the Canterbury Plains, and it is of especial interest for this reason, though it is quite distinct from *Cruregens fontanus*.

The species to which I have referred it, *Paranthura nigro-punctata*, was first taken by Mr. Thomson among some seaweed washed up on the beach near the mouth of the Taieri River; I have several specimens taken at different localities on the East Coast of Canterbury, which agree closely with the description and figures given by Stebbing and Norman.

6. On the Marine Fauna of the Cape Verde Islands, from Collections made in 1904 by Mr. C. Crossland.—The Polyclad Turbellaria. By F. F. LAIDLAW, M.A. Cantab.

[Received June 8, 1906.]

(Plate LII.* and Text-figures 111–113.)

CONTENTS.

- i. Introduction: p. 705.
 ii. Notes on the Specimens in Mr. Crossland's Collection: p. 706.
 iii. Literature: p. 718.

i. INTRODUCTION.

The collection of Polyclads made by Mr. Crossland is of interest not only on account of the hitherto undescribed species represented in it, but also because it is the first collection which makes it

* For explanation of the Plate, see p. 719.

possible to form any idea as to the characters of the Polyclad fauna of the warmer waters of the Eastern part of the Atlantic.

Its close general resemblance to the Mediterranean fauna is obvious. Compared with that of the Western Atlantic, so far as this has been made known to us through the researches of Verrill [1888], it need only be said that the two areas, the Cape Verde Islands on the one hand and the New England Coast on the other, do not appear to have a single species in common. When contrasted with the fauna of our own coasts, it is evident that there is a limit to the northward extension of many of the species characteristic of the Mediterranean and warmer parts of the Atlantic. Thus *Prosthiostomum siphunculius* occurs on the Jersey coast, but has never been recorded from the northern shores of the Channel. But at the same time our Polyclad fauna must not be regarded as being merely an impoverished 'Lusitanian' type, there is some evidence that it includes also 'Boreal' species which find in British seas the southern limit of their range. For example, *Cryptocelides loveni* has been taken in the Clyde area, but has not been found further south than this (I am strongly inclined to believe that the locality given for a specimen in the British Museum, namely Port Phillip, is a mistake).

So that it will, I believe, in the future be possible to recognise faunistic areas in the Atlantic for Turbellaria just as such areas have already been delimited for Mollusca.

The absence of any species of *Pseudoceros*, and the presence of several members of the Euryleptidæ in a collection containing some sixteen species, at once marks a striking contrast with any series of specimens I have had the opportunity of examining from the Indian Ocean, though perhaps further collecting may serve to decrease the distinction.

ii. NOTES ON THE SPECIMENS IN THE COLLECTION.

Notes supplied to me by Mr. Crossland on his material are here printed between inverted commas. Numbers in square brackets give reference to literature. Numbers between curved brackets () refer to Mr. Crossland's register of specimens.

PLANOCERIDÆ.

PLANOCERA GRAFFII Lang.

Planocera graffi Lang, Naples Monograph xi., Polycladen, 1885, p. 434.

Three specimens. (15-17.)

"Translucent brown with sparse reticulum of darker, more opaque lines. Outline very wavy during the act of crawling; the animal uses muscular action in progression and extends and attaches a small part of the margin of the front of the body, then hauling itself along by this. It reminds one somewhat of an octopus when crawling."

Dredged 1 fathom, Boa Vista. (15.)

This specimen is 25 mm. long and 18 mm. broad; much smaller than the Mediterranean specimen described by Lang, which had a length of 65 mm. and a breadth of 40 mm. Except for the difference in size, however, I can find no character which will serve to distinguish Mr. Crossland's specimen from the type.

Two smaller specimens found at St. Vincent at low tide (17) are to be referred here. They are about 5-6 mm. long and, unlike the Boa Vista specimen, quite immature sexually.

STYLOCHIDÆ.

STYLOCHUS NEAPOLITANUS (Delle Chiaje) ?

Stylochus neapolitanus Lang [1884] pp. 447-449, Taf. i. fig. 7.

(9.) "From the bottoms of lighters; in crevices of compound ascidians; or in empty lamellibranch shells. Large and thick, and though soft, stiff when alive. The specimens differed in colour. Of two (dated 30-7-04) the larger is uniformly of a dull brown, under a lens appearing as dull pink with small grey spots; the smaller specimen is brighter, light orange with large grey spots. Of three specimens found together (dated 17-8-04) one is bright orange in colour, the others brown. In all cases the tentacles are dark grey and the ventral surface white."

The largest specimen is about 35 mm. long.

I have some doubts as to whether this species is really identical with the Mediterranean *S. neapolitanus*. The species of this genus are difficult to diagnose in a satisfactory manner, and their structure does not vary in such a way as to facilitate the description and ready recognition of species. Consequently I think it best to record these Cape Verde Is. specimens under this name. They certainly resemble the typical *S. neapolitanus* very closely and are nearly related to it.

LEPTOPLANIDÆ.

STYLOCHOPLANA (?) SARGASSICOLA von Graff.

Stylochoplana sargassicola v. Graff [1892] pp. 207-213, Taf. ix. figs. 1-5.

"Two specimens, Boa Vista. Dredged in 1 fathom of water." (15. W. 4.)

A widely distributed species, differing to a considerable extent from other forms referred to this genus.

LEPTOPLANA ALCINOI Schmidt.

Leptoplana alcinoi Lang [1884] pp. 486-489, Taf. iii. figs. 2-5

Several specimens which appear to belong to this species "from amongst nodules of nullipore dredged in from 5-10 fathoms," with *Oligocladius sanguinolentus*. (2. W. 2.)

LEPTOPLANA PALLIDA (Quatrefages).

Leptoplana pallida Lang [1884] pp. 459-492, Taf. iv. figs. 2-3.

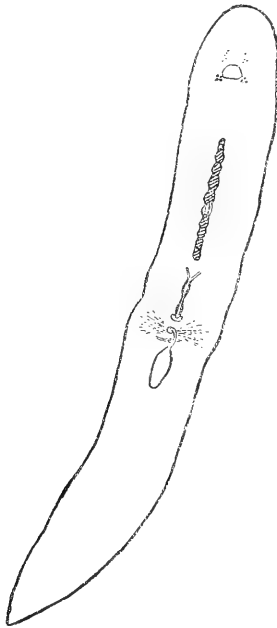
One specimen "from a bucketful of the incrustations of rocks exposed to surf." Port Sal Rei, Boa Vista Is. (W. 9.)

The specimen is about 15 mm. long and has the uteri crowded with eggs.

LEPTOPLANA GRAFFII, sp. n. (Text-fig. 111.)

"Found amongst nodules of nullipores dredged in from 5-10 fathoms. Ribbon-like and a strong swimmer. Light colour, only a broad sandy longitudinal mark centrally and ramifying lines. Contracted on killing." (3.)

Text-fig. 111.

*Leptoplana graffii*. $\times 5$.

This species, represented by a single specimen, has a body relatively longer and narrower than is found in any other *Leptoplana*.

Length	25 mm.
Breadth	3.5 mm.
Brain	3 mm. behind the anterior margin.
Buccal opening	8 mm. behind the brain.
σ aperture	6 mm. behind the buccal opening.

The eye-spots have the arrangement which is typical for the genus. There are a pair of tentacle eye-groups, one on either side of the brain, each consisting of four or five large eye-spots. In front of these on either side are a very few (seven or eight) smaller eyes.

The musculature of the dorsal body-wall is unusually well developed, especially the oblique inner layer. The dorsi-ventral fibres also are unusually abundant and of large size.

The short blunt muscular penis projects downwards and a little backwards into the antrum masculinum. It has no stylet. From it the muscular ductus ejaculatorius runs forward, rapidly widening to form a prostatic compartment whose walls are lined with a secretory epithelium, but are not chambered. From the anterior end of this chamber the duct runs forward again as a narrow muscular tube, again soon widening to form a vesicula seminalis, which receives at its anterior end the vasa deferentia. The prostate and vesicle are not so clearly segmented off from each other as in most species of *Leptoplana*; in fact with the conducting part they form a nearly straight tube whose walls, surrounded throughout their entire length by circular muscle-fibres, vary somewhat in thickness; being thickest in those parts of the tube where the lumen is greatest, that is to say in the prostate and in the vesicula seminalis.

The antrum femininum, opening close behind the antrum masculinum, passes dorsally into a narrow duct which receives the secretions of the shell-glands, and then, turning backwards, opens after a short course into a large accessory vesicle lined with a vacuolated secretory epithelium. This vesicle contains in the present specimen a quantity of spermatozoa. Just before it opens into the accessory vesicle the vaginal duct is joined on its ventral side by the common termination of the uteri.

The shell-glands are very large, disposed in a dorsal and ventral layer on either side of the middle line, converging on the sides of the vagina. They extend outward to the margins of the body.

Leptoplana graffi may be defined as a *Leptoplana* with a very elongated body. Penis without a stylet; prostate unchambered, moderately distinct. Antrum femininum non-muscular; a large spherical accessory vesicle present.

ZYGANTROPLANA, gen. nov.

ZYGANTROPLANA VERRILLI, sp. n. (Plate LIII, figs. 1 & 2.)

Two specimens. St. Vincent Harbour. (6.)

“Amongst weed collected by a diver in 1 or 2 fathoms.

“Oval with a much waved margin. General colour brown, with broad, nearly colourless margin, the edge itself with a light red-brown tinge. Under side colourless.”

Length 7 mm.; breadth 4 mm.

The eye-spots are arranged in two rows convex inwards, lying at the sides and in front of the level of the brain. This organ is

situated at about a fifth of the total body-length from the anterior margin. The pharyngeal opening is subcentral, and the pharynx is fairly large and similar to that of *Leptoplana* in appearance (see text-fig. 111, p. 708).

The gut-branches are numerous.

The male and female genital ducts open together into a small antrum at the extreme hind end of the body.

The epidermis contains no rhabdites, but many of the cells composing it resemble in appearance goblet-cells, and are no doubt concerned in the production and excretion of mucus or pseudo-rhabdites. The preservation of the epidermis is unfortunately not good.

The basement membrane is readily distinguishable in the sections. Under it lie first a layer of longitudinal muscle-fibres, within these are circular and diagonal fibres not differentiated into separate strata, and lastly, on the ventral side only, an inner longitudinal layer.

As is the case in many other Polyclads, the main gut is clearly marked off from the branches by the fact that in its walls are present large numbers of unicellular glands which are not present elsewhere in the alimentary tract.

The main features of the anatomy of this species are shown diagrammatically in fig. 2 of Plate LII.

Male apparatus.—The vasa deferentia unite below about the hinder end of the large female accessory vesicle to form a single rather convoluted duct, which runs backwards through a special sheath or casing of tissue which appears to be prostatic in character. In this part of its course the ductus ejaculatorius has a very thin wall. As it approaches the antrum the wall becomes thicker, and at the same time the tissue surrounding it takes on gradually a definite muscular character. Finally the duct opens at the apex of a small, conical, muscular penis which projects into the antrum immediately below the termination of the vagina (Pl. LII, fig. 2, ♂).

It will be most convenient to describe the female apparatus by following its course in the opposite direction, that is to say forwards. The vagina is a simple non-muscular tube which receives the secretion of the shell-glands near its termination and runs forwards, lying at first above the sheath of the ductus ejaculatorius. It passes beyond this for some distance, nearly as far as the hinder level of the pharynx, there turning first upwards and then backwards, it opens at once into a large accessory vesicle. Just before this it receives the common opening of the two uteri. Beyond the point where the shell-glands lie, the vagina is surrounded along its whole course by unicellular glands which form as it were a second outer layer of the wall of the duct.

The accessory vesicle is large, non-muscular, with glandular walls. It extends backwards nearly as far as the antrum, and is distended with a granular secretion to such an extent that it presses on and nearly occludes the lumen of the vagina when that lies below it.

The uteri are crowded with eggs (Pl. LIII. fig. 1, *ut.*).

The ovaries lie dorsally to the gut-branches and to some extent between them, whilst the testes are on the ventral side.

The affinities of the genus are doubtful, but seem to me to be most probably with the Leptoplanidæ, though perhaps some affinity with *Stylochocestus* may be suggested.

Zyganthropiana may be defined as follows:—

An Acotylean genus in which the body is of an elongate-oval shape, without tentacles. The terminal genital ducts open into a small common antrum situated at the extreme hinder end of the body. Penis small, without stylet, no definite prostate gland. Pharynx subcentral. No marginal eye-groups.

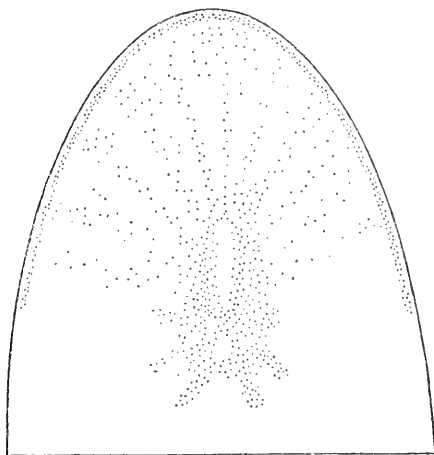
The species bears some resemblance to *Leptoplana angusta* Verrill [1888] pp. 485–486, pl. xl. fig. 8, pl. xlv. figs. 2, 2 a, 3, but the latter has, according to Verrill's figure, more distinct traces of a tentacle eye-group. *L. angusta* may perhaps prove to be congeneric with the present species.

LATOCESTIDÆ.

LATOCESTUS PLEHNI, sp. n. (Text-fig. 112.)

Several specimens "found in deep crevices of nullipore, or in shells, never in the open. The worm will crawl out of its hiding-place at night if kept in a basin of sea-water, and will even leave the water and reach out over the edge of the basin, holding the anterior half of its body horizontally in the air.

Text-fig. 112.



Latocestus plehni, anterior end. $\times 9$.

"Uniformly opaque and rather dark brown in colour. Central line darker. The margins are kept applied to surface on which

the animal is crawling. It is about 2 inches long but narrow, and contracts considerably when killed. In appearance it reminds one of a horse-leech, but never swims. It is common everywhere where suitable crannies in the rocks occur."

The arrangement of the eye-spots at the anterior end of the body is shown in text-fig. 112 (p. 711.) The marginal spots form a continuous series round the body. This complete ring of eye-spots serves at once to distinguish the present species from the type of the genus, *L. atlanticus* Plehn [1896], which is recorded from the same neighbourhood. In fact *L. plehni* resembles much more closely *L. argus* from the Straits of Malacca. In respect to the structure and arrangement of the internal organs of the body, *L. plehni* shows no noteworthy departure from that found in the typical species of the genus.

CESTOPLANIDÆ.

CESTOPLANA RUBROCINCTA (Grube).

Cestoplana rubrocincta Lang [1884] pp. 516-520, Taf. ii. fig. 5.

"Under stones at low tide, Boa Vista.

"Very contractile." (3.)

A small specimen 30 mm. long, 3 mm. broad.

ANONYMIDÆ.

ANONYMUS VIRILIS Lang (?). (Plate LII. fig. 3.)

Anonymus virilis Lang [1884] pp. 522-523, Taf. ii. fig. 4.

Dredged amongst nullipores, 3 and 10 fathoms. St. Vincent Harbour. (8. W. 3.)

"Pink or brownish pink with a white transparent border. Under a simple lens the central part of the body shows a network of broken light-brown lines, the main lines being radial. Marginal eyes extend half way down the sides of the body (at least). General texture thick and soft, shape broadly oval, margin wavy when crawling."

Unfortunately this interesting species is evidently a most difficult creature to preserve satisfactorily. All Mr. Crossland's specimens are coated thickly with foreign particles felted together by the copious epidermal discharge. In the second place, they are all extremely contorted, and any attempt to flatten them for examination results in the breaking of the soft body. Two specimens are already broken into fragments in the bottle. Hence I give only an incomplete account of them here. The larger specimens are about 12 mm. long and 7 mm. wide. In colour, distribution of the eye-spots, and arrangement of the penes (of which there are ten or eleven pairs) they resemble closely Lang's type.

Sections were cut of a specimen which has the body crowded with large eggs, and contains spermatozoa in the "Samenblase" of the penial structures, although the numerous testes have not reached a condition of maturity.

The structure of the penes and other organs of the body, such as the musculature, shows a complete agreement with that found by Lang in his specimens. A difference is, however, to be met with in the case of the epidermal structures.

Lang has described nematocysts or needle-like bodies of four types, grouped in batteries, occurring in the dorsal epithelium.

In a young specimen which I have examined I could find no structures of this type. In sections of the more mature specimen referred to above are spindle-shaped bodies, each of which has discharged a thread from its outer end, lying in batteries on the dorsal surface (Pl. LII. fig. 3, *f*). These are perhaps to be referred to Lang's fourth type ("Freie nadeln, an welchen ein Faden spiralig aufgerollt ist"). Both the spindle and the thread discharged from it are deeply stained. A number of undischarged needle- or spindle-shaped bodies occur in the parenchyma, but I have not been able to see any spiral thread inside these. These are the only nematocyst-like organs that I have been able to find in my specimens. As, however, they agree very closely in all other respects with the type of *A. virilis*, I have not ventured to give them a distinct name.

PSEUDOCERIDÆ.

THYSANOZOOON BROCCII (Risso) var. CRUCIATUM ?

Thysanozoon broccii Lang [1884] pp. 525-536, Taf. vi. figs. 3, 4 ; von Stummer-Traunfels [1895] p. 161.

Several specimens, "from under stones at low tide at St. Vincent and at Porto Praya." (I. W. 7.)

"Drab-yellow with dark grey markings. There may be very little yellow and the general colour becomes a dark grey. Generally, but not in all the specimens, there is a narrow longitudinal white stripe and a broader transverse one at about $\frac{1}{3}$ of the length of the body from the anterior end."

The specimens vary in size from about 8 to 16 mm.

EURYLEPTIDÆ.

CYCLOPORUS PAPILLOSUS Lang.

Cycloporus papillosus Lang [1884] pp. 568-571, Taf. vi. figs. 1, 2, Taf. viii. fig. 5.

Under stones at low tide, Porto Praya. (11.)

Small, rather rectangular in shape; margin colourless, nearly transparent. The hinder edge of the body is carried folded into a bag dorsally.

This specimen is without papillæ, and in all probability is to be referred to Lang's var. *lævigatus*.

Hallez has described a second species of the genus.

The examination of a large series of specimens referable to this genus from the various localities in which it occurs would in all probability reveal the existence of several recognisable races.

PROSTHECERÆUS RUBROPUNCTATUS Lang.

Prostheceræus rubropunctatus Lang [1884] p. 562, Taf. vii. fig. 5.

"From the bottoms of lighters, along with *Stylochus*." (12.)

"A very beautiful species."

Four specimens, one of them very young.

Length of larger individuals about 13-14 mm.; breadth 6·7 mm.

OLIGOCLADUS SANGUINOLENTUS (Quatrefages).

Oligocladus sanguinolentus Lang [1884] pp. 580-582, Taf. viii. fig. 7.

"From amongst nodules of nullipores (*Lithothamnion*) dredged in St. Vincent Harbour, 5-10 fathoms."

A number of specimens. (2. W. 7.)

PROSTHIOSTOMIDÆ.

PROSTHIOSTOMUM DOHRNII Lang.

Prosthiostomum dohrnii Lang [1884] pp. 601-603, Taf. v. fig. 2.

Several specimens. (4.) "Amongst nullipores at low tide, and at 10 fathoms, St. Vincent." Ribbon-like, of a translucent yellowish colour, with distinct round spots of a darker tint on the dorsal surface, most numerous medianly. About 2 inches long when fully expanded.

PROSTHIOSTOMUM sp.

One specimen "from nullipore of Bird Rock, St. Vincent Harbour. It is remarkable that so delicate a creature should live in a place exposed to the whole force of the Atlantic rollers." (W. 13.)

The specimen is very small, only 7·5 mm. long. It has the terminal male apparatus developed and the vesicula seminalis full of spermatozoa. There is no appearance of ova, though the position of the female aperture is indicated by the clearly visible shell-glands. There are very few rather large eye-spots over the brain, and some smaller marginal ones arranged very much as in the young specimens of *P. siphunculus* figured by Lang. Perhaps this specimen should be referred to that species, but as I have neither seen any mature specimens of *P. siphunculus* from this locality, nor have any intermediate stages of *P. dohrnii* with which to compare it, I think it best to leave it without a definitive name.

DIPOSTHIDÆ.

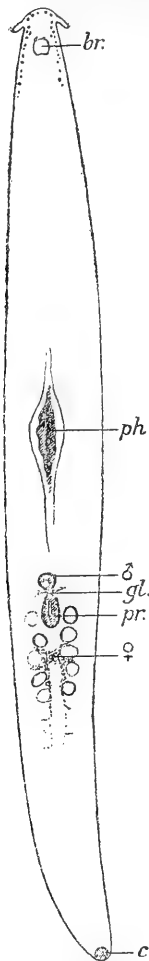
TRAUNFELSIA ELONGATA, sp. n. (Plate LII. figs. 4-5 and Text-fig. 113.)

"From sandy shore among weed.

"Vermiform, thin, flattened; about $1\frac{1}{2}$ inches long by $\frac{1}{16}$ inch broad, but can contract to half this length. Resemblance to a worm enhanced by the presence of a pair of slender tentacles carried at right angles to the body. Ground-colour white, but,

except at the margins, this is largely hidden by granular markings of a sandy colour." (5.)

Text-fig. 113.

Sketch of anatomy of *Traunfelsia elongata*. $\times 12$.

br., brain; *c*, sucker; *gl.*, glandular organs; *ph.*, pharynx; *pr.*, prostatic organ; δ , male aperture; ♀ , female aperture.

A very remarkable new species.

The preserved specimens have a length of about 12 mm. and a breadth roughly of 1 mm. The anterior extremity is rounded and has lying along either margin for about a millimetre a row

of some 20 eye-spots (see text-fig. 113, p. 715). Almost at the extreme anterior extremity there projects outwards on either side a fine tentacle-like process devoid of eye-spots, and evidently very contractile, varying much in length in the different individuals preserved.

The brain (*br.*) lies about half a millimetre behind the anterior extremity, over it lie a few eye-spots. The pharynx opening is near the middle of the ventral surface; the pharynx is rather elongate and convoluted. The genital apertures lie close together in the middle line, the female behind the male, about a millimetre and a half behind the pharyngeal aperture. At the extreme hinder extremity of the ventral surface is a sucker-like organ (*c.*)

The cells forming the epidermis are rather flattened and show no rhabdites; some of them contain irregular thread-like secretions. The cells at the margin of the body are more columnar than those on the dorsal or ventral surfaces. The ventral cilia are three times as long as the dorsal.

The muscles of the body-wall consist of an outer, longitudinal layer, and of an inner, circular layer, both feebly developed: on the ventral side there is a second longitudinal layer internal to the circular fibres, well developed, and occupying nearly one-fourth of the total thickness of the body.

Gut.—The main-gut extends from just behind the brain to the hinder end of the body, and gives off numerous lateral branches; a branch also passes forward over the brain.

Structurally the branches are distinguished from the main-gut by the fact that in them the large gland-cells, which, from their deep staining, are very conspicuous, are scarce or as a rule absent, whilst in the main-gut they are very abundant.

Genital apparatus.—The testes and ovaries both lie dorsal to the gut-branches, though sometimes the ovaries extend down between them. In the specimen sectionised both testes and ovaries are mature, and, as in other Polyclads, very numerous.

The contorted ends of the vasa deferentia run forwards and inwards to open together into the base of the penis. This is a conical organ which projects backwards into a small cavity, the antrum masculinum. This organ is not muscular, but consists of a spongy mass of tissue through which the duct runs to open at its apex. The projecting part of the penis is lined with an epithelium continuous with the lining of the antrum. This latter opens into a small depression or cup on the ventral surface, and on either side of it is the opening of a very remarkable duct leading from a compound racemose gland of a type quite unlike anything I have met with in other Polyclads. These ducts are lined with columnar ciliated cells; they run upwards and outwards on either side of the penis in a transverse plane, and each terminates by branching into a number of small chambers. These are themselves lined with columnar epithelium of the same type as the ducts, but that forming the roof of each chamber projects more into the lumen of that chamber than does the epithelium of

the walls. Consequently each chamber-cavity is in section rather crescentic, with the horns of the crescent directed upwards. Each is connected with the terminal duct by a well-defined stalk or 'neck.' On either side there are some fifteen or so of these chambers.

Lying over every one of these is a deeply-staining glomerulus-like mass of cells, each glomerulus having an oval or nearly circular outline in section and consisting of a central mass of cells forming a core, and lying round these an irregular scanty layer serving as a capsule. The cells of the central core-mass in one or two cases are wedged at its lower end in amongst the cells of the roof of the small chamber lying immediately below them; in other cases there seems to be a very minute channel leading from the centre of the core into the chamber, but this if it exists is so small that I cannot consider it satisfactorily demonstrated. The cells which make up the core have abundant protoplasm, which stains rather deeply and is very finely granular. Some few of these cells are larger than the others, more deeply stained, and pyriform.

Lastly, in the same transverse plane as the two ducts described above, but in the middle line, the lumen of another conical or pyriform organ opens into the ventral depression, behind the penis, directed forwards in this case and armed with a short cylindrical stylet. At the hinder end of this organ, which must be regarded as an intromittent prostate, its lumen ends blindly. The outer wall is muscular, the fibre being almost entirely circular; and between the muscular wall and the lumen lies prostatic tissue crowded with rather large feebly staining granules. So that the complicated male terminal apparatus consists of (1) a penis into whose lumen the vasa deferentia open; (2) a pair of problematic compound ducts lying on either side of the penis; (3) an intromittent prostate lying behind the penis.

Scarcely less elaborate are the terminal parts of the female organs. The vagina opening in the middle line, close behind the depression in which the outlet of male organs lies, runs at first upwards and forwards surrounded by numerous shell-glands. In this part of its course it is widened transversely and has a musculature but feebly developed. Soon the vagina turns backwards, at the same time becoming narrow and cylindrical, so that the circular muscle coat is relatively, if not actually, thicker. At a level behind its opening to the exterior this part of the vagina receives the terminations of the two uteri, which run nearly transversely from without inwards to join it. Behind this it widens again immediately to form a spherical accessory vesicle whose non-muscular walls consist of a single layer of cubical non-ciliated epithelium. This vesicle contains spermatozoa.

The uteri pass outwards and a little forwards from the vagina, until they reach a point on either side well to the outside of the main-gut and at a lower level, where each turns backwards and runs longitudinally. In this longitudinal part of their course

each bears some five sessile spherical vesicles, which are non-muscular. The cells lining the walls of these vesicles project inwards, so that the vesicle is almost entirely filled up with a reticulum of protoplasmic material which contains numerous well-defined vacuoles; in these coils of spermatozoa lie, and in two cases sperm-coils are seen passing between the uterus and a vesicle.

Traunfelsia is altogether a remarkable form, but undoubtedly is most closely allied to *Diposthus*. Special features to which attention should be directed are, the presence of marginal tentacles combined with very elongated body; the remarkable pair of compound glands developed in connection with the terminal parts of the male ducts; and, thirdly, the coexistence of an accessory vesicle opening on the vagina with uterine glands along the course of the uteri.

The genus shows affinities to *Diposthus* in the central position of the pharynx and in the structure of the genital glands, particularly in the possession of an intromittent muscular prostatic organ. It bears to *Diposthus* much the same relationship as *Disparoplana* does to *Planocera*, and should perhaps be made the type of a subfamily of the Diposthiidæ.

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

A genus of the Diposthiidæ of a very elongated form. A pair of marginal tentacles present which bear no eye-spots. Eye-spots lie on the anterior margin and over the brain. Pharynx subcentral. Testes and ovaries dorsal. In addition to the penis and intromittent prostate which lies behind it, there is a pair of glandular structures opening on the ventral surface on either side of the penial aperture. Female apparatus provided both with accessory vesicle and with uterine vesicles.

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1903. ——. “A Collection of Polyclad Turbellaria from the Straits of Malacca (Skeat Expedition).” P. Z. S. 1903, i. pp. 301–318, pl. 23.

EXPLANATION OF PLATE LII.

- Fig. 1. *Zygartropiana verrilli*, sp. n.: p. 709. Appearance of a specimen cleared in cedar-wood oil. \times c. 15.
 2. Longitudinal section of the same (diagrammatic).
 3. Group of nematocyst-like structures from the dorsal epidermis of a specimen of *Anonymus viridis* (?): p. 712. \times 500.
 4. Transverse section across the body of *Trautfelsia elongata* (p. 714) at the level of the penis and accessory male glands (diagrammatic). \times 50.
 5. One of the accessory male glands more highly magnified. \times 450.

Explanation of lettering of the Figures.

<i>acc.ves.</i> , accessory vesicle.	<i>gl.</i> , accessory male gland.
<i>a.m.</i> , antrum masculinum.	<i>glom.</i> , glomerulus.
<i>ant.</i> , antrum.	<i>nem.</i> , nematocysts.
<i>al.</i> , alveolus of gland.	<i>nuc.</i> , nucleus of epidermal cell.
<i>b.m.</i> , basement-membrane.	<i>ov.</i> , ovary.
<i>br.</i> , brain.	<i>ph.</i> , pharynx.
<i>cap.</i> , capsular cells.	<i>sec.</i> , secretion of glomerulus.
<i>d.</i> , duct.	<i>te.</i> , testis.
<i>d'</i> , duct epithelium.	<i>ut.</i> , uterus.
<i>f.</i> , threads of nematocysts.	<i>v.d.</i> , vas deferens.
<i>g.</i> , main gut.	σ , penis.
<i>g'</i> , gut-branches.	$\text{\textcircled{f}}$, external opening of vagina.

7. Description of an unknown Animal seen at Sea off the Coast of Brazil. By E. G. B. MEADE-WALDO, F.Z.S., and MICHAEL J. NICOLL, F.Z.S.

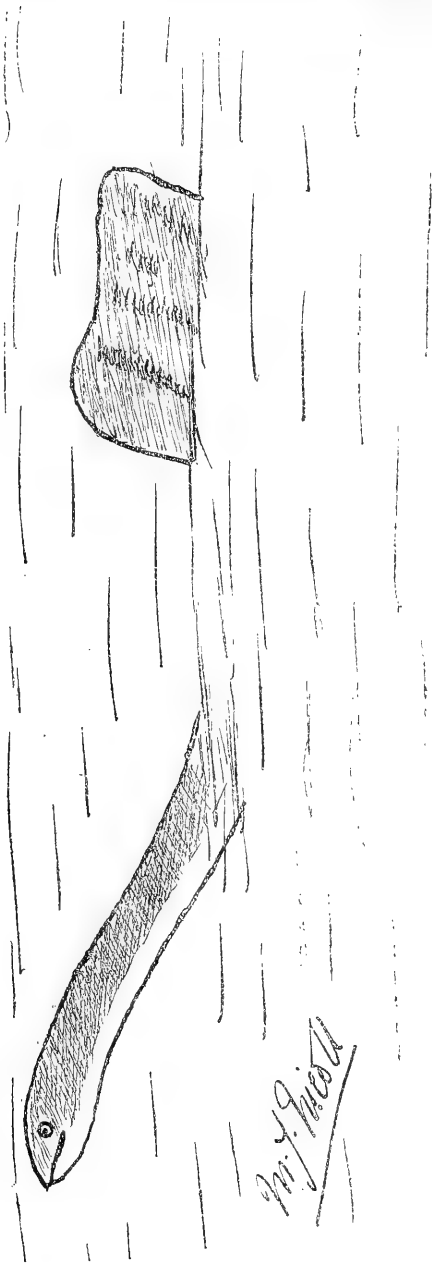
[Received June 19, 1906.]

(Text-figure 114.)

The following are accounts of a large marine animal (text-fig. 114, p. 720) seen off the coast of Brazil, copied from the journals made by us during our cruise in the Earl of Crawford's yacht 'The Valhalla':—

"On Dec. 7th, 1905, at 10.15 A.M., I was on the poop of the 'Valhalla' with Mr. Nicoll, when he drew my attention to an object in the sea about 100 yards from the yacht; he said: 'Is that the fin of a great fish?' I looked and immediately saw a large fin or frill sticking out of the water, dark seaweed-brown in colour, somewhat crinkled at the edge. It was apparently about 6 feet in length and projected from 18 inches to 2 feet from the water. I could see, under the water to the rear of the frill, the shade of a considerable body. I got my field-glasses on to it (a powerful pair of Goerz Triöder), and almost as soon as I had them on the frill, a great head and neck rose out of the water in front of the frill; the neck did not touch the frill in the water, but came out of the water in *front* of it, at a distance of certainly not less than 18 inches, probably more. The neck appeared about the thickness of a slight man's body, and from 7 to 8 feet was out of the water; head and neck were all about the same thickness. The head had a very turtle-like appearance, as had also the eye. I could see the line of the mouth, but we were sailing pretty

Text-fig 114.



Sketch of marine animal as seen by Messrs. Meade-Waldo and Nicoll off the coast of Brazil.

fast, and quickly drew away from the object, which was going very slowly. It moved its neck from side to side in a peculiar manner: the colour of the head and neck was dark brown above, and whitish below—almost white, I think. When first seen it was about level with the poop of the yacht, and on the starboard side. I made it out by the chart to be in about S. lat. $7^{\circ} 4'$, long. $34^{\circ} 20'$, but I think this is not quite correct. Mr. Nicoll got the correct position from the captain. The depth of the water where we saw it was about 300 fathoms, but quickly went to as much as 1300 fathoms. Since I saw this creature I consider on reflection that it was probably considerably larger than it appeared at first, as I proved that objects, the size with which I was well acquainted, appear very much smaller than they really are when seen on the ocean at a similar distance with nothing to compare them with.”

E. G. B. MEADE-WALDO.

“At 10.15 A.M. on Thursday, December 7, 1905, when in lat. $7^{\circ} 14'$ S., long. $34^{\circ} 25'$ W., in a depth of from 322 to 1340 fathoms, Meade-Waldo and I saw a most extraordinary creature about 100 yards from the ship and moving in the same direction, but very much slower than we were going. At first, all that we could see was a dorsal fin about four feet long sticking up about two feet from the water; this fin was of a brownish-black colour and much resembled a gigantic piece of ribbon seaweed. Below the water we could indistinctly see a very large brownish-black patch, but could not make out the shape of the creature. Every now and then the fin entirely disappeared below the water. Suddenly an eel-like neck about six feet long and of the thickness of a man's thigh, having a head shaped like that of a turtle, appeared in front of the fin. This head and neck, which were of the same colour above as the fin, but of a silvery-white below, lashed up the water with a curious wriggling movement. After this it was so far astern of us that we could make out nothing else.

“During the next fourteen hours we ‘went about’ twice and at about 2 A.M. the following day (Dec. 8th), in lat. $7^{\circ} 19'$ S., long. $34^{\circ} 04'$ W., the first and third mates, Mr. Simmonds and Mr. Harley, who were on the bridge at the time, saw a great commotion in the water. At first they thought it was a rock awash about 100–150 yards away on the port side, just aft of the bridge, but they soon made out that it was something moving and going slightly faster than the ship, which at that time was doing about $8\frac{1}{2}$ knots. Mr. Simmonds hailed the deck, and one of the crew who was on the ‘look-out’ saw it too. Although there was a bright moon at the time they could not make out anything of the creature itself, owing to the amount of wash it was making; but they say that from the commotion in the water it looked as if a submarine was going along just below the surface. They both say most emphatically that it was not a whale, and that it was not blowing, nor have they ever seen anything like it before. After they had watched it for several minutes it ‘sounded’ off the port bow, and they saw no more of it.”

MICHAEL J. NICOLL.

8. A Classification of the Selachian Fishes.

By C. TATE REGAN, B.A., F.Z.S.

[Received May 29, 1906.]

(Text-figures 115-124.)

The classification of the Selachians which I propose is as follows:—

Subclass **SELACHII**.*Series I. *TREMATOPNEA*.†Order 1. **PLEUROPTERYGII**.Family 1. *Cladoselachidae*.

Cladoselachus.

Family 2. *Cladodontidae*.

Cladodus, Symmorium.

Order 2. **ACANTHODII**.Family 1. *Acanthoessidae*.

Acanthoessus, Chiracanthus.

Family 2. *Diplacanthidae*.

Diplacanthus, Climatias, Ischnacanthus.

Order 3. **ICHTHYOTOMI**.Family 1. *Pleuracanthidae*.

Pleuracanthus, Xenacanthus.

Order 4. **EUSELACHII**.‡Suborder 1. **PLEUROTREMATA**.§Division 1. **NOTIDANOIDEI**.Family 1. *Chlamydoselachidae*.

Chlamydoselachus.

Family 2. *Hexanchidae*.

Hexanchus, Heptanchias.

* I use the word Selachii in the same sense as did Müller in 1846 and as the equivalent of the Sélaciens of Cuvier in 1817 (*Règne Anim.* ii. p. 121).

† The names *Trematopnés* and *Chismopnés*, the latter an obvious misspelling, proposed in 1806 by C. Duméril with a wider significance, may be Latinised and applied to the two series of Selachians.

‡ The *Petalodontidae* and *Psammodontidae*, comprising several genera from Permian and Carboniferous strata, appear to pertain to this Order, but cannot be assigned a definite position.

§ The *Pleurotremata* and *Hypotremata* are equivalent to the *Pleurotrèmes* and *Hypotrèmes* of C. Duméril.

Division 2. GALEOIDEI.

Family 1. *Odontaspidae*.

Odontaspis, Scapanorhynchus.

Family 2. *Lamnidae*.Lamna, Carcharodon, Cetorhinus,
Alopias.Family 3. *Orectolobidae*.Parascyllium, Ginglymostoma, Rhinodon,
Orectolobus, Chiloscylidium, Stegostoma.Family 4. *Scyliorhinidae*.

Scyliorhinus, Pristiurus, Pseudotriacis.

Family 5. *Carchariidae*.Carcharias, Galeocerdo, Thalassorhinus,
Galeus, Triænodon, Triacis, Mustelus, Sphyrna.

Division 3. SQUALOIDEI.

Family 1. *Cochliodontidae*.Psephodus, Pleuroplax, Xystrodus,
Deltodus, Pœcilodus, Cochliodus.Family 2. *Hybodontidae*.a. *Hybodontinae*—Orodus, Campodus, Sphenacanthus,
Tristychius, Hybodus, Acrodus, Asteracanthus.b. *Palæospinacinae*—Palæospinax, Synechodus.Family 3. *Cestraciontidae*.

Cestracion.

Family 4. *Squalidae*.a. *Squalinae*—Centroscyllium, Echinorhinus, Oxynotus,
Etmopterus, Squalus, Scymnodon, Centrosymnus,
Centrophorus, Scymnorhinus, Somniosus, Isistius, Euprotomicrus.b. *Pristiophorinae*—Pristiophorus, Pliotrema.Family 5. *Squatinidae*.

Squatina.

Suborder 2. HYPOTREMATA.

Division 1. NARCOBATOIDEI.

Family 1. *Torpedinidae*.Torpedo, Narcine, Hypnos, Narce, Temera,
Discopyge.

Division 2. BATOIDEI.

Family 1. *Rhinobatidae*.a. *Pristina*—Sclerorhynchus, Propristis, Pristis.b. *Rhinobatina*—Rhynchobatus, Rhina, Rhinobatus, Discobatus, Trygonorhina, Astrodermus.Family 2. *Raiidae*.

Raia, Psammobatis, Sympterygia, Cyclobatis.

Family 3. *Dasybatidae*.

Xiphotrygon, Pteroplatea, Urolophus, Dasybatis, Urogymnus, Ptychodus, Myliobatis, Aetobatis, Rhinoptera, Dicerobatis, Ceratoptera, Ceratobatis.

Series II. CHASMATOPNEA.

Order HOLOCEPHALI.

Family 1. *Pycnodontidae*.

Pycnodus, Rhynchodus, Palæomylus.

Family 2. *Squaloraiidae*.

Squaloraia.

Family 3. *Myriacanthidae*.

Myriacanthus, Chimæropsis.

Family 4. *Chimæridae*.

Ganodus, Ischyodus, Edaphodon, Elasmodus, Rhinochimæra, Harriotia, Callorhynchus, Chimæra.

I am of the opinion that any attempt to apply the rule of priority to the nomenclature of groups such as suborders, orders, &c., unless it is convenient to do so, cannot succeed. To call the Notidanoidei either Palæonotidani, Diplospondyli, or Opistharthri is to give a misleading idea of the characteristics of the division.

Although the Selachii may quite well be regarded as a subclass of the Pisces, it is not improbable that they will be generally accepted as constituting a class distinct from the true Pisces (Teleostomi) when their characteristic peculiarities are more widely known.

The Selachii * may be thus defined:—

Craniate vertebrates with jaws. Nasal organs paired blind

* In the definition and classification of the Selachii I have left out of account the Heterostraci and their supposed allies, primitive fishes of Palæozoic times, as to whose position in the system no two authors seem to agree.

sacs, each with a single external aperture*. Exoskeleton of dermal denticles which are structurally identical with the teeth; no membrane-bones†. Endoskeleton cartilaginous, the cartilage often calcified. Gills supported by visceral arches and functional throughout life; no lungs‡. Median and paired fins with horny dermal rays§ and with endoskeletal supports in the form of series of cartilaginous rods, the arrangement of which may be variously modified. Vertebral column comprising the notochord and its sheath, simple neural and hæmal arches, and intermuscular elements, the so-called ribs; no supra-neural or infra-hæmal arches||. In all the living forms, the males with intromittent organs, the mixopterygia, which are appendages of the pelvic fins.

* The Teleostomi have two nostrils on each side, except in certain specialised Teleosts. It has been supposed that these are homologous with the external and internal nares of higher Vertebrates, the Dipneusti, in which the posterior nostril is included within the mouth, being cited as evidence of this, especially by those who consider them to be transitional between Fishes and Batrachians. The development of these parts in Reptilia, Aves, and Mammalia has also been considered to support this position, the internal nares being the remnants of open grooves originally connecting them with the olfactory pits.

From this view I must dissent, regarding the external nares, whether single or divided into two, as homologous throughout the Fishes and the higher Vertebrates, and the internal nares as a new formation peculiar to the latter. In the Dipneusti the absence of præmaxillaries and maxillaries permits the extension of the nasal sacs to the palate; but it appears to me that the posterior extension of the nasal sacs external to functional præmaxillaries and maxillaries, so as to carry the posterior nostril into the mouth, is quite impossible. In the Amphibia, the lowest group with true internal nares, their development supports the view that they are a new formation.

For a general account, with opposite conclusions, see Balfour, 'Comparative Embryology,' ii. pp. 531-538.

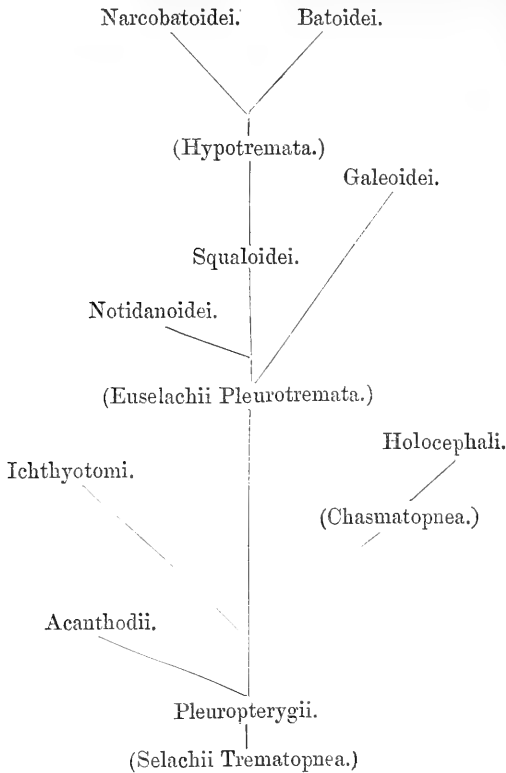
† The exoskeletal peculiarities of the Teleostomi may be summarised in the phrase "dermal ossification." On the body, where flexibility is a requirement, juxtaposed rhombic bony plates or "ganoid scales," arranged in parallel longitudinal and oblique series, are developed; these are found in the more generalised forms, and in the more specialised ones may be variously modified or may disappear. Other parts of the fish become strengthened and protected by membrane-bones, and whether we examine the more primitive members of either the Chondrosteo-Teleostean or the Crossopterygii-Dipneust series, we find in each the same cranial roof-bones, paired parietals, frontals, nasals, post-frontals, and supratemporals, also the parasphenoid covering the *basis cranii*, the præmaxillaries and maxillaries (probably originally overlying labial cartilages like those of the Selachians), the dentary, angulare and splenial, sheathing the Meckelian cartilage, the circumorbitals, postorbitals and præoperculum, the opercular and subopercular bones, protecting the branchial chamber, and finally a series of bones overlying the pectoral arch and connecting it with the cranium, post-temporal, supra-cleithrum, cleithrum, and clavicle.

‡ The Teleostomi have typically either a lung or its homologue, the air-bladder.

§ The dermal rays of the Teleostomi differ from those of the Selachii in being more or less ossified; in order to retain their flexibility, they have become segmented. In the two subclasses the dermal rays occupy exactly the same position with regard to the muscles and the endoskeletal supports, and they appear to me to be unquestionably homologous throughout both groups. For another view, see Goodrich, Quart. Journ. Micr. Sci. xlvii. (1904) p. 464.

|| In the Teleostomi, in addition to the neural arches which are present in the Selachii, we find a series of paired elements which are the dorsal equivalents of the ribs. In the living Chondrostei and Dipneusti these supra-neurals are attached proximally to the neural plates (basi-dorsals) on each side of the longitudinal ligament, and they meet above to form the neural spines. The ribs in the Teleostomes appear not to be homologous with those of the Selachians; in the former group they lie internal to the muscles and bound the abdominal cavity, whilst in the latter they lie between the dorsal and ventral muscles, corresponding rather to the intermuscular bones of many true Fishes. That the Teleostome ribs

The relations of the principal groups may be diagrammatically expressed thus:—



The diagnostic features of the two series may be compared as follows:—

<i>Trematopnea.</i>	<i>Chasmatopnea.</i>
Gill-clefts opening directly to the exterior.	Gill-clefts opening into a chamber with a single external aperture.
Pterygo-quadrates distinct from the cranium.	Pterygo-quadrates fused with the cranium.

or infrahæmals are the ventral counterparts of the supraneurals is shown especially well in the Dipneusti, the ribs meeting in the caudal region to form hæmal spines, so that the ventral arches are exactly similar to the dorsal ones. In the Chondrostei infrahæmal elements are wanting in the posterior abdominal and caudal regions. In fishes with a bony vertebral column the presence of centra and the co-ossification of the neural and supraneural and in the caudal region of the hæmal and infrahæmal elements usually obscure the structure. I would, then, define the Selachians as having neural and hæmal arches only, and the Teleostomes as having not only neural and hæmal arches, but also supraneural and infrahæmal arches.

Thus in their essential features the Chasmatopnea are the more specialised, but on the other hand they are in some respects more primitive than any other living Selachians. Of the Trematopnea, the Pleuropterygii, Acanthodii, and Ichthyotomi are exclusively Palæozoic, whilst the Euselachii include all the living Sharks and Rays. These orders rest solely on what is known as to the structure of the paired fins, and our views as to their relationships are determined by our conception of the evolution of those organs, which must therefore be discussed.

The view which is here taken as to the origin and evolution of the paired fins in the Selachians is as follows:—

The median and paired fins were originally continuous and were supported by series of parallel cartilaginous rods—pterygiophores—set at right angles to the axis of the body. At the line of junction of fin and body each rod became segmented; thus we get a differentiation into basals—the proximal segments within the body, and radials—the distal segments. The radials often became subdivided, a series of short “marginal” segments being the most constant. Hypertrophy in certain regions and atrophy in others led to the establishment (at least in the Euselachii) of two dorsals, a caudal, an anal and paired pectoral and pelvic fins. In the pelvic fins concentration and fusion of the anterior basalia on each side led to the formation of a pelvis (except in the Pleuropterygii); in the Euselachii these united to form a single unpaired cartilage, and some or all of the remaining basalia fused to form a basipterygium. From their position of greater importance, evolution has proceeded further in the pectoral than in the pelvic fins; the cartilages formed by the fusion of the anterior basalia have grown out dorsally and ventrally to form the pectoral arch, and the normal course of evolution of the fin has been in the direction of shortening the base of attachment, thus permitting more varied movements in different planes. This shortening of the base has not been accomplished by a simple concentration and reduction of elements, as in the Teleostean Fishes, but by the outward rotation of the basipterygium, which has retained its anterior articulation to the pectoral arch, but posteriorly has separated from the body and has come to lie at the posterior (inner) edge rather than at the base of the fin. Evolution in this direction has proceeded furthest in the Ichthyotomi, in which the posterior radials have extended round on to the inner edge of the segmented basipterygium.

It is now nearly thirty years since Thacher and Balfour* independently put forward the theory that the median and paired fins were of similar origin, both being the remnants of originally continuous fins. The former based his view on the similar structure of the median and paired fins in the Selachians and the Chondrostean Fishes, whilst the latter came to his conclusions

* I am not overlooking the fact that Mivart also put forward this theory; but his memoir, although more elaborate than that of Thacher, is less complete. The researches of Dohrn, Mayer, Dean, and others have developed and extended this theory.

from a study of the development of Selachians. The memoirs of both authors were so complete and so lucidly written that no one who carefully studies them can come to any conclusion other than that the writers had proved their case, and that the theory of Gegenbaur, that the paired fins and their girdles were derived from posterior branchial arches and their rays, had been absolutely and finally disposed of.

However, this latter theory still continues to be put forward by the Gegenbaurian school, and most writers of text-books seem to consider it of equal importance with the Thacher-Balfour hypothesis. Some authors who accept the theory of the similar origin of the median and paired fins have shown themselves to be unacquainted with the facts of comparative anatomy and embryology on which it is based, and have consequently failed in the attempt to apply it to the elucidation of the relationships of the various groups of fishes, whilst the writer of a recent memoir (Kerr, No. 32) has so little understood Balfour's observations as to offer an absolutely impossible explanation of them.

Thacher examined the median and paired fins in a number of Selachian and Chondrosteian Fishes. According to him, in the former group the dorsal and anal fins are supported by a series of cartilaginous rods, each usually composed of 3 segments [which may be called basals (within the body-wall), radials (in the muscular lobe of the fin), and marginals (the distal segments)], sometimes of 2 only, sometimes of more. Concrecence of adjacent segments frequently occurs. Each cartilaginous rod has on each side a special muscle, separated from its fellows by the fibrous sheets which run from between the rods to the integument. Each muscle develops a flat tendon which lies parallel to the surface of the fin and inserts itself in the fascia covering the exterior of the cartilaginous rods and the proximal ends of the horny fibres.

Comparison of the dorsal and pelvic fins in *Mustelus canis* showed Thacher that they were closely similar. He found that in the pelvic fin the horny fibres, the muscles and their tendons, and the cartilaginous supports were of the same structure and stood in the same relation to each other as in the case of the dorsal fin. The difference consisted only in that the series of basal segments of the supporting cartilages in the dorsal fin remained separate, but were represented in the pelvic fin by 2 basal cartilages—a shorter anterior piece, the pelvis, united to its fellow in the median line, and a longer posterior piece, the basipterygium. He considered that the resemblance of the pelvic fin to the dorsal was at least as close as to the pectoral, and that the formation of pelvis and basipterygium was due to concrecence of the basal segments of the cartilaginous supports, a process of common occurrence in the unpaired fins.

In the more specialised pectoral fin the pectoral arch was compared to the pelvis, and the metapterygium to the basipterygium, whilst the propterygium and mesopterygium were

regarded as formed by concrescence of the proximal segments of the radials articulating with the pectoral arch.

The innervation of the paired fins in *Mustelus canis* was studied by Thacher, who found that the pectoral fin was innervated by branches of the first fifteen myelonal nerves. The posterior four (12-15) ran direct to the metapterygium and then divided into dorsal and ventral branches; the next four (8-11) formed a plexus, from which they emerged and then behaved in a similar manner to the ones behind them; the first seven united with each other and with a minute branch of the vagus to form a cord which passed through the foramen of the pectoral arch and then divided to form a dorsal and a ventral branch. In the pelvic fin a considerable number of nerves anterior to the fin took part in forming a cord which passed through the foramen of the pelvis, and posterior nerves ran to the basipterygium and bifurcated in the same way as the posterior nerves of the pectoral fin*.

In the Chondrostei the dermal fin-rays are more or less ossified and segmented; except for this, the median fins were found to be exactly similar to those of generalised Selachians, and the pelvic fins to be of a more primitive type than the Selachian pelvics, and to bear even a closer resemblance to the dorsal and anal fins, inasmuch as the posterior basals remained separate, and the pelvis, formed by the union of the anterior ones, did not meet its fellow of the other side.

Thacher's main results may be stated as follows:—In Selachii and Chondrostei both median and paired fins consist of dermal rays, muscles, and endoskeletal supports which are similar in structure and in relative position. The pectoral and pelvic girdles must have been formed by fusion and subsequent outgrowth of the anterior basalia. Both median and paired fins are to be regarded as derived from originally continuous fins, perhaps homologous with the median fin-folds and metapleural ridges of *Amphioxus*. The type of fin termed "archipterygium" by Gegenbaur must be secondary, and the suggested homology of limb-girdles with gill-arches cannot be seriously entertained.

Thacher must be held to have proved his case from the facts of comparative anatomy alone; but, even if it be granted that the extraordinary resemblances between median and paired fins might possibly have arisen in organs of dissimilar origin, the proofs of so improbable a hypothesis must be substantial. If they wish to be taken seriously, supporters of the theory of the dissimilar origin of median and paired fins must bring forward evidence to show that this similar structure is secondary; and if that be the case we should expect to find signs of it in their

* Whilst the Gegenbaurian school have explained the innervation of the pelvic fins as due to their migration, they have all ignored the similar innervation of the pectoral fin, which is absolutely inexplicable in terms of their hypothesis. Moreover, since forward migration of the pelvic fins in Teleostei has not led to their innervation by a number of spinal nerves belonging to the myotomes through which they have passed, why should such an effect have been produced by their backward migration?

development. But here we are met with the fact that Balfour independently arrived at the theory of the similar origin of median and paired fins from their similar development in Selachian fishes.

In the types which he studied, Balfour found that the median and paired fins first appeared as special developments of continuous ridges of columnar epiblast. In the case of the paired fins this ridge was a very transitory structure, connecting the fin-rudiments only at their first development, and disappearing before they became at all prominent. In the case of the unpaired fins the connecting ridge attained a somewhat greater development before disappearing. Balfour considered that these facts could only bear one interpretation, viz., that the limbs were the remnants of continuous lateral fins.

But Prof. Graham Kerr gathers from Balfour that this ridge connecting the paired fins does not occur in *Scyllium* (*Scylliorhinus*), and considers that we now know that it is confined to the Rays (Hypotremata), from which he infers that the continuity of the paired fins in the embryo may only be a foreshadowing of their extension along the sides of the body, which is so characteristic of this group.

Even if this ridge were confined to the Hypotremata, it must be evident that a very transitory structure, connecting the fin-rudiments only at their first development, can have no relation to the secondary extension of the pectoral fins in these Selachians. But Balfour leaves no doubt as to what were the forms in which he observed these phenomena. In the 'Monograph of the Development of Elasmobranch Fishes,' p. 97, a footnote says: "Unless the contrary is stated, the facts recorded in this chapter [Chapter VI.] apply only to the genera *Scyllium* and *Pristiurus*." After describing the early development of the fins, without reference to special genera, he notes that the connection of the paired fins is especially well shown in *Torpedo*. In his wonderful text-book of 'Comparative Embryology,' p. 610, we find: "For the remaining history it is necessary to confine ourselves to *Scyllium* as the only type which has been adequately studied. The direction of the original ridge which connects the two fins of each side is nearly, though not quite, longitudinal, etc., etc."

In Balfour's account of the subsequent development the chief interest attaches to the fin-skeleton. The principal points may be stated thus:—The supports of both median and paired fins are segmented from continuous laminae, the segmentation being to a great extent completed before the differentiation of the tissue as cartilage. In *Scyllium* the fin-skeleton of both pectoral and pelvic fins in its earliest stages consists of a bar parallel to the long axis of the body, the outer side of which is continued into a plate which extends into the fin and very early becomes segmented into a series of parallel rays at right

angles to the longitudinal bar, or basipterygium, which is continuous in front with the fin-girdle. Further changes in the pelvic fin consist chiefly in the segmentation of basipterygium from pelvis and of the radials from both. The pectoral arch develops as a vertical bar of cartilage at the front border of the rudimentary fin, and *externally to the muscle-plates**; the first part to be formed is that in the neighbourhood of the basipterygium, the dorsal and ventral prolongations being subsequent outgrowths. Changes similar to those described in the pelvic fin occur in the pectoral, but, in addition, the basipterygium (metapterygium) rotates outwards and comes to form the posterior border of the skeleton of the fin.

Balfour's conclusions are that the homology of the pectoral metapterygium with the pelvic basipterygium is established, and its primitive position is shown to be within the body-wall and parallel to the long axis of the body. The pelvic fin represents a stage in the evolution of the pectoral fin, and what Gegenbaur conceived to be the primitive axis of the biserial fin is demonstrated to be really the base, so that post-axial rays must be secondary. The mode of development of the fin-girdles is in favour of the hypothesis that they are outgrowths of the basipterygia, and the latter may well have been formed from the coalescence of the originally separate basal segments of the supporting cartilages, since in the median fins also these are segmented from continuous laminae. On the other hand, it is difficult to see how a limb formed on the type of the embryonic limb of Elasmobranchs could be derived from a visceral arch with its branchial rays.

The fact that the theory of the similar origin of the median and paired fins was put forward on the ground of their similar structure and development in the living Selachians and Chondrostean Fishes cannot be too strongly emphasised. To consider the Euselachii and Chondrostei as respectively derived from the Ichthyotomi and Crossopterygii, in which the paired fins are of a more specialised type, is to ignore the evidence on which the theory rests.

The order Pleuropterygii includes the Devonian *Cladoselachus*, which had broad-based paired fins, the pelvis without fusion of the basalia, the pectorals scarcely more advanced in structure †. *Cladodus* and *Symmorium*, of which only the pectoral fins are known, may be placed in this order provisionally, but are perhaps transitional to the Ichthyotomi and Euselachii. The anterior

* Balfour has evidently italicised this phrase, because he has shown elsewhere that the branchial bars are developed in the deeper parts of the mesoblast which constitutes the primitive branchial arches, and on the inner side of the section of the body-cavity primitively present in the arches.

† The strongly heterocercal caudal fin described by Dean shows that *Cladoselachus* was more or less pelagic, and lends no support to the view that the broad-based paired fins of this fish were a special adaptation to bottom living.

pectoral radials articulated to the pectoral arch are present, but there is no fusion of their proximal segments; the basipterygium is short and may be followed by a series of basalia*.

The Acanthodii comprise Palæozoic Selachians apparently related to the Pleuropterygii, but with a strong spine at the anterior edge of each of the fins. As in *Cladoselachus* mixopterygia do not seem to have been developed, a feature which distinguishes these two orders from the other Selachians. The Ichthyotomi differ from the Pleuropterygii in that the anterior pelvic basalia on each side have fused to form a pelvis, whilst the pectoral fins are of a highly specialised type, the basalia forming the segmented axis of a biserial fin and the anterior radials articulated to the pectoral arch having been lost. In the Euselachii the pelvis is a single unpaired piece; basipterygia are formed in both pectoral and pelvic fins, and in the former the proximal segments of the anterior radials have united to form two cartilages, the propterygium and mesopterygium. In the Holocephali the paired fins bear a considerable resemblance to those of the Euselachii, but the pelves remain separate, and the piece formed by the fusion of the anterior pectoral radials does not seem to be the homologue of either propterygium or mesopterygium.

The order Euselachii includes all the living Sharks and Rays and may be divided into two very natural and sharply defined suborders, which may be compared thus:—

<i>Pleuretremata.</i>	<i>Hypotremata.</i>
Eyes with free margins.	Superior margins of eyes not free.
Gill-openings lateral, the last in front of or above the base of the pectoral fin.	Gill-openings ventral, all below the base of the pectoral fin, which extends forward above them.
Anterior (propterygial) margin of pectoral fin free.	Anterior margin of pectoral fin joined to the side of the body or head,* the elongate propterygium lying at the base of the fin.
Pectoral radials typically simple and of few segments, usually only the anterior ones reaching the free edge of the fin.†	Pectoral radials numerous, multisegmented, distally bifurcated, all reaching the free edge of the fin.
Two halves of the pectoral arch well separated above (text-fig. 123, p. 754).	Suprascapular cartilages either united to the vertebral column or else above it.

* Some authors have placed *Cladodus* with the Ichthyotomi, a view not endorsed either by Cope or Boulenger. The structure of the pectoral is very similar to that of the pelvic fins of the Ichthyotomi or of *Hybodus*, as described by Campbell Brown.

† See exception in definition of the Lamnidae.

Pleurotremata (con.).

Cranium without cartilages attached to the olfactory capsules* (text-fig. 118, p. 742).

Pterygo-quadrate with a process (palato-basal process of Gegenbaur) which is articulated or attached by ligament to the cranium.

Hyomandibular and ceratohyal both bearing cartilaginous rays and supporting the first hemibranch; ceratohyal a single cartilage attached to the lower end of the hyomandibular (text-fig. 115, p. 734.)

Hypotremata (con.).

Paired præorbital cartilages, attached or articulated to the olfactory capsules, always present and well-developed (text-fig. 122, p. 753).

Pterygo-quadrate without palato-basal process, not attached or articulated to the cranium.

Hyomandibular purely suspensory, not bearing cartilaginous rays; first hemibranch supported only by the ceratohyal, which is segmented into 2 or 3 pieces and is either attached high up on the posterior edge of the hyomandibular or else is entirely separated from it.

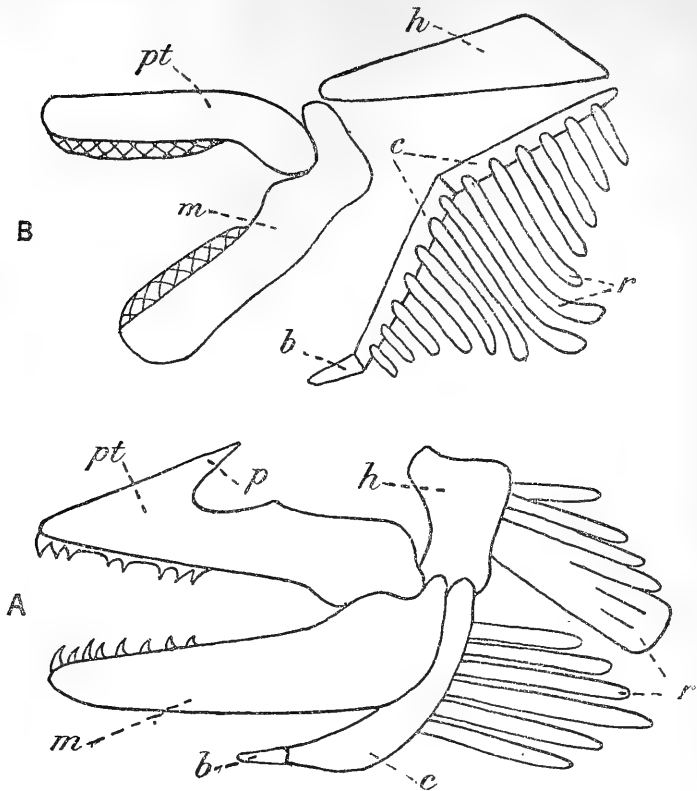
It would be difficult to imagine a group more natural or better defined by a number of anatomical peculiarities than the Hypotremata. The idea sometimes expressed that the ventral position of the gill-clefts is of little importance, and that *Pristiophorus* and *Squatina* would be almost as well placed among the Rays as with the Sharks, is founded on ignorance of the many and striking differences between the Sharks and the Rays.

Dr. Smith Woodward divides the Euselachii into two groups, to which he applies Hasse's terms Asterospondyli and Tectospondyli, the latter including the Rays and the Sharks without an anal fin. This is so far natural in that there can be no doubt that the loss of the anal fin in the Squalidæ indicates affinity to the Hypotremata, but it does not take into account the resemblances between the Cestraciontidæ and the Squalidæ or the differences between the latter and the Hypotremata.

Dr. Woodward has been influenced by the resemblance of *Pristiophorus* to *Pristis* and by the Ray-like features of *Squatina*. The Tectospondyli are also said to be characterised by the presence of large spiracles, even in the most specialised forms; but this does not hold good for pelagic Sharks of this group (e. g. *Somniosus*), and Ground-Sharks of the other (e. g. *Orectolobus*) have the spiracles as large as in the Rays. A supposed difference in the structure of the vertebral column is the remaining reason for the recognition of the Asterospondyli and Tectospondyli, the latter being defined as having the vertebræ, when fully developed, with the concentric calcified laminae predominating over the radiating laminae, and the former as having the radiating laminae predo-

* Paired processes of the præorbital margin of the ethmoidal region may be present, and in *Heptranchias* segment off as separate cartilages.

Text-fig. 115.



Mandibular and hyoid arches of a Pleurotreme (A) and a Hypotreme (B).

A. *Squatina angelus* (after Gegenbaur). B. *Raia clavata* (after Parker).

pt, pterygo-quadrate; *p*, palato-basal process; *m*, meckelian cartilage; *h*, hyo-mandibular; *c*, cerato-hyal; *b*, basi-hyal; *r*, cartilaginous branchiostegal rays.

minant. These terms have no practical application; both groups include types in which the secondary calcification of the vertebral centra has no laminar structure (e. g. *Rhynchobatus*, *Oxyrhina*), and others in which it is deposited as a series of concentric laminae (*Squatina*, *Cetorhinus*); also in both are forms in which the calcification presents a radiating pattern in cross section (e. g. *Narcine*, *Orectolobus*).

In order to arrive at a natural arrangement of the Euselachii I have studied at any rate the more important of the numerous memoirs dealing with their anatomy, and wherever possible, and

especially in the case of genera of doubtful position, I have endeavoured to confirm or to extend the observations which have been made by others. The endoskeleton of the Selachii may be conveniently considered under the heads: (1) the axial skeleton, or cranium and vertebral column; (2) the visceral skeleton, comprising the labial cartilages, jaws, and branchial arches; and (3) the pterygial skeleton, comprising the supports of the median and paired fins, including the pectoral and pelvic arches and the mixopterygia. Modifications in structure of these three systems are considered in the account which follows.

In all living Selachians the vertebral column is made up of the notochord and its cartilaginous sheath and of dorsal and ventral series of paired cartilages attached to the latter. These paired cartilages consist of principal pieces, neural plates (basi-dorsals) and hæmal plates (basi-ventrals), and of intercalary pieces alternating with these, the interneural and interhæmal plates. Centra may be formed by the segmentation of the cartilaginous notochordal sheath. The neural plates are typically broad at the base and narrowed above and vertebral in position, whilst the interneurals are correspondingly narrowed below and intervertebral in position. Both neurals and interneurals may meet in the middle line and unite above the spinal cord; or if the interneurals of one side are juxtaposed above the apices of the intervening neurals, then only the interneurals may so unite.

A median series of cartilages may sometimes apparently be segmented off from the united paired elements. The neurals and interneurals may not meet above, and in that case the roof of the neural canal may be completed by a longitudinal strip of cartilage, apparently of independent origin, usually, but not always, segmented*. Sometimes the incomplete union of neurals and interneurals leaves a series of interspaces, which are filled by a median series of cartilages †. The plates composing the neural and hæmal arches may each become secondarily segmented into two or more pieces ‡.

The hæmal plates correspond to the neurals and are vertebral in position, whilst the interhæmals are intervertebral. The latter are often reduced or absent, especially in the caudal region. In the præcaudal region the hæmals remain separate and may bear rib-like cartilages, which are intermuscular in position and probably not homologous with the ribs of Teleostomi. In the caudal region the hæmals unite below to form a complete hæmal arch, and a median series of cartilages may be segmented off. Primitively the neural and hæmal plates are loosely attached to the chordal sheath, but sometimes they become more intimately united with it, and

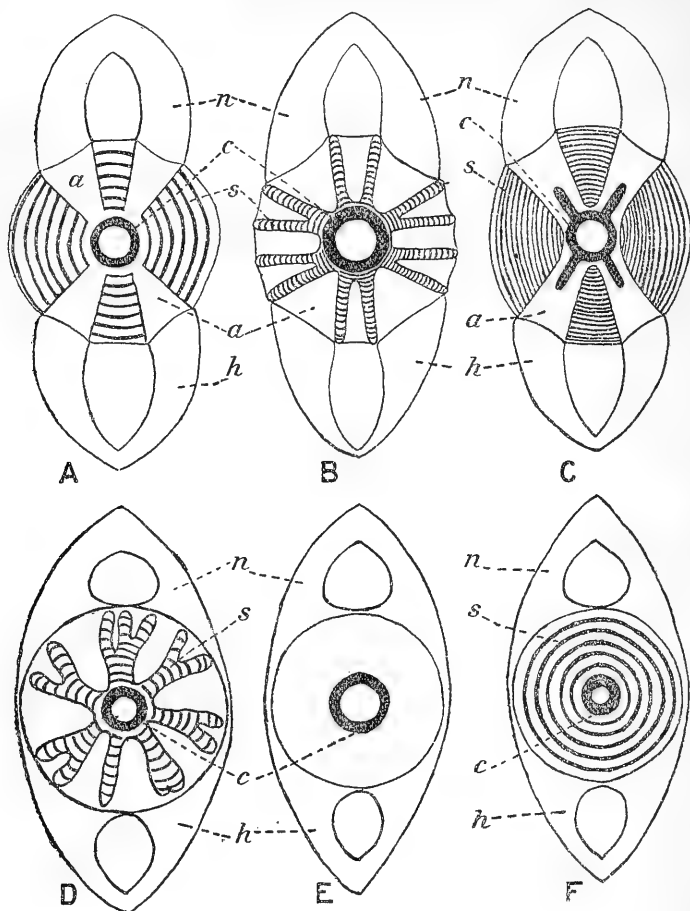
* In a young *Carcharias melanopterus* I find an unsegmented median longitudinal rod of cartilage completing the neural canal.

† The median cartilages of *Scyliorhinus* are probably not derived from the neural arches.

‡ Compare Hasse's plates of various Hypotremata and also Helbing's figures of *Læmargus borealis* and *L. rostratus*.

they may even grow round it and meet laterally, each neural uniting with the corresponding hæmal*.

Text-fig. 116.



Diagrammatic transverse sections of vertebræ of *Cetorhinus* (A), *Ginglymostoma* (B), *Galeocerdo* (C), *Narcine* (D), *Etmopterus* (E), and *Squatina* (F). (All after Hasse.)

n, neural arch; *h*, hæmal arch; *c*, calcified double cone; *s*, secondary calcification; *a*, principal uncalcified areas, radiating to the bases of the arches in A, B, and C.

* This extension of the neural and hæmal plates round the chordal sheath appears to be often inversely proportional to the secondary calcification of the centra. In nearly all the Galeoidei the calcifications extend throughout the centrum and the neural and hæmal arches do not extend downwards or upwards, but in *Pristiurus*, where the secondary calcification has disappeared, they meet round the centra.

The notochord may be unconstricted and its sheath unsegmented, as in the Holocephali and in the greater part of the vertebral column of *Chlamydoselachus*; or it may be constricted by an annular thickening of the cartilaginous sheath below the middle of each neural plate, but without the formation of a calcified ring and with imperfect segmentation, as in *Hexanchus*; or calcified rings may be formed in the chordal sheath, which usually take the form of double cones, so that the notochord is constricted vertebraally and expanded intervertebrally, whilst the centra are better defined and more completely separated. This type of centrum, with a calcified double cone and without further calcification, as in the Squalidæ, is termed "cyclospondylic" by Hasse (text-fig. 116, E).

Secondary calcification may be deposited round the central double cone either homogeneously or as a series of concentric lamellæ, and may form a complete and continuous investment, or may be broken up by uncalcified areas so as to present a radiating pattern in cross section. "Astero-spondylic" centra (text-fig. 116, A, B & C) may be defined as those in which the secondary calcification leaves four principal uncalcified areas radiating from the central double cone to the bases of the neural and hæmal arches, and are characteristic of the suborder Galeoidei, although in the Scyliorhinidæ a series of modifications set in which culminate in a complete reversion to the cyclospondylic type in the genera *Pristiurus* and *Pseudotriacis*.

"Tectospondylic" centra (text-fig. 116, D & F) are those with well-developed secondary calcifications not arranged on the astero-spondylic plan. Hasse has applied this term to the various types of centra found in the Batoidei, and in *Squatina* and *Pristiophorus*, and it is impossible to give any definition which will include these and exclude *Cestracion*. Probably also the so-called astero-spondylic centra of some Hybodonts would have to be included.

In the præcaudal region the vertebræ are as numerous as the myotomes, and the neural plate is typically either perforated or notched posteriorly for the exit of the ventral root of a spinal nerve, whilst the interneural is perforated or notched posteriorly for the exit of the dorsal root. In the greater part of the caudal region of all Plagiostomi the vertebræ are twice as numerous as the myotomes, and consequently every other pair of neurals and interneurals are not perforated or notched for nerve-exits. To this condition the name "diplospondylic" has been applied, and the condition which obtains in the caudal region of the Holocephali, where the vertebræ, as ascertained by the number of neurals and interneurals, are more than twice as numerous as the myotomes, as indicated by the nerve-exits, has been turned "polyspondylic" by Hasse.

The transition from monospondylic to diplospondylic myotomes may be abrupt, as in *Squalus*, or there may be an intermediate region. Thus in *Hepranchias*, as described by Mayer, the duplication of the arches precedes that of the centra, a number of these bearing two pairs of neurals and hæmals, so that every other pair of interneurals in this region corresponds to the middle of a

centrum. In *Mustelus*, according to the same author, the centra become more and more elongated in the posterior præcaudal region, and we pass from normal vertebræ to some in which the broader neural plates bear an extra median cartilage, which are followed by others with two extra median cartilages corresponding to the still broader neural plates; then follow the "half-vertebræ." In *Scyliorhinus*, as described by Ridewood, the transitional stages are (1) the broadening of the neural plate and introduction of an extra median cartilage, (2) the division of the centrum and of the neural and hæmal plates, (3) the intercalation of an extra inter-neural between two contiguous neurals.

Hasse considered polyspondyly to be the original condition, but it seems more probable that monospondyly is primitive and that diplospondyly and polyspondyly are secondary. Ridewood has suggested that the diplospondyly of the caudal myotomes of the *Euselachii* may be due to the need for greater flexibility in this region, and if we add to this the fact that the caudal myotomes are longer than those of the trunk*, we seem to have a basis for a possible explanation of this phenomenon.

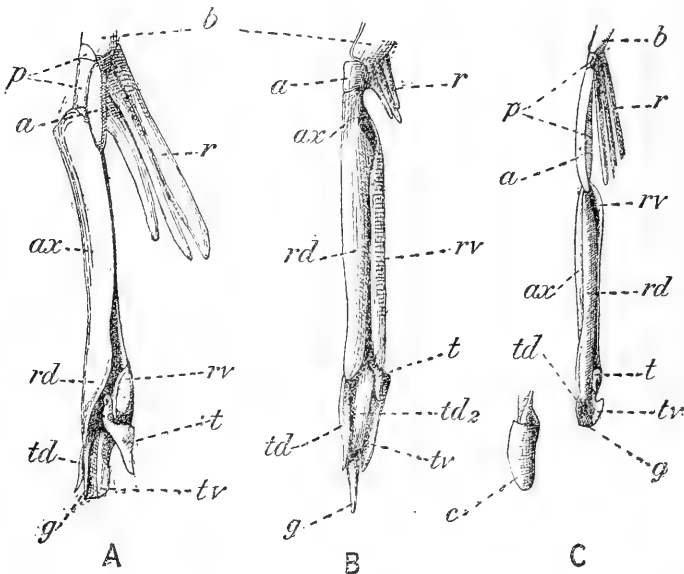
Some explanation of the structure of the mixopterygia (text-fig. 117) is necessary. These paired intromittent organs, which have been especially studied by Jungersen and Huber, are appendages of the pelvic fins, and are supported by a cartilaginous skeleton. A groove extending for the whole length of each appendage is the duct of a glandular sac at its base, which may or may not contain a special glandular body. In the *Euselachii* the skeleton of the appendage consists principally of an *axial cartilage*, either a prolongation of the basipterygium, or more probably the last radial, enlarged and modified. Proximally one to four short segments of the axial cartilage may be defined, and an *accessory cartilage*, which appears to be the displaced penultimate radial, is attached to these or to the axial cartilage proper. The groove of the appendage is bordered by a *dorsal* and a *ventral marginal cartilage*, which are united basally to the axial cartilage. Articulated to these distally are dorsal and ventral *terminal cartilages*, and a varying number of additional terminal pieces may be present, some of which may be spinous. Finally, one or more *covering pieces*, sheathing the terminals, may be present.

The contents of the glandular sac are driven by means of special muscles along the duct formed by the closing of the edges of the groove, and out through the aperture formed by the extension of the terminal pieces, which appear also to have the function, when extended, of retaining the organ in position. From the structure of the mixopterygia alone Huber has arranged the *Euselachii* in three groups—the first corresponding to the

* In a specimen of *Squalus acanthias* I find 4 anterior præcaudal vertebræ have the same length as 3 posterior præcaudals, 5 posterior præcaudals are equal in length to 8 anterior caudal "half-vertebræ," which again are as long as 6 "half-vertebræ" of the region behind the second dorsal fin; one of these last, in fact, is of the same size as one of the anterior trunk vertebræ, showing that the myotome is twice as long-

Notidanoidei and Squaloidei (except *Squatina*), the second to the Galeoidei, the third to the Hypotremata and *Squatina*. The last-named is admitted, however, to belong as much to the Squaloidei as to the Hypotremata. The Holocephali have mixopterygia which differ considerably from the Euselachian type.

Text-fig. 117.



Dorsal views of the skeleton of the mixopterygia of *Somniosus* (A), *Lamna* (B), and *Rhinobatus* (C). (All after Jungersen.) In C the covering piece has been removed, and is shown in a ventral view of the terminal part.

b, pelvic basiptyrgium; r, radials; a, accessory cartilage; p, proximal segments of axial cartilage; ax, axial cartilage proper; g, terminal portion of axial cartilage; rd, dorsal marginal cartilage; rv, ventral marginal cartilage; td, dorsal terminal piece; tv, ventral terminal piece; t and td₂, terminal pieces; c, covering piece.

The Euselachii are the only group which call for a detailed systematic account.

Order EUSELACHII.

Suborder 1. PLEUROTREMATA.

Division 1. NOTIDANOIDEI.

Six or seven gill-clefts on each side; a single dorsal fin, not preceded by a spine, opposite to the anal.

The Sharks of the two closely allied families which comprise this suborder show a combination of primitive and specialised

features, and form an isolated group without very close relationships to other Euselachii.

The gill-clefts retain their primitive position, as in the Lamnidæ and Squalidæ, the last being in front of the base of the pectorals. It is probable that their large number is a primitive feature, but the recent discovery of a *Pristiophorus* with six gill-clefts shows that the importance of this character has been overestimated. In this case, however, it is accompanied by a very generalised arrangement of the branchial skeleton.

The snout is supported by a simple anterior prolongation of the cranium.

In *Chlamydoselachus* the notochord is unconstricted, except anteriorly, where there are a few calcified rings. In *Hexanchus* the notochord is constricted by annular thickenings of the cartilaginous sheath, there being no calcification. In *Heptranchias* the notochord is constricted vertebally by a series of calcified rings, which assume more and more the form of a double cone towards the tail. In the caudal region, secondary calcification may give rise to four, six, or eight short rays, radiating from the central double cones.

The dorsal and anal fins have numerous pterygiophores, which in *Chlamydoselachus* are rather irregularly arranged and exhibit some fusion, especially basally. In *Heptranchias* the radials are regular and the basals of each fin are fused to form two large cartilages (text-fig. 120, B, p. 747).

The pectoral fin has a rather peculiar and quite unique structure. The propterygium is rather small, but broad, and distally forms a convex surface for the articulation of the mesopterygium, which it partly excludes from the pectoral arch. The mesopterygium is well-developed, and extends to the anterior edge of the fin distally to the propterygium. In *Chlamydoselachus* it is smaller than in *Hexanchus* and *Heptranchias*, and bears fewer radials than the metapterygium, which is composed of a long proximal and a short distal segment. In the Hexanchidæ the metapterygium consists of a very short proximal and a long distal segment; it bears about as many radials as the mesopterygium. The radials are simple and composed of from three to five segments (text-fig. 119, D, p. 743).

The mixopterygia are of the Squaloid type, the axial cartilage being cylindrical and pointed, the ventral marginal cartilage short and distal in position. It is evident that this is a more primitive structure than that of the Galeoid Sharks.

The Hexanchoidei resemble the Galeoidei in the absence of fin-spines. They resemble the Squaloidei in the structure of the cranium and of the mixopterygia. These features, which they have in common with the Sharks of the two other suborders, are undoubtedly primitive and indicate only the derivation of all three from the same stock. Their peculiar characters may be either primitive, as in the case of the vertebral column and the gill-clefts, or specialised, *i. e.* the absence of the first dorsal fin and the structure of the pectoral.

Family 1. CHLAMYDOSELACHIDÆ.

Body very elongate; mouth nearly terminal. Pterygo-quadrate not articulated to the cranium. Teeth with broad bases and with three slender erect subconical cusps.

The only representative of this family is the widely distributed *Chlamydoselachus anguineus*, the anatomy of which has been described by Dr. S. Garman.

Family 2. HEXANCHIDÆ.

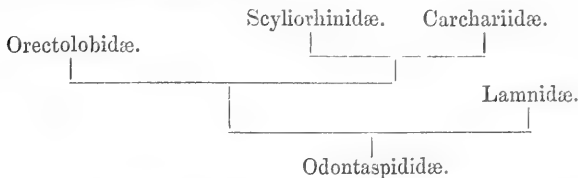
Body moderately elongate; mouth inferior. Pterygo-quadrate with postorbital articulation to the cranium. Teeth with elongate bases and with a series of compressed oblique cusps.

Teeth similar to those of the living *Hexanchus* and *Heptranchias* are found in Jurassic and Cretaceous strata. The cranium, visceral arches, and paired fins of the two genera of this family have been described by Gegenbaur, the vertebral column by Hasse and Mayer, the median fins by Mivart and Mayer.

Division 2. GALEOIDEI.

Five gill-clefts on each side; two dorsal fins, neither preceded by a spine; anal fin present.

The relationships of the five families which comprise this sub-order may be expressed thus:—

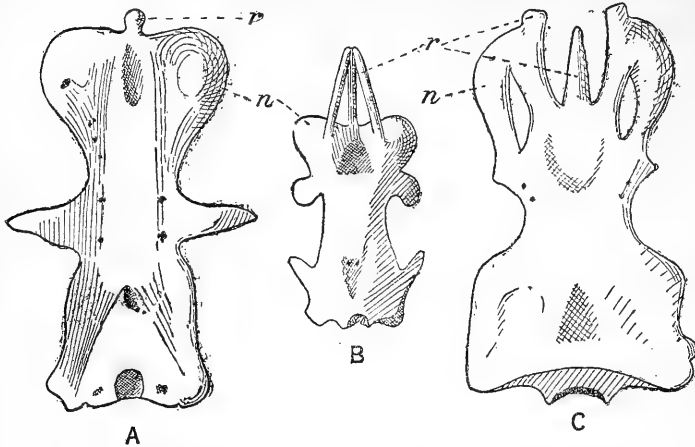


In the Odontaspididæ and Lamnidæ the last gill-cleft is in front of or vertically above the origin of the pectoral fin, whilst in the other families it is above the base of that fin. The Carchariidæ are remarkable for the development of a nictitating membrane, and the Orectolobidæ for the presence of a pair of oro-nasal grooves.

The pterygo-quadrate is not articulated to the cranium, which in the typical forms is easily distinguished from that of other Sharks by the structure and arrangement of the rostral cartilages. These are three rods, of which the lower median one, an anterior prolongation of the basis cranii, is directed obliquely upwards, whilst the two upper ones, arising from the walls of the olfactory capsules, converge inwards, the three nearly or quite meeting anteriorly (text-fig. 118, B, p. 742). This arrangement is constant throughout the Odontaspididæ, Lamnidæ, Scyliorhinidæ, and Carchariidæ. In the Orectolobidæ, all of which have a very short and broad snout,

the three rods may be present, but short and not convergent anteriorly, or they may be entirely absent (text-fig. 118, C).

Text-fig. 118.



Crania of *Scymnorhinus* (A), *Carcharias* (B), and *Orectolobus* (C), seen from above. (A and B after Gegenbaur, C after Haswell.)

r, rostrum; n, nasal capsules.

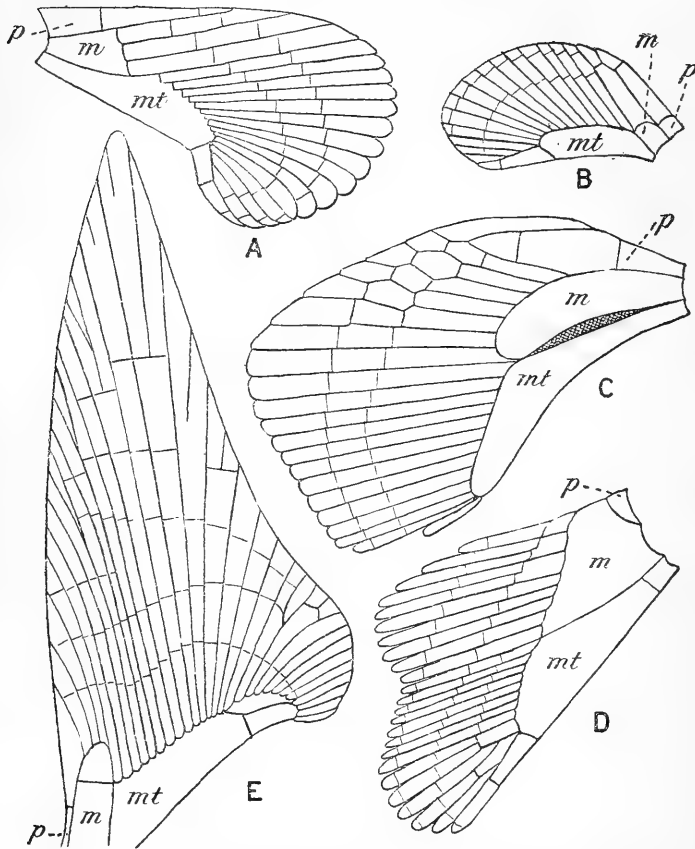
The calcification of the vertebral centra, although subject to considerable modifications within the group, is nevertheless of great importance in determining the relationships of the families. The primary calcifications take the form of a series of double cones which constrict the notochord vertebally. In the Odontaspididae, Lamnidæ, and most Orectolobidae, the secondary calcifications, usually deposited as concentric laminae, radiate from these to the periphery in such a way as to leave four principal uncalcified areas running from the central double cone to the bases of the neural and hæmal arches (text-fig. 116, A, B & C, p. 736). In *Chiloscyllium* and in the Scyliorhinidae and Carchariidae, modifications of this arrangement result from a tendency for these calcifications to start, not from the central double cone, but from points nearer the periphery. In the Carchariidae and Scyliorhinidae, there may be developed four calcified rays, running from the central double cone into the four principal uncalcified areas above mentioned (text-fig. 116, C). The extreme of specialisation is reached in the Scyliorhinid genera *Pristiurus* and *Pseudotriacis*, in which the secondary calcification is represented only by a thin peripheral layer.

The dorsal and anal fins have their cartilaginous supports typically well-developed, numerous and regularly arranged, with little tendency to fusion (text-fig. 120, A, p. 747).

The pectoral fin in the Odontaspididae, Lamnidæ, Scyliorhinidae, and Carchariidae has perhaps a more primitive structure than in

any other Euselachii. The propterygium excludes the mesopterygium from the margin of the fin. The mesopterygium is small and articulates directly with the pectoral arch, and most of the radials are attached to the metapterygium. In the Odontaspididæ the radials are simple, of moderate length and of comparatively few segments. In the Lamnidæ (text-fig. 119, E) they

Text-fig. 119.



Skeleton of the pectoral fin of *Mustelus* (A), *Pristiurus* (B), *Orectolobus* (C), *Heptanchias* (D), and *Carcharodon* (E). (A after Thacher, B and D after Gegenbaur, C and E after Haswell).

p, propterygium; *m*, mesopterygium; *mt*, metapterygium.

are composed of several segments, and extend to the free edge of the fin; they show a tendency to bifurcate, whilst short distal intercalated cartilages are developed, recalling the structure of the pectoral fin in *Cladoselachus*. In the Scyliorhinidæ and Carcha-

riidæ each radial consists usually of three segments, the proximal being longer than the middle ones. In the former family (text-fig. 119, B, p. 743) the distal segments are short, in the latter (text-fig. 119, A) they are more or less elongate. The *Orectolobidæ* have a more specialised type of fin (text-fig. 119, C), which bears considerable resemblance to that of the *Squalidæ*. The propterygium is usually small or absent, and the mesopterygium is enlarged and expanded distally; it is more or less similar to the metapterygium, from which it is almost completely separated by an oval foramen, and bears about the same number of radials, each of which is simple and formed of three or more segments.

The *micopterygia* (text-fig. 117, B, p. 739) have a very uniform and special structure throughout the suborder. The axial cartilage is dorso-ventrally flattened; it is usually only partly separated from the basipterygium by a single small proximal segment; the accessory cartilage is small, rounded, oval or oblong in shape. The dorsal and ventral marginal cartilages are elongate and extend to the proximal end of the axial cartilage; their free edges are approximated and, in the *Scyliorhinidæ*, may even coalesce. The terminal cartilages vary somewhat in number. The glandular sac contains no special glandular body.

Family 1. ODONTASPIDIDÆ.

No nictitating membrane; no oro-nasal grooves; last gill-cleft in front of the base of pectoral*. Rostral cartilages convergent anteriorly. Vertebral centra with secondary calcifications extending from the central double cones to the periphery, leaving four principal uncalcified areas radiating to the bases of the neural and hæmal arches. Pectoral fin with small propterygium and mesopterygium; radials mostly attached to the metapterygium of moderate length.

The genera *Odontaspis* and *Scapanorhynchus*, which comprise this family, date from the Cretaceous. They may be distinguished from the *Lamnidæ* by the subequal dorsal fins. I have examined a centrum of *Odontaspis*, which presents exactly the same appearance in transverse section as that of *Orectolobus*, described by Hasse.

Family 2. LAMNIDÆ.

Closely allied to the *Odontaspididæ*, differing as follows:—Last gill-opening, if small, vertically above the origin of the pectoral fin, if wide extending downwards in front of the base of the pectoral. Pectoral radials long, extending to the free edge of the fin.

Large pelagic Sharks, with spiracles minute or absent, pectoral fins falcate and caudal strongly heterocercal. The second dorsal fin much smaller than the first and opposite to the anal. Most of the existing genera appear to date from the Cretaceous.

* In a stuffed specimen of *Scapanorhynchus oustoni* the last gill-opening appears to be anterior to the pectoral fin.

Family 3. ORECTOLOBIDÆ.

Allied to the Odontaspididæ, but distinguished by several features of specialisation. Oro-nasal grooves present; last two to four gill-openings above the base of the pectoral. Rostral cartilages, if present, short and not convergent. Pectoral mesopterygium enlarged and expanded distally, more or less similar to the metapterygium; an oval foramen between the mesopterygium and metapterygium.

Examination of a stuffed specimen of the large *Rhinodon typicus* leaves no doubt that it is closely related to *Ginglymostoma*, from which genus it differs only in those features in which it resembles the Basking Shark, *Cetorhinus maximus*, *i. e.* the small teeth, long gill-rakers, wide gill-clefts, &c., which are obviously of physiological rather than phylogenetic importance.

Probably the Mesozoic *Palæoscyllium* and *Cantioscyllium* should be placed in this family, all the members of which have the dorsal fins placed posteriorly, the first not or scarcely in advance of the ventrals.

Family 4. SCYLIORHINIDÆ.

No nictitating membrane; no oro-nasal grooves; last one or two gill-clefts above the base of the pectoral. Rostral cartilages convergent anteriorly. Vertebral centra with secondary calcifications as in the preceding families or variously degenerated; when complete, with four short calcified rays extending from the central double cones into each of the principal uncalcified areas. Pectoral fin with small propterygium and mesopterygium; radials of moderate length, mostly attached to the metapterygium, of 3 segments. Mixopterygia with the edges of the marginal cartilages united, forming a tube.

Scyliorhinus and *Pristiurus* comprise Dog-fishes of small or moderate size, either littoral or inhabitants of the deep sea. The latter appears to date from the Jurassic, the former from the Cretaceous. The spiracles are well-developed, the first dorsal is above or behind the ventrals, and the caudal is very feebly heterocercal.

I have examined a spirit-specimen of the rare *Pseudotriacis microdon*, which agrees with *Pristiurus* in general form, in the shape and position of the mouth, structure and position of the nostrils and spiracles, in the presence of a fold of skin below the horizontally elongated eye, in the position of the last gill-cleft and the shape of the caudal and paired fins. I have examined one of the caudal vertebræ, in which, as in *Pristiurus*, the secondary calcification is reduced to a thin peripheral layer. From other Scyliorhinidæ, *Pseudotriacis* is distinguished by the longer and more anteriorly placed dorsal fin.

The Cretaceous and Eocene *Mesiteia* may belong to this family.

Family 5. CARCHARIIDÆ.

A nictitating membrane; no oro-nasal grooves; last one or two gill-clefts above the base of the pectoral. Rostral cartilages convergent anteriorly. Vertebral centra with secondary calcifications, starting near the central double cones and extending to the periphery, forming four principal calcified areas (in the shape of a Maltese cross), between which four uncalcified areas radiate to the bases of the neural and hæmal arches; from the central double cones four calcified rays extend a greater or less distance into the uncalcified areas. Pectoral fin with small propterygium and mesopterygium, most of the radials being attached to the metapterygium; radials usually formed of three segments. Mixopterygia with the free edges of the marginal cartilages not coalescent.

The first dorsal is usually in advance of the ventrals, rarely (*Triænodon*) partly above them. The spiracles are small or absent. The caudal fin is strongly heterocercal in the pelagic genera, but not in the others. The family appears to date from the Eocene and there are no extinct genera. The Hammer-headed Sharks (*Sphyrna*) perhaps deserve to rank as a subfamily (*Sphyrninae*).

Division 3. SQUALOIDEI.

Five or six gill-clefts on each side; two dorsal fins; in the living forms each dorsal fin preceded by a spine *or* the anal fin absent.

The reasons which induce me to include the Cestraciontidae and their extinct allies in the same suborder as the Squalidae are especially derived from the structure of the median and paired fins and of the mixopterygia, which affords sufficient evidence of the close relationship of these Sharks. Each of the families defined below possesses certain features of specialisation and, with the exception of the Squatinidae, which are modified Squalidae, must be regarded as having evolved along divergent lines from the same ancestral stock, which the Squalidae, although the anal fin is absent, resemble perhaps more than the Cestraciontidae.

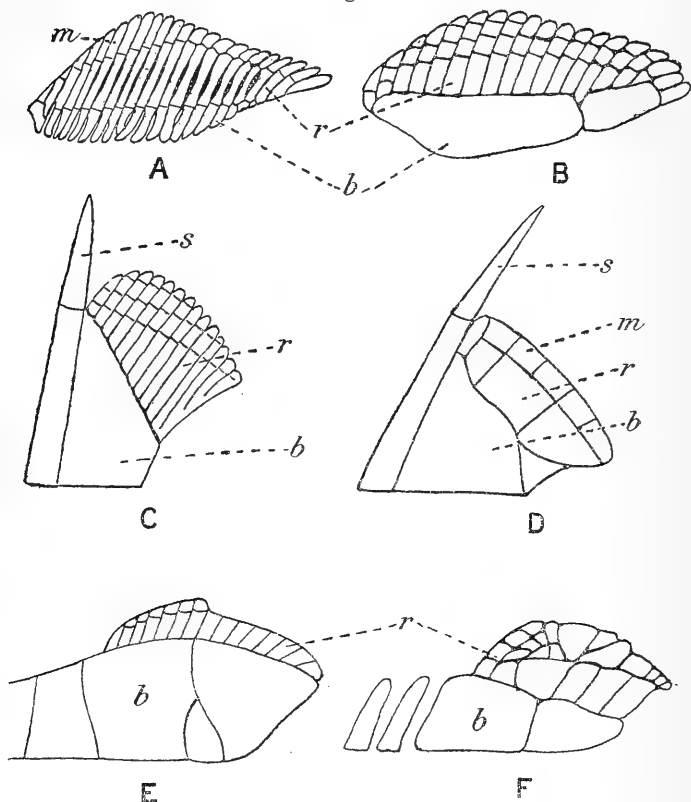
The rostrum is typically a simple prolongation of the anterior wall of the cranium (text-fig. 118, A, p. 742), and never has the form characteristic of the Galeoidei. The pterygo-quadrate is either not articulated to the cranium (Squalidae, Squatinidae), or it may have acquired a præorbital (Cestraciontidae) or postorbital (Hybodontidae) articulation.

In the Squalidae, Squatinidae, and Cestraciontidae, the primary calcifications of the vertebral column are in the form of double cones which constrict the notochord vertebally. In the first family secondary calcification is absent, except in *Pristiophorus*, which has a calcified ring external to and separated from the central double cone. In *Squatina* a series of concentric calcified laminae surrounds the central double cone. In the Cestraciontidae

the secondary calcification forms a series of radiating ridges, which do not appear to reach the periphery and are directed without relation to the neural and hæmal arches. The vertebral column seems to have been uncalcified in the Orodontidæ, Cochliodontidæ, and Hybodontinæ. According to Smith Woodward, the vertebræ in *Palæospinax* were "cyclospondylic, sometimes feebly asterospondylic," and in *Synechodus* "distinctly asterospondylic."

In the Hybodontidæ and Cestraciontidæ, most Squalidæ, and at any rate some Cochliodontidæ, each dorsal fin is preceded by a

Text-fig. 120.



Skeleton of the dorsal fin of *Mustelus* (A), *Heptanchias* (B), *Cestracion* (C), *Squalus* (D), *Pristiophorus* (E), and *Squatina* (F). (A after Thacher, B and F after Mayer, E after Mivart.)

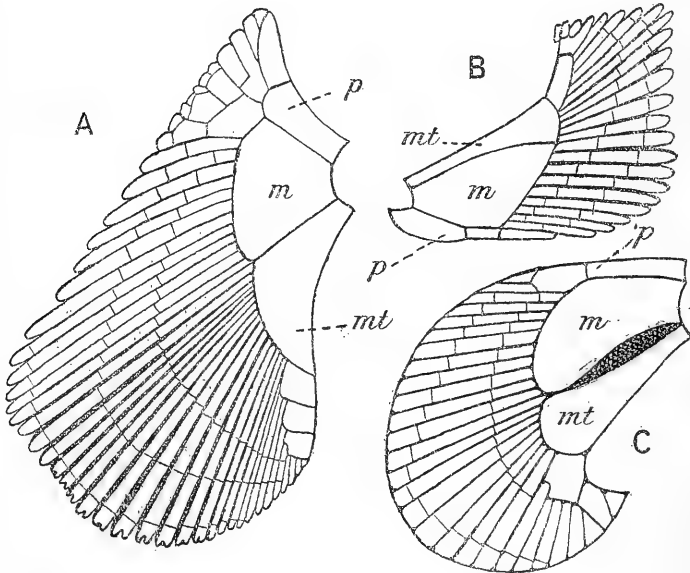
s, spine; b, basals; r, radials; m, marginals.

spine. There can be no question as to the homology of the dorsal fin-spines in the Cestraciontidæ and Squalidæ, since they

are exactly similar in structure and position, and pierce the skin in the same manner. Each spine is pointed and more or less cylindrical, and is hollow and implanted on a process of a large basal cartilage which supports all or most of the series of radials. This cartilage is deep proximally and has the upper edge oblique; it may be triangular or four-sided, but with the posterior edge much shorter than the anterior one. A precisely similar arrangement has been found in *Hybodus*. When the spine becomes rudimentary or is entirely lost, this characteristic arrangement of the cartilages may be slightly modified (text-fig. 120, C, D, E & F, p. 747).

The cartilaginous supports of the pectoral fin (text-fig. 121) have typically the following arrangement:—The propterygium bears a single radial and excludes the mesopterygium from the edge of the fin. The mesopterygium is well-developed; it is narrowed

Text-fig. 121.



Skeleton of the pectoral fin of *Squatina* (A), *Squalus* (B), and *Pliotrema* (C).
(B after Gegenbaur.)

p, propterygium; *m*, mesopterygium; *mt*, metapterygium.

proximally, where it articulates direct with the pectoral arch, and expanded distally, bearing a considerable number of radials. The metapterygium is usually similar to the mesopterygium and bears about as many radials. The radials are simple and mostly formed of 3 segments (*Squalidæ*) or 4 (*Squatinaidæ*) or several (*Cestraciontidæ*).

This type of fin is found in *Squalus*, *Pristiophorus*, and *Hybodus*. Modifications arise from the fusion of pro- and meso-pterygia (*Cestracion*), or of meso- and meta-pterygia (*Centrophorus*), or of all three (*Scymnorhinus*), and also from fusion of the proximal segments of the mesopterygial radials (*Cestracion*). The pectoral fin in *Squatina* is very similar to that of *Squalus*, but the propterygium is directed forward and bears several radials.

The mixopterygia (text-fig. 117, A, p. 739) present certain constant characteristics. The axial cartilage is cylindrical and distally pointed; it is separated from the basipterygium by one, two, or three proximal segments; the accessory cartilage, when present, retains the form of a radial with but little modification. Usually the ventral marginal cartilage is confined to the distal part of the appendage, but sometimes (*e. g.* in *Scymnorhinus*) it extends nearly to the proximal end of the axial cartilage. The glandular sac contains no special glandular body, except in *Squatina*, which is peculiar also in that a ventral covering piece is developed.

Family 1. COCHLIODONTIDÆ.

Carboniferous Sharks in which "at least one of the transverse series of teeth encircling each ramus of the jaw is fused into a continuous curved plate." Dorsal fin-spines often present; vertebral column uncalcified and probably acentrous.

Family 2. HYBODONTIDÆ.

Body not depressed; five gill-clefts on each side. Each dorsal fin preceded by a spine; anal fin present; pectorals normally shaped. Teeth all separate. Pterygo-quadrate with a well-developed postorbital articulation with the cranium.

Palæozoic and Mesozoic Sharks which may be grouped into two subfamilies:—

- A. *Hybodontinae*. Fin-spines with longitudinal ridges or series of tubercles; vertebral column uncalcified and probably acentrous.

This subfamily perhaps includes two groups which cannot, at present, be properly defined. The Permian and Carboniferous *Orodus*, *Campodus*, etc. are, according to Eastman, characterised by the presence of a single enlarged series of symphyseal teeth, presumably belonging to the lower jaw. The Mesozoic *Hybodus*, *Acrodus*, and *Asteracanthus* form a very natural group; the males have paired postorbital cephalic spines. The lateral teeth are elongate and the symphyseal teeth few and large (in comparison with *Cestracion*). From *Hybodus*, with conical or cuspidate teeth, we pass to *Acrodus*, with rounded non-cuspidate teeth, and thence to *Asteracanthus*, with flattened quadrate teeth. Extraordinarily well-preserved remains of *Hybodus* have been described by Campbell Brown. They show the postorbital articulation of the pterygo-quadrate and the structure of the median and paired fins. The

cartilages of the dorsal fin are very similar to those of the existing Cestraciontidae and Squalidae. The pelvic fin is remarkable for its primitive structure, only 6 basalia being fused to form a basiptyergium, the posterior 8 being distinct. If Campbell Brown's interpretation of the pectoral fin be accepted, its structure is quite unlike that of any known Shark. I am convinced, however, that he has mistaken the proptyergium for the metapteryergium and *vice versa*, and that the fin is in reality almost exactly similar to that of *Squalus* or *Pristiophorus*.

B. *Palaeospinacinae*. Dorsal fin-spines smooth. No cephalic spines. Vertebral column with calcified centra.

The Triassic and Cretaceous genera *Palaeospinax* and *Synechodus* have a dentition not unlike that of *Hybodus*, to which they are evidently related. The postorbital articulation of the pterygoquadrate has been described in *Synechodus* by Smith Woodward.

Family 3. CESTRACIONTIDÆ.

Body not depressed; five gill-clefts on each side, the posterior ones above the base of the pectoral fin. Paired oro-nasal grooves present. Each dorsal fin preceded by a spine; anal fin present; pectorals normally shaped. Pterygoquadrate with præorbital articulation to the cranium, the palato-basal process being broad and greatly developed. Vertebral centra calcified.

The genus *Cestracion*, ranging from the Jurassic to the present day, may be regarded as allied to the *Hybodontidae* in so far as both have been derived from a common ancestor with a generalised dentition and without articulation of the pterygoquadrate to the cranium. The resemblance of the lateral teeth to those of *Acerodus* most certainly does not indicate any special relationship to that genus, which is clearly a modified *Hybodus*.

Family 4. SQUALIDÆ.

Body not depressed. Five or six gill-clefts on each side, the last in front of the base of the pectoral, which is normally shaped. No oro-nasal grooves. Each dorsal fin often preceded by a spine; no anal fin. Teeth small or moderate, sometimes conical or cuspidate, often compressed. Pterygoquadrate not articulated to the cranium. Vertebral centra calcified.

Of the *Squalinae*, *Squalus* and *Centrophorus* appear to date from the Cretaceous.

Some authors would place the genera with normal snout and without apparent dorsal fin-spines in a distinct family, but it must be borne in mind that the recent researches of Helbing have shown that rudimentary spines are present. Moreover, in some species of *Centroscymnus* the spines are very small and do not even pierce the skin.

Jaekel has described the anatomy of *Pristiophorus* in detail and

has shown that it is closely related to *Squalus*. The anatomy of *Pristis* has been described by Gegenbaur and agrees in all essential features with that of *Rhinobatus*. In spite of these researches the writers of modern text-books still seem to believe in some special relationship between these two genera, which resemble each other to a certain extent in the appearance of the saw-like rostrum, but differ so widely in other respects.

Family 5. SQUATINIDÆ.

Body depressed. Five gill-clefts on each side, the last in front of the base of the pectoral, which is produced forward external to the gill-clefts, this anterior extension being free from the body. Dorsal fins without spines, situated on the tail; anal fin wanting. Teeth subconical, pointed. Pterygo-quadrates not articulated to the cranium. Vertebral centra calcified.

The remarkable genus *Squatina*, dating from Jurassic and Cretaceous times, is unquestionably related to the Squalidæ. It has been regarded as a connecting-link between the Sharks and Rays, but in the strongly depressed form of the body and the backward shifting of the dorsal fins it has gone further than the more primitive of the true Batoids, yet without modification of pterygo-quadrates, hyomandibular, hyoid or pectoral arch from the Squaloid type. The gill-clefts are lateral in position and crowded together. The arrangement of the cartilages of the pectoral fin is far more similar to that found in the Squalidæ than to that of the Batoids. The cartilaginous supports of the dorsal fin are arranged as in the Squalidæ. The paired præorbital cartilages typical of the Batoidei are absent.

In favour of Batoid relationships may be cited the calcification of the vertebral column, which is rather similar to that of the Rhinobatidæ, and the structure of the mixopterygia, which, although extremely similar to those of *Squalus*, present two features characteristic of the Batoids, viz. the development of a ventral covering piece and the presence of a special glandular body in the glandular sac.

To sum up then:—In all essential characters, *i. e.* position of the gill-clefts, structure of pterygo-quadrates, hyomandibular, hyoid and pectoral arch, arrangement of the cartilaginous supports of the pectoral fin, *Squatina* is a typical *Squaloid*. In these and other features it shows specially close relationship to the Squalidæ. The depressed body, the extension forward of the pectoral fins, and the backward position of the dorsal fins are Ray-like features of specialisation which do not, however, appear to indicate Batoid relationships. Finally, the structure of the vertebral column and the mixopterygia point to real affinity to the Hypotremata, and we must infer that both they and *Squatina* have evolved from Sharks similar to the Squalidæ, but in which probably the vertebral column and the mixopterygia had already attained a structure somewhat similar to that found in *Squatina*.

Suborder 2. HYPOTREMATA.

In addition to the features enumerated above which distinguish the members of this suborder from the Pleurotremata, we may note others which are common to all the members of the group.

The body is depressed. There are 5 pairs of gill-openings. The dorsal fins, if present, are not preceded by spines and are placed more or less posteriorly, the first never in advance of the pelvics; the anal fin is wanting. The elongate propterygium is directed forwards and may be divided into several segments; it bears a considerable number of radials; the backwardly directed metapterygium is similar to the propterygium; the comparatively small mesopterygium bears relatively few rays; increase in length of the region of articulation may or may not be accompanied by a corresponding elongation of the mesopterygium. In the former case (*Rhinobatidæ*, *Raiidæ*) one or more radials become distinctly attached to the pectoral arch between mesopterygium and metapterygium; in the latter (*Dasybatidæ*) the mesopterygium may segment into two or three pieces*.

The mixopterygia (text-fig. 117, C, p. 739) show the following peculiarities:—The axial cartilage ends in a rather broad, flat process with a rounded edge; it is separated from the basiptyrgium by from two to four proximal segments. The accessory cartilage (wanting in *Narcine*) is radial-like, but more or less flattened; proximally it is attached to the first axial segment and distally to the axial cartilage proper. One or more covering pieces are developed and there is a special glandular body in the glandular sac.

Division 1. NARCOBATOIDEI.

Paired electric organs between the pectoral fins and the head. Rostral cartilages paired or branched. Præorbital cartilages greatly expanded, reticulated or branched, extending forwards to the anterior margin of the snout, articulated on each side proximally to a process of the upper or anterior wall of the nasal capsule and distally to the anterior end of the propterygium (text-fig. 122, B). Suprascapulæ united above the vertebral column (text-fig. 123, A, p. 754).

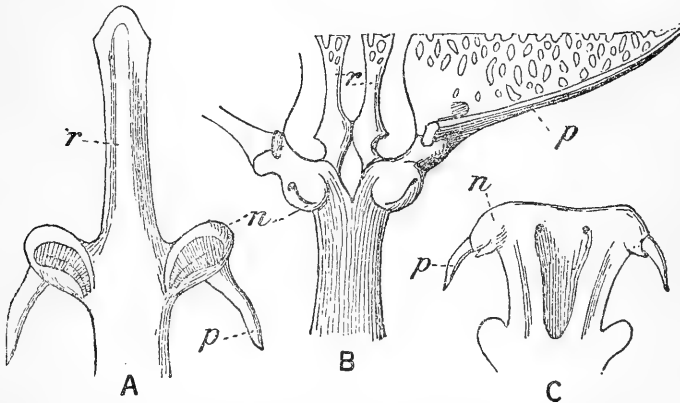
Family TORPEDINIDÆ.

Dorsal fins two, one or none, if present situated on the tail; caudal fin present; pelvics not notched. Basalia of the dorsal fin in small number (3); radials in moderate number (8), simple, of moderate length, not nearly extending to the free edge of the fin. None of the radials of the pectoral fin directly attached to the

* Comparison of the pectoral cartilages in *Dasybatis* and *Myliobatis* convinces me that this is the true explanation of the structure of the latter. Gegenbaur considered that the posterior segments were formed by the fusion of proximal segments of radials which had become attached to the pectoral arch.

pectoral arch. Mixopterygia with two proximal axial segments, with the marginal cartilages rather short and distal in position, with three terminal pieces and a large ventral covering piece, and with the glandular body extending nearly to the distal end of the appendage. Vertebral centra with secondary calcifications deposited either continuously or as concentric laminae, forming ridges which show various patterns in cross section*.

Text-fig. 122.



Anterior part of cranium of *Rhynchobatus* (A), *Torpedo* (B), and *Dasybatis* (C). (A and B seen from below, after Gegenbaur; C seen from above, after Haswell.)

r, rostrum; n, nasal capsules; p, præorbital cartilages.

The head and trunk, with the pectoral fins, form a smooth subcircular disc, and the tail is rather short and stout, with a longitudinal fold on each side.

Division 2. BATOIDEI.

No electric organs between the pectoral fins and the head. Rostrum, if developed, simple, unpaired. Præorbital cartilages simple, short or of moderate length, not extending forwards, attached on each side to the lateral or posterior wall of the nasal capsule (text-fig. 122, A & C). Suprascapulæ united to the vertebral column † (text-fig. 123, C, p. 754).

* The forms figured by Hasse in some cases bear a considerable resemblance to the Lamnidæ, in others to the Cestraciontidæ.

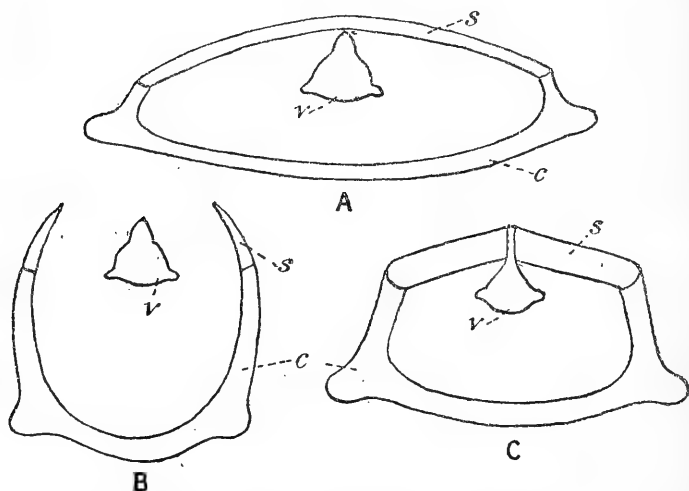
† According to Gegenbaur, who has been followed in this matter by other anatomists, there is no separate suprascapula in these fishes, but a cartilaginous expansion of the fused neural arches, to which the pectoral arch is on each side either simply attached (*Rhinobatidæ*, *Raiidæ*) or articulated by means of a ball-and-socket joint (*Dasybatidæ*).

Dissection of several genera has convinced me that this view is erroneous. The neural arches in this region form a ridge to which the suprascapular cartilages are firmly united, the line of junction in all cases remaining quite visible. Although different enough from the *Narcobatoid* type, the distinction is not so marked as has been supposed.

Family 1. RHINOBATIDÆ.

Dorsal fins two; caudal fin present; pectorals of varying extent; pelvics not notched. Basalia of the dorsal fin in small number (2 only supporting the radials of the fin); radials rather numerous, simple, short or of moderate length, not nearly extending to the free edge of the fin. One or more of the radials of the pectoral fin often articulated directly to the pectoral arch between mesopterygium and metapterygium. Mixopterygia with 3 or 4 proximal axial segments, with the marginal cartilages long and extending to the proximal end of the axial cartilage (in *Rhinobatus*), with three terminal pieces and a large ventral covering piece, and with the glandular body extending nearly to the distal end of the appendage. Vertebral column with the secondary calcification either homogeneous or lamellar in structure, complete or forming 8 rays—a dorsal, a ventral, 2 lateral, and the others between them.

Text-fig. 123.



Diagrams illustrating the relations of pectoral arch and vertebral column in the Narcobatoidei (A), Pleurotremata (B), and Batoidei (C).

v, vertebral column; c, coraco-scapular cartilage; s, suprascapula.

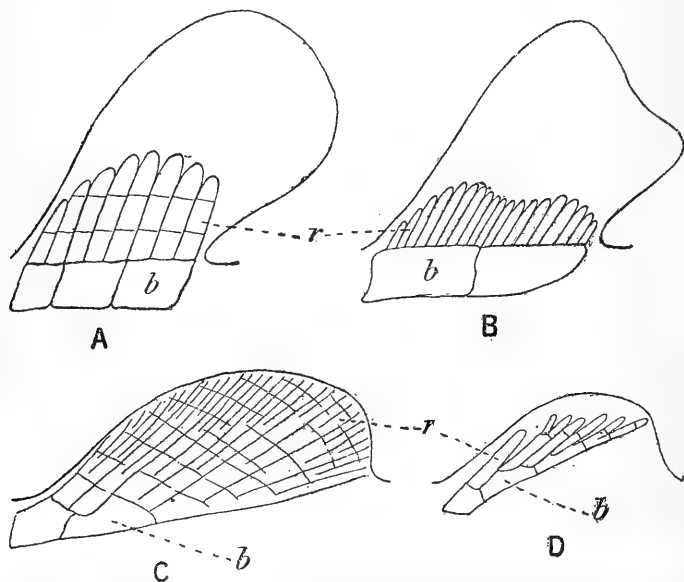
In the *Pristinæ* the produced rostrum is armed on each side with a series of teeth and the pectoral fins do not reach the præorbital cartilages. The extinct *Sclerorhynchus* occurs in the Cretaceous and *Pristis* dates from the Eocene. In the *Rhinobatinæ* the snout is not armed with teeth and the præorbital cartilages articulate with the propterygia. *Rhinobatus* of the present day had several representatives in Jurassic and Cretaceous times. The remarkable Jurassic genus *Astrodermus* should apparently be placed here.

In all the members of this family the teeth are small and obtuse. There is a more or less distinct longitudinal fold on each side of the tail. The differences in the shape of the body and the development of the pectoral fins are considerable, but from anatomical considerations there can be no question that we are here dealing with a very natural group. *Discobatus*, in which the pectoral fins extend as far forward as in *Raia*, resembles *Rhinobatus* in the arrangement of the cartilages of the dorsal fin and in the shape of the ventrals, and should not be placed in the *Raiidæ*. The number of radials directly attached to the pectoral arch varies from none in *Sclerorhynchus* and one in *Pristis* to eight in *Trygonorhina*.

Family 2. RAIIDÆ.

Præorbital cartilages articulated to the propterygia. Usually two small dorsal fins near the extremity of the tail; caudal fin

Text-fig. 124.



Skeleton of the dorsal fin of *Torpedo* (A), *Rhinobatus* (B), *Myliobatis* (C), and *Psammobatis* (D).

b, basals; *r*, radials.

small or absent; pectorals extending to the snout, sometimes confluent anteriorly; pelvis notched. Basalia of the dorsal fin directed obliquely upwards and backwards, anteriorly imbedded in the body, elsewhere connected by a membrane to the back of the tail; radialia nearly reaching the free edge of the fin, some

of them branched. Some of the radials of the pectoral fin articulated directly to the pectoral arch between mesopterygium and metapterygium. Mixopterygia with 2 proximal axial segments, with the marginal cartilages long, the dorsal one extending nearly to the proximal end of the axial cartilage and the ventral one not quite so far, with 5 or 6 terminal pieces and 1 to 3 dorsal covering pieces, and with the glandular body restricted to the glandular sac proper. Vertebral column with the secondary calcification much as in the preceding family, but with dorsal and ventral rays most developed.

Principal genera: *Raia*, *Psammobatis*, *Sympterygia*. The former dates from the Cretaceous; the Cretaceous genus *Cyclobatis* is allied to *Sympterygia**.

The Raiidæ are clearly modified from Rhinobatidæ of the type of *Rhinobatus*, to which they bear a considerable resemblance. In the dentition and in the presence of two longitudinal folds on the side of the tail similar to the preceding family, but in the greater development of the pectorals and the degeneration of the vertical fins of a more specialised type. *Psammobatis* is peculiar in lacking a rostral prolongation of the cranium.

Family 3. DASYBATIDÆ.

Præorbital cartilages articulated to the propterygia. Dorsal fin absent or else a single small fin situated near the root of the tail; caudal fin present or not; pectoral fins extending to the extremity of the snout; pelvics not notched. Often one or more strong serrated spines on the tail, behind the dorsal fin if this be present. Basalia of the dorsal fin more deeply imbedded anteriorly than posteriorly; radials branched, extending to the free edge of the fin. Pectoral mesopterygium extending the whole of the distance between propterygium and metapterygium, sometimes segmented into 2 or 3 pieces. Mixopterygia with 2 proximal axial segments, with marginal cartilages of moderate length and distal in position, with 2 terminal pieces and 1 or 2 ventral covering pieces, and with the glandular body extending nearly to the distal end of the appendage. Vertebral column with secondary calcification much as in the Rhinobatidæ.

Several of the recent genera as well as the extinct *Xiphotrygon* occur in the Eocene. The Cretaceous *Ptychodus* appears to be intermediate between *Dasybatis* and *Myliobatis*.

The lateral tail-folds characteristic of the preceding families are usually absent, but vertical folds may be developed. A cartilaginous rostrum is absent. Dissection of a specimen of *Myliobatis aquila* shows that the generally accepted idea that the pectoral fins are interrupted, leaving the sides of the head free and reappearing at the extremity of the snout, is erroneous. The propterygia have exactly the same form and extent as in *Dasybatis*

* In *Sympterygia* the pelvis has well-developed præpubic processes, as in *Cyclobatis*. In the latter the enlarged anterior pelvic radial has been mistaken for a lateral process of the pelvis.

and bear well-developed radialis throughout. For *Myliobatis* and the allied genera it may then be stated that the pectoral fins are continuous, but are very muscular and have the anterior edge emarginate. Gegenbaur's dissection of the pectoral fin in this species shows a radial attached to the pectoral arch between the first and second segments of the mesopterygium; this is not the case in my specimen.

The mixopterygia of *Dasybatis*, *Tæniura* and *Myliobatis* have been described by Huber, who has shown that they are extremely similar throughout.

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Gegenbaur has described the cranium and visceral arches (14), the pectoral arch and fin (13), and the pelvic fins (15) in a number of types. This work has been supplemented by Haswell (6); whilst other authors have described the skeleton of isolated genera—*i. e.*, *Chlamydoselachus* (16), *Pristiophorus* (17), *Scapanorhynchus* or *Mitsukurina* (18), *Somniosus* (19).

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

NOTICE.

The 'Proceedings' for the year are issued in *four* parts, forming two volumes, as follows:—

- Papers read in January and February; in June.
- " " March and April, in August.
- " " May and June, in October.
- " " November and December, in April.

'Proceedings,' 1906, pp. 179-462, were published on August 23rd, 1906.

**The Abstracts of the papers read at the Scientific Meetings in
May and June are contained in this Part.**



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OF THE

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November 13, 1906.

HOWARD SAUNDERS, Esq., Vice-President,
in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie in June, July, August, and September, 1906 :—

The registered additions to the Society's Menagerie during the month of June were 366 in number. Of these 125 were acquired by presentation and 36 by purchase, 161 were received on deposit, 24 by exchange, and 20 were born in the Gardens. The total number of departures during the same period, by death and removals, was 192.

Amongst the additions special attention may be directed to :—

A Collection of Indian Animals presented by H.R.H. The Prince of Wales, K.G., on June 9th, amongst which may be mentioned an Indian Elephant, an Indian Rhinoceros, 3 Tigers, 2 Leopards, 2 Himalayan Bears, 2 Nylghai, 5 Indian Antelopes, 2 Albino Barking-Deer, and 2 Swamp-Deer.

A fine pair of Siberian Tigers from Vladivostock, presented by H.G. the Duke of Bedford, K.G., President of the Society, on June 11th. This is the first occasion on which this fine race of Tiger has been exhibited in the Society's Gardens.

A young male Banteng (*Bos sondaicus*), received in exchange on June 9th.

The registered additions to the Society's Menagerie during the month of July were 393 in number. Of these 249 were acquired by presentation and 22 by purchase, 66 were received on deposit, 2 by exchange, and 54 were born in the Gardens. The total number of departures during the same period, by death and removals, was 188.

Amongst the additions special attention may be directed to :—

A Collection of 81 South-American Birds, including three Violet-tailed Humming-birds (*Lampornis violicauda*), an Ænone Humming-bird (*Chrysuronia ænone*), new to the Collection, a Sun-Bittern (*Eurypyga helias*), as well as representatives of many other interesting species, presented by Capt. Albert Pam, F.Z.S., on July 3rd.

Twenty-four birds, including four Great Saltators (*Saltator magnus*) and two Red-breasted Guiana Marsh-birds (*Leistes guianensis*), from British Guiana, presented by Mr. E. W. Harper, F.Z.S., on July 14th.

A Japanese Bear (*Ursus japonicus*) and a White-whiskered Boar (*Sus leucomystax*) from Japan, presented by Mr. Frederick Ringer on July 17th.

Thirteen birds, including a Levaillant's Parrot (*Psecephalus robustus*), a White-necked Crow (*Corvus scapularis*), a White-

bellied Amethyst Starling (*Pholidauges leucogaster*), from Senegambia, presented by Dr. E. Hopkinson, D.S.O., F.Z.S., on July 20th.

An African Rhinoceros (*Rhinoceros bicornis*), and two Grant's Zebras (*Equus granti*), deposited on July 24th.

The registered additions to the Society's Menagerie during the month of August were 298 in number. Of these 104 were acquired by presentation and 11 by purchase, 96 were received on deposit, 66 by exchange, and 21 were born in the Gardens. The total number of departures during the same period, by death and removals, was 136.

Among the additions special attention may be directed to :—

A female Dusky Gelada (*Theropithecus obscurus*) from Abyssinia, new to the Collection, presented by the Hon. George Savile on August 16th.

A Collection of 53 South-African Birds, including many species new to the Menagerie, amongst which a Two-banded Courser (*Rhinoptilus africanus*), and a Lesser Red-shouldered Glossy Starling (*Lamprocolius phaenicopterus bispecularis*) are of special interest, presented by Capt. Horsbrugh, F.Z.S., on August 7th.

The registered additions to the Society's Menagerie during the month of September were 211 in number. Of these 92 were acquired by presentation and 9 by purchase, 74 were received on deposit, 6 by exchange, and 30 were born in the Gardens. The total number of departures during the same period, by death and removals, was 319.

Among the additions special attention may be directed to :—

A specimen of Hamlyn's Mangabey (*Cercocebus hamlyni*) from the Upper Congo, new to the Collection, deposited on Sept. 18th.

A specimen of Chapman's Squirrel (*Sciurus chapmani*) from Trinidad, new to the Collection, presented on Sept. 22nd by Mr. A. Giuseppi.

A specimen of a new local race of the Serow (*Capricornis sumatrensis*) from Selangore, new to the Collection, presented on Sept. 13th by the Government of Selangore.

A specimen of the Chilian Mocking-bird (*Mimus thenca*) from Chile, new to the Collection, deposited on Sept. 28th.

Dr. P. L. Sclater, F.R.S., read some extracts from a letter of Capt. P. H. G. Powell-Cotton, F.Z.S., about the Okapi (*Okapia johnstoni*), published in 'The Times' of Sept. 27th, 1906, and made the following remarks :—

In his very interesting letter to 'The Times' on the Okapi, Capt. Powell-Cotton states that he fancies "there must be some misunderstanding as to Dr. David having himself hunted the Okapi in its native wilds." To this I reply that Dr. David certainly *claims* to have performed this feat, as I have already

stated to this Society (see P. Z. S. 1904, vol. ii. p. 180). In his letter published in the 'Basler Nachrichten' of May 22nd, 1904 (of which I produce a copy), Dr. David distinctly says—"Also, Ende November schoss ich (als erster Weisser) eine *Okapia*." Why the statement of Capt. Powell-Cotton's native hunter (who alleges that *he* shot the specimens sent home by Dr. David) should be preferred to that of a European scientific man, I cannot understand. The stories of native Africans on such subjects are not always reliable.

I may add that I have examined most of the accessible specimens of the Okapi as yet received in Europe, including the very fine male example recently mounted by Mr. Rowland Ward, and am strongly of opinion that there are no sufficient grounds for considering that there is more than one species of Okapi (*Okapia johnstoni*). The *O. liebrechtsi* of Major* and *O. erikssoni* of Lankester† are, I believe, based upon individual variations.

Mr. Arthur Dicksee exhibited a strange variety of the cock Golden Pheasant (*Thaumalea picta*) that he himself had bred in 1905, the colouring of which was about half way between the normal colour of the first and second moults, with the exception of the fact that the back was a most brilliant scarlet. Mr. Dicksee considered this to be a case of arrested development and believed that the bird would come correctly to colour at the next moult.

Mr. Horace C. Beck, F.Z.S., exhibited a skull of a Capybara (*Hydrochaerus capybara*) in which the first premolar of the left side of the lower jaw had overgrown in such a way as to chamfer off the corresponding edge in the upper jaw, and also to cut away a considerable portion of the bone. The lower tooth was extremely loose in its socket, but this may have been caused by the pushing-out effect of the two chamfered edges of the teeth. The whole skull showed considerable signs of disease. Perforations were present through the outer lamina of the ramus into the cavity of the last molar on each side, and several of the other teeth showed signs of decay.

Prof. E. A. Minchin, F.Z.S., exhibited some diagrams of Trypanosomes from Tsetse-flies and made remarks on the dissemination of diseases by these insects.

The following papers were read:—

* P. Z. S. 1902, vol. ii. pp. 72, 343.

† Trans. Z. S. vol. xvi. p. 279; Ann. & Mag. N. H. x. (ser. 7) p. 417; P. Z. S. 1903, vol. ii. p. 338.

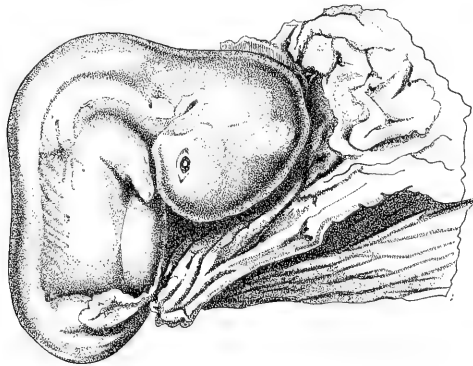
1. On the Embryo of the Okapi.
By Prof. R. BURCKHARDT, C.M.Z.S.

[Received July 9, 1906.]

(Text-figure 125.)

Dr. I. David* on his last expedition shot two Okapis in the forests of Semliki. In one, which was a female, he examined the uterus, and was fortunate enough to find an embryo, which he removed and preserved in spirit. He brought this rare specimen to me, his former teacher in embryology, with the wish that I should give a description of it. Unfortunately, the object is in an early stage and not in good enough preservation for sections to be made. I can therefore only give the accompanying sketch showing the outlines and some details of its external features.

Text-fig. 125.



Embryo of Okapi, probably about one month old. $\times 3$.

The embryo corresponds to that of the Pig, fig. 26 of Keibel's 'Normentafeln zur Entwicklungsgeschichte' (i.), or of a Deer (Sakurai, *ibidem*, vi. fig. 31), or of a Sheep of about one month (R. Bonnet, *Grundr. Entwicklungsgesch. Haussäugetiere*, fig. 68). So it is likely that it is not less than one month old, but as we do not know if it may persist at the same stage for a certain time like that of the Sheep, we cannot determine whether it is some weeks older. It is a single one, as in the Giraffe, which also produces only one at a birth. The sketch gives the Okapi embryo from the right side enlarged 3 times, together with a part of the egg-membranes. The head, in comparison with that of a human embryo of the same stage, is rather small. In it may be distinguished the eye with the pigmented choroid, the lens and the primitive eyelid-walls. Behind the head the ear is to be seen,

* See Sclater, P. Z. S. 1904, vol. ii. p. 180.

which shows already a membranous and somewhat pointed³ fold directed backwards, the future *concha*. Between the prominence produced by the liver and the abdomen in general on the one side and the snout on the other, appears the fore-leg bent downwards. On the surface of the abdomen slight traces of 8 or 9 ribs may be observed. The hind-leg is not very clear, as parts of the membranes have dried with it. The tail is rather long and disappears in the membranes. Three characters may be pointed out as especially unguulate:—1, the small size of the head; 2, the length of the fore-leg, which distinguishes also sheep and deer from pig embryos of the same stage; 3, the length of the tail.

I am obliged not only to Dr. I. David, but also to Prof. F. Keibel, who kindly verified my statements.

2. List of further Collections of Mammals from Western Australia, including a series from Bernier Island, obtained for Mr. W. E. Balston; with Field-notes by the Collector, Mr. G. C. Shortridge. By OLDFIELD THOMAS, F.R.S.

[Received August 18, 1906.]

In the March number of the 'Proceedings'* I gave a list of a number of mammals obtained in S.W. Australia by Mr. G. C. Shortridge, who had been commissioned for the purpose by Mr. W. E. Balston, by whom a complete series has been presented to our National Museum.

In making his first collection Mr. Shortridge had been disappointed at the rarity or absence of many of the species supposed to be common and characteristic of Western Australia. Fortunately, however, in making the second collection he hit on a region where the fauna still persists in its original state, and he has therefore been able to send home a remarkably fine series of a number of species hitherto only represented by faded old specimens of the Gould & Gilbert era, or by the one or two examples picked up as great rarities in regions where the native animals have been more nearly killed out.

The places now visited were four in number—Stockpool, Dwaladine, and Woyaline, respectively some twenty to thirty miles to the east of Burnley, Brookton, and Pinjelly, stations south of York on the Perth-Albany railway-line, and Dale River, a similar distance to the west of the line. These localities are all in the upper part of the watershed of the River Avon, in the county of the same name, about 117° E. and between 30° and 31° S.

Finally, Mr. Shortridge paid a visit to Bernier Island, off

* P. Z. S. 1906, p. 460.

Shark's Bay, a locality interesting for many reasons, and the specimens obtained there are included in an appendix to the present paper.

The series of specimens amounts to about 400, a number indicative of a vast amount of energy and hard work on the part of Mr. Shortridge and of the friend who accompanied him, Mr. John W. Bell.

Mr. Shortridge's field-notes on the species occupy the greater part of the present paper, and are of much value as putting on record the status of each animal at the present time. Every species obtained in either the first or second collection is mentioned, as the field-notes apply to both; but the record of the specimens sent only refers to the second collection, a list of the first having been already published.

One novelty only from the mainland now needs description, a Rat allied to *Mus lineolatus* of Eastern Australia. Two of the Bernier Island specimens also require new names.

It may be noted that before Mr. Shortridge's expedition only two Bats, *Nyctophilus timoriensis* and *Vespertilio pumilus*, were recognised as occurring in Western Australia. This number is now raised to ten by the capture there of *Pipistrellus tasmaniensis*, *Chalinolobus gouldi* and *morio*, and *Nyctinomus australis* and *planiceps*, by the discovery of *Pipistrellus regulus* and *Scoteinus balstoni*, and by the recognition of *Nyctophilus geoffroyi* as a valid species.

1. NYCTOPHILUS TIMORIENSIS Geoff.

2. NYCTOPHILUS GEOFFROYI Leach.

3. VESPERTILIO PUMILUS Gray.

7 specimens from Dwaladine, Woyaline, and Dale River.

4. PIPISTRELLUS REGULUS Thos.

5. PIPISTRELLUS TASMANIENSIS Gould.

♂. 503. Dwaladine.

6. CHALINOLOBUS GOULDI Gray.

11 specimens from Dwaladine and Dale River.

"Very plentiful in the districts between Beverley and Kalgurli, extending as far eastward as Laverton, where it is not quite so common.

"Native name, 'Tarding' (applicable to all bats)." — *G. C. S.*

7. CHALINOLOBUS MORIO Gray.

♂. 479. Dwaladine.

8. SCOTEINUS BALSTONI Thos.

9. NYCTINOMUS AUSTRALIS Gray.

10. NYCTINOMUS PLANICEPS Peters.

Nyctinomus wilcoxi Krefft; *N. petersi* Leche.

12 from Dwaladine and Dale River.

"The specimens obtained were always flying over water."—*G. C. S.*

This Bat is an addition to the West Australian list, all previous examples having come from the south and east.

It differs by its flattened head from *N. norfolcensis* Gray, to which Dobson assigned it. He stated at the same time that Gray's species had six lower incisors, but this is not the case in any of these small Australasian *Nyctinomi*, as I have proved by the examination of a considerable number of specimens, including Gray's type of *norfolcensis*, a typical example of *wilcoxi*, and a co-type of *petersi*.

11. CANIS DINGO Blum.

"Apparently occurring throughout the South-west, but very much thinned out in the farming districts on account of their being very destructive to stock.

"Native names, 'Yarging,' 'Dwert.'"—*G. C. S.*

12. HYDROMYS FULIGINOSUS Gould.

3 from Dale River.

"Very plentiful throughout the South-west, near rivers and swamps, not extending very far inland. It seems to feed to a large extent on freshwater crayfish and shell-fish, the former when used as a bait being very successful.

"Native name, 'Wamp wamp.'"—*G. C. S.*

The increase in the length of the hind feet with age is well exemplified by these Dale River specimens, No. 194 having the feet only 59 mm., while in No. 198, an old male, they are no less than 72 mm. in length.

13. MUS RATTUS L.

"Plentiful around Albany, where it seems to be the common house-rat. I did not obtain any specimens of *Mus norvegicus* in the district."—*G. C. S.*

14. MUS FUSCIPES Waterh.

"A water-rat, frequenting the banks of rivers and reedy swamps; plentiful around Albany."—*G. C. S.*

15. MUS SHORTRIDGEI, sp. n.

♂. 542. Woyaline, east of Pinjelly, 970', 27 April, 1906. B.M. No. 6.8.1.73. *Type*.

"Trapped near water."—*G. C. S.*

Size rather smaller than in *Mus lineolatus*, about three-fourths that of *Mus rattus*. Fur long, soft and loose; ordinary hairs of back about 17, longer hairs about 22 mm. in length. General

colour above pale hair-brown with a tinge of buffy, the lining from the dark tips of the longer hairs well-marked. Individually the ordinary hairs are dark slaty for three-fourths their length, their ends dull clay-colour. Under surface similar to upper, but rather paler, without lines of demarcation. Ears of medium length, their proectote black, their metentote grizzled blackish, their edges with a well-defined white rim. Upper surface of hands and feet dull greyish white. Tail rather short, well-haired, the scales quite hidden; dark brown above, dull white below.

Skull with many of the essential characters of that of *M. lineolatus*, but smaller, the supraorbital margins more sharply angular, the front edge of the zygomatic plate less deeply concave, the palatal foramen much shorter, and the bullæ smaller. The palatal foramina are narrowly pointed behind, and barely project between the front of the roots of m^1 . Mesopterygoid fossa broadly open, the palatal edge well in front of the anterior end of the parapterygoid fossæ.

Molars constructed as in *M. lineolatus*, but narrower, though broader than in *M. higginsii*.

Dimensions of the type, measured in the flesh:—

Head and body 145 mm.; tail 110; hind foot 27; ear 20.

Skull—greatest length 32 mm.; basilar length 26; greatest breadth 17.2; nasals 11.5×3.7 ; interorbital breadth 4.2; breadth of brain-case 14.4; palatilar length 14.6; palatal foramina 7×2 ; length of upper molar series 5.7; breadth of m^1 2.

Hab. & type as above.

This Rat, which I have much pleasure in naming after its captor, belongs to the peculiar Australian group of which *Mus lineolatus* Gould, of New South Wales, and *M. higginsii* Trouessart (*M. leucopus* Higg. & Pett.), of Tasmania, have hitherto been the only known members. Within the group the Tasmanian species is at once distinguished from both the Australian forms by its very long tail and narrow molars, while the new western species may be separated from its eastern ally by its rather smaller size, paler colour, and by the cranial characters above noted, of which the most tangible are the narrowness of the molars and the shorter palatal foramina.

16. *MUS ALBOCINEREUS* Gould.

22 from Stockpool and Dwaladine.

“Frequenting sand plains; plentiful east of Beverley. Their burrows differ from those of *Notomys gouldi* by having sand thrown up around them; they also often seem to fill up the entrance of these burrows when inside—when they are very difficult to detect.”—*G. C. S.*

17. *MUS MUSCULUS* L.

5 from various localities.

“The common House-Mouse, besides swarming in all the

inhabited districts, seems also to have adapted itself to an entirely out-door life here. I have come across it in every place that I have visited in the South-west, in some places at least twenty miles from any house."—*G. C. S.*

18. NOTOMYS GOULDI Gould.

20 from Stockpool, Dwaladine, and Woyaline.

This fine series is of particular value, as these peculiar native Muridæ seem to be dying out everywhere in competition with the introduced forms, and the preservation of proper specimens is therefore of much importance.

This is the *Hapalotis mitchelli* of Gould's 'Mammals of Australia,' but not the original *Dipus mitchelli* of Ogilby. Finding out the mistake when writing the Introduction, Gould said: "*H. gouldii* of Gray will be the correct designation of the animal I have called *H. mitchelli*." But unfortunately *H. gouldii* was never described by Gray, its description having been accidentally omitted from the Appendix to Grey's 'Australia,' where the name merely occurs as a *nomen nudum*. Consequently, on the above sentence, the species seems to stand as *gouldii* of Gould himself, and the specimen figured by him as *H. mitchelli*, recently received with the Tomes Collection (B.M. No. 7.1.1.135), would be the type.

I may here draw the attention of Australian zoologists to the fact that the genus I recently called *Ammonomys* has been renamed *Mesembriomys* by Mr. T. S. Palmer, the former name having been preoccupied.

"The burrows of this species are very difficult to find, the entrances being very small and often hidden by tufts of grass. Each burrow has two or more outlets which descend perpendicularly for some distance and then wind about in all directions, sometimes nearly three feet below the surface. Each burrow contains one pair or family, the usual number of young being four, but occasionally as many as six. Frequenting heavily timbered country and seeming to prefer the neighbourhood of water. This species is said to be migratory, their movements probably being affected by dry seasons.

"Native name, 'Gunding.'"—*G. C. S.*

[ORYCTOLAGUS CUNICULUS Linn.

"The Rabbit has so far been kept out of the agricultural districts of the South-west by a rabbit-proof fence that passes through Burracoppin on the Eastern railway, extending to Israelite Bay on the south. It seems to have spread everywhere east of the fence."—*G. C. S.*]

19. MACROPUS GIGANTEUS Zimm.

13 specimens from Stockpool, Dwaladine, and Woyaline.

"The common or grey Kangaroo of the south-west, not

extending very far inland, and replaced in the interior by *Macropus rufus*.

“Native names, ‘Yongure’ ♂, ‘Woyre’ ♀.”—*G. C. S.*

20. *MACROPUS RUFUS* Desm.

“Occurring in the South-west—from the west of Southern Cross throughout the Interior, evidently not so dependent on water as *M. giganteus*. The females, which are normally blue, are not infrequently of the same sandy-red colour as the males.

“Native name, ‘Bigoder.’”—*G. C. S.*

21. *MACROPUS IRMA* Jourd.

14 specimens from Stockpool, Dwaladine, Woyaline, and Dale River.

“Generally distributed over the South-west. Not gregarious like the smaller wallabies; more resembling the larger kangaroos in habits. When hunted with dogs they are very swift and can turn and double with great agility.

“Brush Kangaroo of Colonists, ‘Quoirer’ of natives.”—*G. C. S.*

22. *MACROPUS EUGENEI* Desm.

19 specimens from Stockpool, Dwaladine, Woyaline, and Dale River.

“The most plentiful and widely-distributed wallaby in the South-west. Frequenting dense thickets, where they usually collect together in large numbers.

“Native name, ‘Tammar.’”—*G. C. S.*

23. *MACROPUS BRACHYURUS* Quoy & Gaim.

“Very plentiful around Albany, but not extending very far inland. It seems to be far more coastal in its range than any of the other wallabies, not appearing to occur anywhere at a great distance from the sea; gregarious. Resembling *M. eugenei* in habits.

“Native name, ‘Bangcup.’”—*G. C. S.*

24. *PETROGALE LATERALIS* Gould.

9 specimens from Stockpool, east of Beverley.

“Fairly plentiful among low rocky hills around York and Beverley. Seemingly local and patchy in its distribution; according to the natives it does not occur among the Stirling Ranges.

“Native name, ‘Boggile.’”—*G. C. S.*

25. *ONYCHOGALE LUNATA* Gould.

18 specimens from Woyaline, east of Pinjelly.

“More local than *Macropus eugenei* and seeming to prefer lower and more scrubby thickets than that animal. Very numerous in some localities; it rather resembles the Kangaroo-

Rats (*Bettongia penicillata*) in some of its habits, often running into hollow logs when disturbed.

"Native name, 'Wurrine' or 'Wurrung.'"—*G. C. S.*

26. *LAGORCHESTES HIRSUTUS* Gould.

"Occurring very sparingly on sand-plains to the east of York and Beverley. Known locally as the Whistler.

"Native name, 'Wurruip.'"—*G. C. S.*

No specimens of this species were sent home by Mr. Shortridge, so that in working out the Bernier Island form I have had to trust to the old Gould & Gilbert material.

27. *LAGOSTROPHUS FASCIATUS ALBIPILIS* Gould.

17 from Woyaline.

"Apparently local in the South-west, occurring very plentifully about twenty miles east of Pinjelly, but only in certain districts, among thick low prickly scrub. Also said to be found east of Wagin and near the Salt River.

"Native name, 'Munning' or 'Munnine.'"—*G. C. S.*

For the nomenclature of this animal, see below in the Bernier Island Appendix (p. 774).

28. *BETTONGIA PENICILLATA* Gray.

16 from Dwaladine and Woyaline.

"Very plentiful. The Kangaroo-Rat of colonists. Nocturnal. This species simply swarms about twenty miles east of Pinjelly, as it probably does in many other places. Said to be rather destructive to crops. Both this animal and *B. lesueuri* are great scavengers, and collect often in large numbers around camps at night in order to feed on any scraps that may be lying about. They become wonderfully fearless, often approaching within a foot or two of where people are sitting, when they might easily be knocked over with sticks. However, when startled they are marvellously quick, and can double and dodge about with such agility that it is almost impossible for a dog to catch them at night; when put up in the daytime they will generally make for the nearest hollow log or cover. Sleeping by day in a grass nest rather like those made by Bandicoots. I do not think that the Kangaroo-Rats can be said to have prehensile tails, although in the case of '*penicillata*' they seem inclined to curve downwards. But *Thalacomys lagotis* has this peculiarity still more strongly developed, though not enough to be used for any prehensile purpose.

"Native name, 'Woylyer' or 'Woyre.'"—*G. C. S.*

29. *BETTONGIA LESUEURI GRAYI* Gould.

17 from Dwaladine, Woyaline, and Dale River.

"Very plentiful in most districts throughout the South-west. Making a rather smaller burrow than *Thalacomys lagotis*, a number

often getting together and forming warrens similar to those of rabbits. This species does not seem to occur around Albany.

“ ‘Boodee’ of colonists and natives.”—*G. C. S.*

For nomenclature see below, p. 773.

30. *TARSIPES SPENSERÆ* Gray.

“Seeming to prefer damp localities in the vicinity of Ti trees (*Melaleuca*), among the branches of which they are said to build small round nests, like Dormice.”—*G. C. S.*

31. *DROMICIA CONCINNA* Gould.

“Said to be fairly plentiful near Parker’s Range.”—*G. C. S.*

32. *PSEUDOCHIRUS OCCIDENTALIS* Thos.

“Apparently local, frequenting well-watered districts. Plentiful in some localities.

“Native name, ‘Wormp.’”—*G. C. S.*

33. *TRICHOSURUS VULPECULA* Kerr.

20 from Stockpool, Dwaladine, Woyaline, and Dale River.

“Abundant and generally distributed throughout the South-west, although very much thinned out in the more settled districts; not extending in any numbers far inland. The red patch on the throat only appears in adult specimens, often becoming more suffused over the rest of the body in aged individuals. The black form seems to be local and more plentiful in the coastal districts. The common method of trapping ‘Possums’ is by a snare set on a slanting stick fixed against the base of a tree. They will always come down a tree on the sloping side, however slight the slope is; and the stick being in a more sloping position still, they invariably run down it and get caught in the snare.

“Native name, ‘Coomul.’”—*G. C. S.*

34. *THALACOMYS LAGOTIS* Reid.

15 from Woyaline.

Mr. Shortridge has drawn my attention to the fact that this animal has a distinct horny spur at the tip of its tail, of a similar nature to that in *Onychogale lunata*.

“With the exception of *Bettongia lesueuri*, this seems to be the only true burrowing marsupial in the South-west. *Bettongia penicillata* and the Bandicoots dig little holes in the ground in search of roots &c., but they do not live in burrows. It makes a larger and deeper burrow than *B. lesueuri*, and, like a badger, it is difficult to dig for, as it will burrow almost as fast as a man can dig. Although more plentiful near the coast, it has a wide range inland, occurring sparingly as far as Laverton; but for some reason it seems to have become scarcer in the interior than formerly, for while old burrows are plentiful, it seems to have almost left parts of the country where it was once well known—

perhaps on account of the succession of droughts inland of late years.

“Native name, ‘Dalgyte.’”—*G. C. S.*

35. *PERAMELES BOUGAINVILLEI MYOSUROS* Wagn.

♂. 504. Woyaline.

For the use of the name *myosuros* see below, p. 777.

“One specimen only was obtained, about twenty miles east of Pinjelly, where it is evidently far from common.

“Native name, ‘Marl.’”—*G. C. S.*

36. *ISOODON OBESULUS* Shaw.

15 from Dwaladine and Woyaline.

“The common Bandicoot of the South-west, not extending inland, or far from permanent water. Hiding by day in a nest on the ground, generally hidden either under a fallen tree or under a tuft of grass. Making for the nearest hollow log or thick patch of scrub when disturbed. Insectivorous: the stomachs of all specimens examined contained numerous wing-cases and legs of beetles, and orthopterous insects. I believe they also feed to a certain extent on roots and vegetable matter. The native Pig of colonists.

“Native name, ‘Quaint.’”—*G. C. S.*

The nomenclature of the Bandicoots is dealt with in my previous paper.

37. *DASYURUS GEOFFROYI FORTIS* Thos.

20 from Dwaladine and Woyaline.

“Numerous in some localities, especially where there is rocky country, but killed off as much as possible in the more settled districts, as they are very destructive to poultry. Hiding by day in crevices among rocks, hollow logs, deserted burrows, &c. Arboreal to a great extent; resembling the pole-cats and viverrine animals very much in their habits.

“Native name, ‘Chudich.’”—*G. C. S.*

38. *PHASCOGALE FLAVIPES LEUCOGASTER* Gray.

“Five specimens obtained around Albany, in thickly-timbered country. This species and the other smaller kinds of *Phascogale* seem to be more plentiful in the extreme South-west than further inland; the coastal districts, which are for the most part heavily wooded and not so subject to bush fires, probably being a better stronghold for the smaller marsupials than the grass country and farming districts, which are to a large extent annually burnt off between March and April.”—*G. C. S.*

39. *PHASCOGALE PENICILLATA* Shaw.

“Reported from around Beverley and York, but not common; said to become more plentiful further south. Known locally as the Squirrel. Described as being arboreal, and very active among

the branches of trees. Occasionally found around farms, where they come, according to the natives, after mice.

"Native name, 'Cōming-cōming.'"—*G. C. S.*

40. *SMINTHOPSIS MURINA* Waterh.

"Not uncommon around Albany, seeming to be more plentiful in the coastal districts than further inland. Occasionally to be found in the hollow stumps of dead grass-trees (*Xanthorrhœa*)." — *G. C. S.*

41. *MYRMECOBIUS FASCIATUS* Waterh.

10 from Dwaladine, Woyaline, and Dale River.

"Diurnal. Fairly numerous throughout the South-west, especially where the prevailing timbers are the white gum (*Eucalyptus redunca*) and the jam (*Acacia acuminata*), getting less plentiful outside that area. It extends very sparingly as far inland as Laverton. When alarmed it will make for the nearest hollow log, but is unable to climb trees. It does not seem to use its teeth much, either in mastication or self-defence. The stomach of one example proved, on examination, to be full of white ants, most of which had evidently been swallowed whole.

"Native name, 'Numbat.'"—*G. C. S.*

42. *TACHYGLOSSUS ACULEATUS INEPTUS* Thos.

"Rare in the South-west, but seeming to become numerous towards the Interior and North-west. Reported to frequent hills and rocky country. Their claws are very powerful, and when disturbed they will cling to the ground so tightly that it is difficult to dislodge them.

"Native name, 'Ningan.'"—*G. C. S.*

APPENDIX ON A COLLECTION FROM BERNIER ISLAND.

After making the fine collection above described, Mr. Shortridge travelled northward by steamer to Carnarvon, and from there paid a visit to Bernier Island, situated at the mouth of Shark's Bay in 25° S. latitude.

Mr. Shortridge writes as follows about Bernier Island and its mammals:—"The island is quite small—16 miles by 3—sandy, and covered for the most part rather thinly with low scrub, very like the mainland. I am sending you a list of the mammals and birds. *Lagorchestes*, *Lagostrophus*, and *Bettongia* swarmed in the island. In the case of *Lagostrophus* I have never seen any animal, not even rabbits, in such numbers. It has been a particularly dry season, and they were very thin. Food was evidently insufficient for them all, and dead specimens were lying about in all directions. It would seem that they have no natural enemies on the island; and they breed to such an extent that the island will carry no more, and in times of drought a number have to die. *Lagorchestes* was not so plentiful. I believe Bernier Island will be the most northern locality for all the three forms. The distribution of

mammals in this part of the country is very curious, as, with all these Rat-Kangaroos on the islands off the coast, they are entirely absent from the mainland about here (Carnarvon). [It remains to be seen, however, whether there are none on the coast to the south, which a study of the map would indicate as the natural way of entry for the animals of these islands.—*O. T.*] In addition to the species sent, the island possesses *Perameles bougainvillei*, of which there is an example from 'Denham Sound' in the Perth Museum; but I was unable to secure a specimen, though I picked up a dried skull, and I fear that, owing to the presence of cats, they may have been exterminated."

The specimens sent by Mr. Shortridge from Bernier Island prove to be most interesting; for in every case they are definably different from the S.W.-Australian form to which he supposed them to belong, and from which they would appear to be widely separated geographically.

And in this differentiation there is one interesting and noticeable point, namely, that all three of the Rat-Kangaroos differ from their respective allies in one character—the comparative shortness of their ears and a correlated reduction of their auditory bullæ. When we remember that the forms affected belong to three quite distinct genera, this instance of geographical isomorphism is well worthy of mention.

As a cause it may be suggested that since, as Mr. Shortridge states, the animals have on the island no enemies to fear, the faculty of hearing would have lost that supreme importance for the preservation of life that it would have had in the presence of man, dingoes and dasyures. The ears would have consequently tended to become reduced by the survival of individuals with duller hearing, who in other places would have been speedily eliminated by predatory enemies.

43. BETTONGIA LESUEURI Quoy & Gaim.

Three males; six females.

These specimens represent the typical *lesueuri*, which was discovered during the Voyage of the 'Uranie' on the neighbouring island of Dirk Hartog, and, as in the case of *Lagostrophus fasciatus*, prove, on comparison with the good series obtained by Mr. Shortridge in Avon County, to be recognisably different. Their ground-colour is paler, their fur is less long, and their ears (just as in the case of the *Lagostrophus*) are very distinctly shorter. The following are Mr. Shortridge's measurements of a pair from each region:—

		<i>B. lesueuri lesueuri</i> .—Bernier Island.			
		Head and body.	Tail.	Hind foot.	Ear.
		mm.	mm.	mm.	mm.
♂	.....	350	280	102	35
♀	.....	360	300	110	36
		<i>B. lesueuri grayi</i> .—Avon District.			
♂	.....	390	310	112	42
♀	.....	360	285	108	40

In the skull, the bullæ of *lesueuri* are decidedly smaller than in *grayi*—a difference already noted in the ‘Catalogue of Marsupials.’

Gould’s *Hypsiprymnus grayi* was described from the Swan River; and this name will therefore stand for the continental form. Its type is in the Museum, B.M. No. 41.1157.

44. LAGOSTROPHUS FASCIATUS Pér. & Les.

Three males; five females.

In 1807 Péron and Lesueur described the Banded Wallaby from specimens obtained on this very island; so that Mr. Shortridge’s examples are absolute topotypes, and as such of very great interest, no specimens having been again obtained from the islands until quite recently. In 1900, however, the British Museum received from the Perth Museum two skins from Dorre Island; but these were put away without any special comparison being made of them with the mainland form. Indeed, at that date, before the Balston Exploration, no specimens well-enough collected to form the basis of a comparison were available in this country.

Now, however, that the Balston series contains sets from both localities, I am able to state that the two forms—the one from the islands about lat. 25° S., and the other from the Perth and Avon regions of the mainland, about lat. 32° S.—are quite definably different. The latter would bear the name of *L. fasciatus albipilis* Gould, whose *co-types* are nos. 44.9.30.1 & 2 of the British Museum collection.

As the present specimens show, true *L. fasciatus* is a rather shorter-tailed animal than *albipilis*; the fur is shorter, the general colour is paler, the ears are both shorter and paler-coloured than in the allied form, the long white-ringed piles of the coat are less prominent and numerous, and the bristle-hairs of the toes only cover the base of the claws, while in *albipilis* they considerably surpass the latter; the claws are also longer in *fasciatus*, surpassing the tip of the toes by from 2 to 5 mm. more than is the case in *albipilis*.

The following are the measurements of a pair of each subspecies, taken in the flesh by Mr. Shortridge:—

L. fasciatus fasciatus.—Bernier Island.

	Head and body. mm.	Tail. mm.	Hind foot. mm.	Ear. mm.
♂ 593	400	330	106	48
♀	400	355	110	51

L. fasciatus albipilis.—Avon District.

♂	410	405	112	62
♀	400	390	110	60

I can find no tangible difference between the Dorre and Bernier Island examples of *L. fasciatus*.

45. *LAGORCHESTES HIRSUTUS BERNIERI*, subsp. n.

Ten males; seven females.

General characters as in the typical subspecies; but the fur is not nearly so long (hairs of back in winter specimens about 18 mm., wool-hairs 12 mm., instead of 32 and 24 mm. respectively); the ears are slightly shorter; the long hairs on the feet are of a more glossy sandy colour, instead of brownish; and the tail, instead of being well-haired throughout and blackish on the upper side of the terminal half, is practically naked above, the few minute scattered hairs being sandy.

The skulls are remarkably uniform in character; but, no equally good material existing of the true *L. hirsutus*, it can now be stated only that the bullæ, in correlation with the shorter external ear, are very decidedly smaller than in the type. The interorbital is broad and parallel-sided.

Dimensions of the type, measured in the flesh:—

Head and body 370 mm.; tail 270; hind foot s.u. 112, c.u. 125; ear 48.

Skull—greatest length 76 mm.; basal length 66; greatest breadth 41.5; nasals 30 × 11.8; interorbital breadth 12.9; palatal length 42; length of secator 4.7; combined length of three anterior molariform teeth 15.2.

Hab. Bernier Island, Shark's Bay.

Type. Adult male. B.M. No. 6.10.5.18. Original number 571. Collected 16 June, 1906, by G. C. Shortridge and presented by Mr. W. E. Balston.

This animal, which differs from its mainland relations in very much the same way as do the other two Rat Kangaroos of the island from theirs, is fortunately able to take its proper position in nomenclature as an insular subspecies of *L. hirsutus*, the mainland form having in this case been first described. No record exists as to how far north the true *L. hirsutus* occurs, the only specimen with an exact locality that I am aware of being the type, which was obtained by Mr. Gilbert at York, in the Avon district inland of Perth.

But further, a careful comparison of two specimens obtained by Mr. J. T. Tunney on Dorre Island, just to the south, with the series from Bernier Island shows that a slight difference has already been developed between the two; and one that I think should be recognised by name. The Dorre Island form may therefore be called *Lagorchestes hirsutus dorreæ*.

Externally the differences are not essential, though it may be noted that the fur of *dorreæ* is slightly softer, and in one example longer (specimens obtained in the southern summer, and compared with winter specimens of *bernieri*), though not so long as in true *hirsutus*, and that the ground-colour is more rufous, the ordinary and wool hairs, and not only the long piles of the rump, having a tinge of sandy rufous.

The skull may be at once distinguished from that of *bernieri*

by the narrowness of the interorbital region, which is only 10 mm. across as compared with over 13 mm. in *bernieri*, and in this respect the skulls of the latter are remarkably uniform.

Dimensions of the type, measured in the skin:—

Head and body 400 mm; tail 280; hind foot s.u. 109, c.u. 124; ear 43.

Skull—greatest length 76 mm.; basal length 66; greatest breadth 44; nasals 19×11.5 ; interorbital breadth 10; length of sector 5.

Hab. Dorre Island, Shark's Bay.

Type. Old male. B.M. No. 0.6.1.18. Original number 93. Collected February 1899 by Mr. J. T. Tunney, and presented by the Western Australian Museum, Perth.

From true *L. hirsutus* the Dorre Island form differs in all the characters mentioned above as distinguishing *L. h. bernieri*, and is of course very closely allied to the latter.

46. *MUS ALBOCINEREUS SQUALORUM*, subsp. n.

One male, four females.

Quite like the true *M. albocinereus* of the Swan and Avon districts in all respects of proportions, colour, and structure of skull, but markedly smaller throughout, as evidenced by the following measurements, all taken by Mr. Shortridge in the flesh:—

M. a. albocinereus.—Dwaladine, Avon District.

	Head and body.	Tail.	Hind foot.	Ear.
	mm.	mm.	mm.	mm.
♂	105	115	23	18
♂	105	105	22	18
♀	98	97	22	18

M. a. squalorum.

♀	90	88	21	18
♀	83	82	21	16
♀	80	85	21	16

The following are the skull-dimensions of the type, followed in brackets by the corresponding dimensions of a rather younger skull of the true *M. albocinereus*:—

Greatest length 25 (27.5); basilar length 18.5 (21); greatest breadth 13 (13.7); length of nasals 9.2 (10.2); interorbital breadth 4 (4); breadth of brain case 11.6 (12.4); palatilar length 10.6 (11.7); palatal foramina 4.7 (5.2); length of upper molar series 3.6 (3.9).

The tails of all the specimens are entirely white, not darker above, but this is frequently the case with inland specimens of true *albocinereus*, although the co-types figured by Gould, from the coast near Perth, both have distinctly darker upper sides.

Hab. Bernier Island, Shark's Bay.

Type. Old female. B.M. No. 6.10.5.6. Original number 622.

Collected 4 July, 1906, by G. C. Shortridge, and presented by Mr. W. E. Balston.

The range of the beautiful grey *M. albocinereus* on the mainland of Western Australia is as yet quite unknown, all the recorded specimens being from one restricted area.

47. *MUS MUSCULUS* L.

Male and female.

48. *PERAMELES BOUGAINVILLEI* Quoy & Gaim.

An imperfect skull, picked up.

Owing to the probable extermination of this species in Bernier Island, and the fact that we have no specimens at all from Shark's Bay, whence the species was originally described, this skull, imperfect as it is, is of much value to us.

It indicates, as in the case of the other Shark's Bay animals, that this Bandicoot is different from the one found further south, to which Wagner's name *myosuros* will be applicable.

The chief difference observable is in the size of the teeth, the combined length of the three anterior molariform teeth of *bougainvillei* being only 9 mm., while in *myosuros* they measure 10-10.5 mm.

3. Zoological Results of the Third Tanganyika Expedition,
conducted by Dr. W. A. Cunningham, 1904-1905.
Report on the Turbellaria. By F. F. LAIDLAW.

[Received July 12, 1906.]

(Text-figure 126.)

[The species of Turbellarian described below by Mr. Laidlaw was the only one observed during the Expedition. Specimens were collected at Niamkolo, at the south end of Tanganyika, and at Ndanvie, near the north end, but the species was observed at several other localities. The specimens were taken on the under side of stones in shallow water.—W. A. C.]

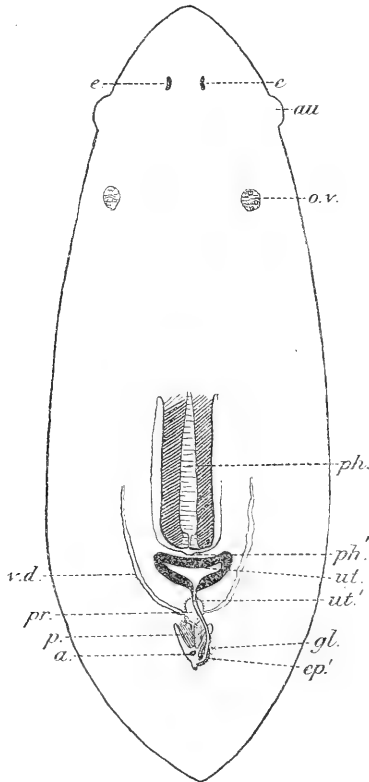
PLANARIA TANGANYIKÆ, sp. n. (Text-fig. 126.)

A small species. Length of the largest spirit-specimen about 8 mm. Breadth 3 mm.

Anterior end rather pointed; eyes (*e.e.*) moderately distant, lying in front of the level of the pair of auricles (*au.*). Body (of spirit-specimen) rather oval, the hinder end pointed. Pharynx opening (*ph.*) a little in front of the commencement of the hinder fourth of the body, at the level of its greatest width. The colour is black in the larger specimens, grey-brown in the smaller. The ovaries lie at the hinder end of the first fourth of the body. The oviducts were not seen. The uterus (*ut.*) is symmetrical and lies

close behind the free end of the pharynx. The epithelium of its walls is secretory. The uterine duct (*ut.*) is at first very small and lies immediately dorsal to the cavity of the base of the penis. Further back it is pushed aside by the penis, increases considerably in size as it approaches the antrum, and here its epithelium takes on a secretory character (*ep.*'), whilst around the duct lie numerous gland-cells (*gl.*). There is no indication of any bursa copulatrix.

Text-fig. 126.



Planaria tanganyikæ, much enlarged.
For explanation of the lettering, see text.

The vasa deferentia (*v.d.*) open into a chamber at the base of the penis (*p.*). This chamber is lined by an epithelium which, in front of the level of the openings of the vasa deferentia and dorsally behind them, is evidently concerned in the production of a granular secretion; the epithelium of the rest of the chamber is of a different character, flattened, and apparently not secretory, but in parts this has been lost. The penis (*p.*) is conical and

shows rather a three-sided outline in transverse section. The duct traversing it is very narrow.

Beyond the level of the penis the walls of the antrum (*a.*) have an epithelium similar to that of the lower part of the uterine duct. Round the penis the walls have a flattened epithelium and are non-muscular.

The vasa deferentia can be traced forward to a level about half-way along the pharynx.

The testes are numerous and contain spermatozoa in all stages of development, the vasa deferentia are crowded with them.

The cells of the gut are large and rounded, and many of them have broken away from the gut-wall.

Planaria tanganyikæ differs from *P. neumanni* Neppi*, in its smaller size. Its penis is more regularly conical and the uterus also is more regular in shape. The body is perhaps, too, a little broader proportionately, and the hinder end not so produced, though it is impossible to rely on the shape of a preserved specimen.

Two other Planarians have been described from fresh-water from East Africa—*P. venusta* Böhmig, and *P. brachycephala* Böhmig†; but both these are known only from immature specimens.

P. tanganyikæ is a very ordinary form, and certainly lends no support to the hypothesis of the marine affinities of the Tanganyikan fauna.

4. The Rudd Exploration of S. Africa.—VI. List of Mammals obtained by Mr. Grant in the Eastern Transvaal. By OLDFIELD THOMAS, F.R.S., and HAROLD SCHWANN, F.Z.S.

[Received October 4, 1906.]

During April and May, before going down into the hotter coast-belt, Mr. Grant made a stay at Legogot, a village in the northern part of the Barberton district, at an altitude of about 3000 feet. There he obtained the Mammals recorded in the following list.

One species, a Shrew, is new, while the most valuable of the other animals are the additional specimens of *Pronolagus ruddi*, the large ally of the Rooi-haas, the description of which was based on a specimen collected in Zululand at an earlier stage of the Rudd Exploration.

Before going to Legogot Mr. Grant made a small collection at a place called Turfloop, between Pietersburg and Woodbush, in

* Neppi, Valeria. "Ueber einige exotische Turbellarien." Zool. Jahrb., Systematik, xxi. 1904-1905, pp. 309-316, Taf. 9. figs. 7-8, Taf. 10. figs. 13-14.

† Böhmig, L. "Die Turbellarien Ost-Afrikas," in Deutsch-Ost-Afrika, iv. (14) pp. 12-13, figs. 11-14 (1898).

the North-Eastern Transvaal; but as he obtained no examples of species not mentioned in our list of his Woodbush collection*, we do not think any list of them is necessary.

1. *CERCOPITHECUS LALANDEI* Geoff.

♂. 1418, 1426, 1464. Legogot.

2. *RHINOLOPHUS AUGUR* K. And.

♀. 1412, 1416. Legogot.

♂. 1363-5. ♀. 1366. Woodbush.

"These six specimens give the following range of variation:—

"Forearms 52-55.7 mm.

"Upper canine to back of m^3 8.3-8.7 m. Maxillary width across parastyles of m^3 8.3-8.7.

"Minute lower premolar present on both sides in one specimen; absent but with trace of the alveolus, in three; absent without trace in two.

"Upper canine and p^1 slightly separated in three, in simple contact in one; slightly overlapping at base in two."—K. A.

3. *RHINOLOPHUS DARLINGI* K. And.

♀. 1427. Legogot.

"Forearm 46.2 mm. Upper canine to back of m^3 7.5. Maxillary width 7.8. P_3 wanting on both sides. P^2 external; upper canine and p^1 practically in contact.

"Of the five examples of this species in the Museum, p_3 is wanting on one side and present but exceedingly minute on the other in three; in the other two skulls this tooth is wholly absent. In all five skulls the teeth are unworn."—K. A.

4. *VESPERTILIO CAPENSIS* A. Sm.

♀. 1372. Pietersburg.

5. *PIPISTRELLUS KUHLLI FUSCATUS* Thos.

♂. 1437. ♀. 1444. Legogot.

6. *PIPISTRELLUS NANUS* Peters.

♂. 1443, 1449. ♀. 1431, 1440. Legogot.

7. *CROCIDURA* sp. (near *argentata* Sund.).

♂. 1371. Pietersburg, 4350'.

♂. 1397, 1417, 1453, 1460. Legogot.

8. *CROCIDURA* sp. (near *martensi* Dobs.).

♂. 1375, 1376. Pietersburg.

♂. 1414. Legogot.

* P. Z. S. 1906, p. 585.

9. *PACHYURA GRATULA*, sp. n.

♂. 1436, 1458, 1476. Legogot.

A medium-sized species of a bluish-grey colour, with bicolor tail.

Size about as in *Crocidura pilosa*, therefore immensely larger than such pygmy shrews as *P. gracilis* and *P. varilla*. Fur close and fine, rather over 3·5 mm. in length on the back. General colour above clear uniform bluish grey (between grey No. 5 and "plumbeous"). Under surface not sharply defined, more whitish grey (about grey No. 7). Upper surface of hands and feet white. Tail about two-thirds the length of the head and body, well-haired with fairly numerous bristle-hairs on its proximal half; dark brown above, white below. Lateral gland of male distinct, half-way between elbow and hip, its hairs whitish.

Skull of normal proportions. Third unicuspid slightly larger than second, fourth about half the size of third.

Dimensions of the type (measured in the flesh):—

Head and body 76 mm.; tail 50; hind foot 13; ear 10.

Skull—greatest length including incisors 20 mm.; basal length 17·2; greatest breadth 8·7; length of upper tooth-row 8·4; breadth of palate across molars 6; combined length of p^1 , m^1 & m^2 4·4; tip of i^1 to tip of p^1 4·3.

Hab. as above.

Type. Male. B.M. No. 6.8.246. Original number 1476. Collected 22 May, 1906.

No members of *Pachyura* have hitherto been described from South Africa other than the pygmy shrews *P. gracilis* and *varilla*. The bluish pelage and bicolor tail will also distinguish this well-marked species.

10. *MYOSOREX VARIUS* Smuts.

♀. 1471. Legogot.

11. *LYCAON PICTUS* Temm.

♀. 1472, 1473, 1474, 1475. Legogot.

12. *GENETTA LETABÆ* Thos. & Schw.

♀. 1445. Legogot.

13. *HERPESTES GRACILIS PUNCTULATUS* Gray.

♂. 1466. Legogot.

14. *DENDROMUS NIGRIFRONS* True.

♀. 1478. Legogot.

This little animal agrees so closely with True's description of *nigrifrons* that we see no reason to distinguish it. Mr. Darling obtained examples of the same species at Mazoe, Mashonaland. In the presence of a nail instead of a claw on the fifth hind toe, it agrees with the *D. melanotis* group.

15. ARVICANTHIS DORSALIS A. Sm.

♂. 1410. ♀. 1400, 1411. Legogot.

16. ARVICANTHIS PUMILIO DILECTUS de Wint.

♂. 1401. Legogot.

17. MUS CHRYSOPHILUS de Wint.

♂. 1395, 1421, 1422, 1429, 1430, 1431, 1434. ♀. 1399, 1428, 1433, 1454. Legogot.

18. MUS COUCHA A. Sm.

♀. 1370. Pietersburg.

♂. 1393, 1394, 1402, 1403, 1404, 1446. Legogot.

♀. 1398, 1406, 1407, 1408, 1409, 1415, 1419, 1420, 1423, 1432, 1450. Legogot.

19. LEGGADA MINUTOIDES A. Sm.

♀. 1405, 1435, 1457. Legogot.

20. STEATOMYS PRATENSIS Pet.

♂. 1413. Legogot.

21. GEORYCHUS, sp. (near *hottentotus*).

♂. 1448, 1451, 1452, 1455, 1459, 1461. Legogot.

♀. 1439, 1447.

The Legogot specimens seem to show the lateral grooves on the molars for a longer period than is customary in this group. Perhaps the local food is softer, so that the teeth wear down less quickly than usual.

22. LEPUS ZULUENSIS Thos. & Schw.

♂. 1462, 1467. Legogot.

23. PRONOLAGUS RUDDI Thos. & Schw.

♂. 1424, 1425, 1470. Legogot.

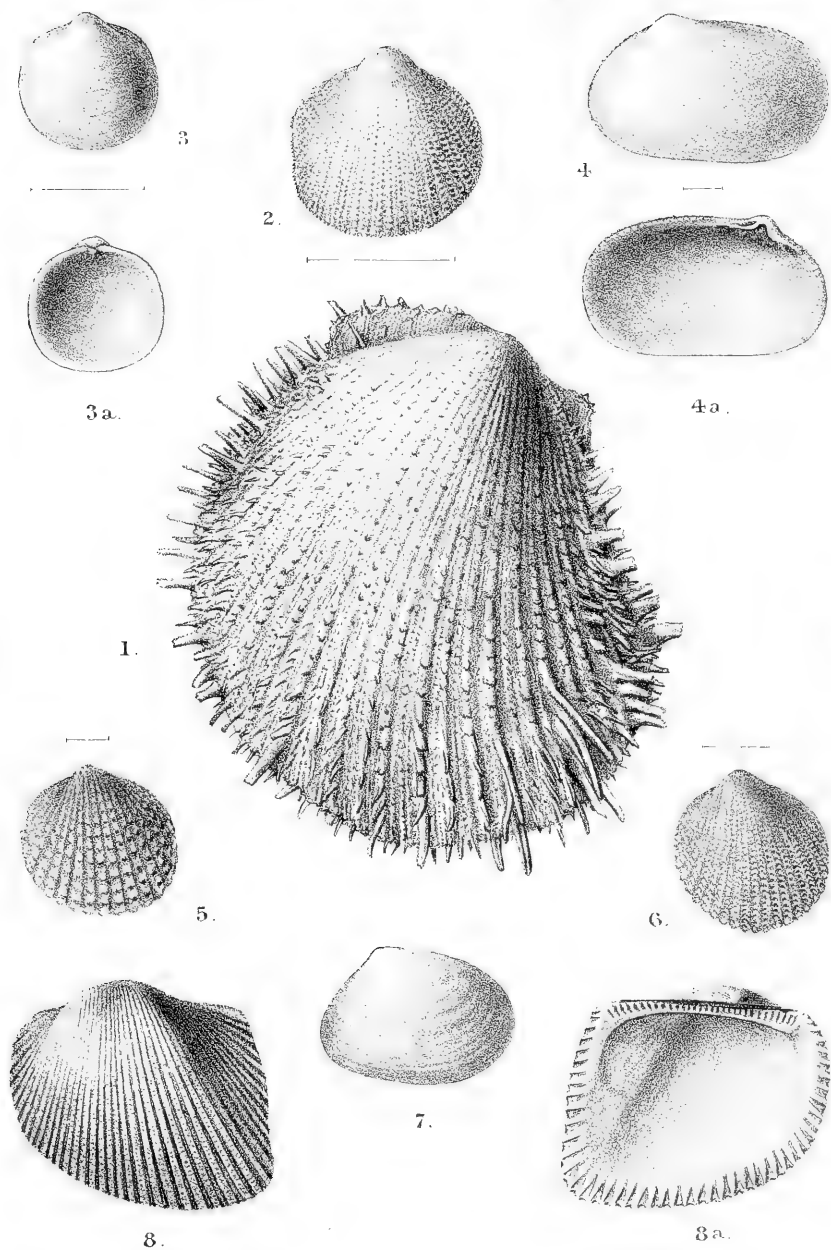
These additional specimens of the rare large form of *Pronolagus* are most welcome. The species was only previously known from Natal and Zululand.

24. PROCAVIA CAPENSIS Pall.

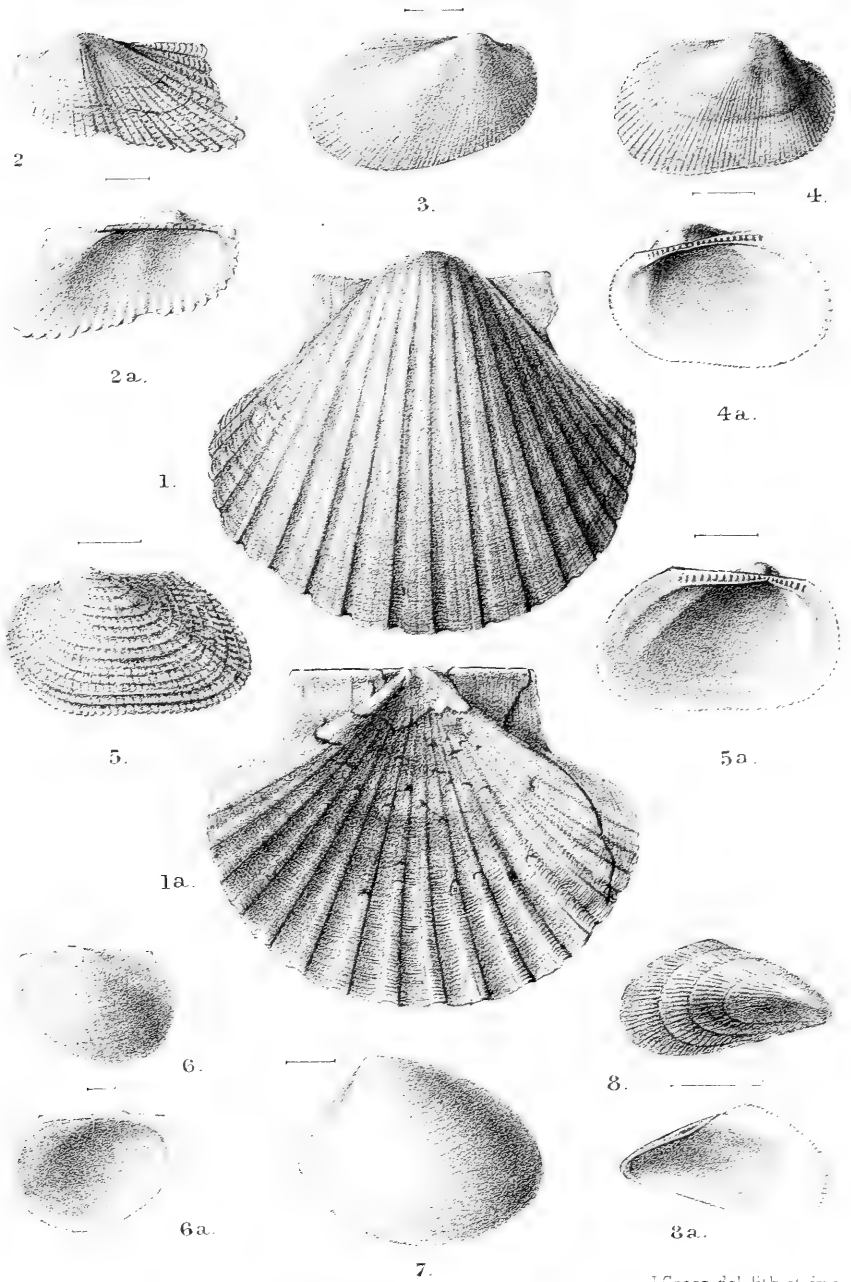
♂. 1442. ♀. 1441. Legogot.

25. CEPHALOPHUS NATALENSIS Smith.

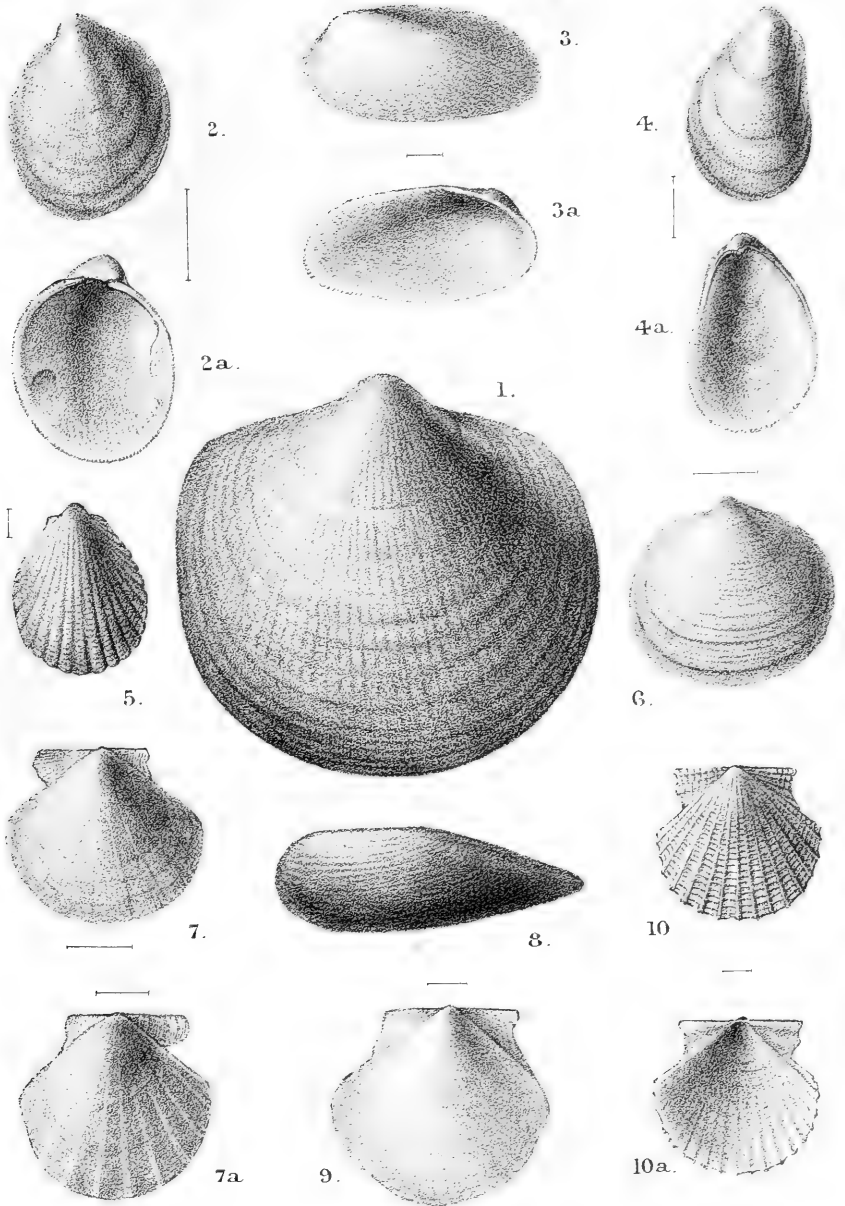
♂. 1468, 1469. ♀. 1456. Legogot.



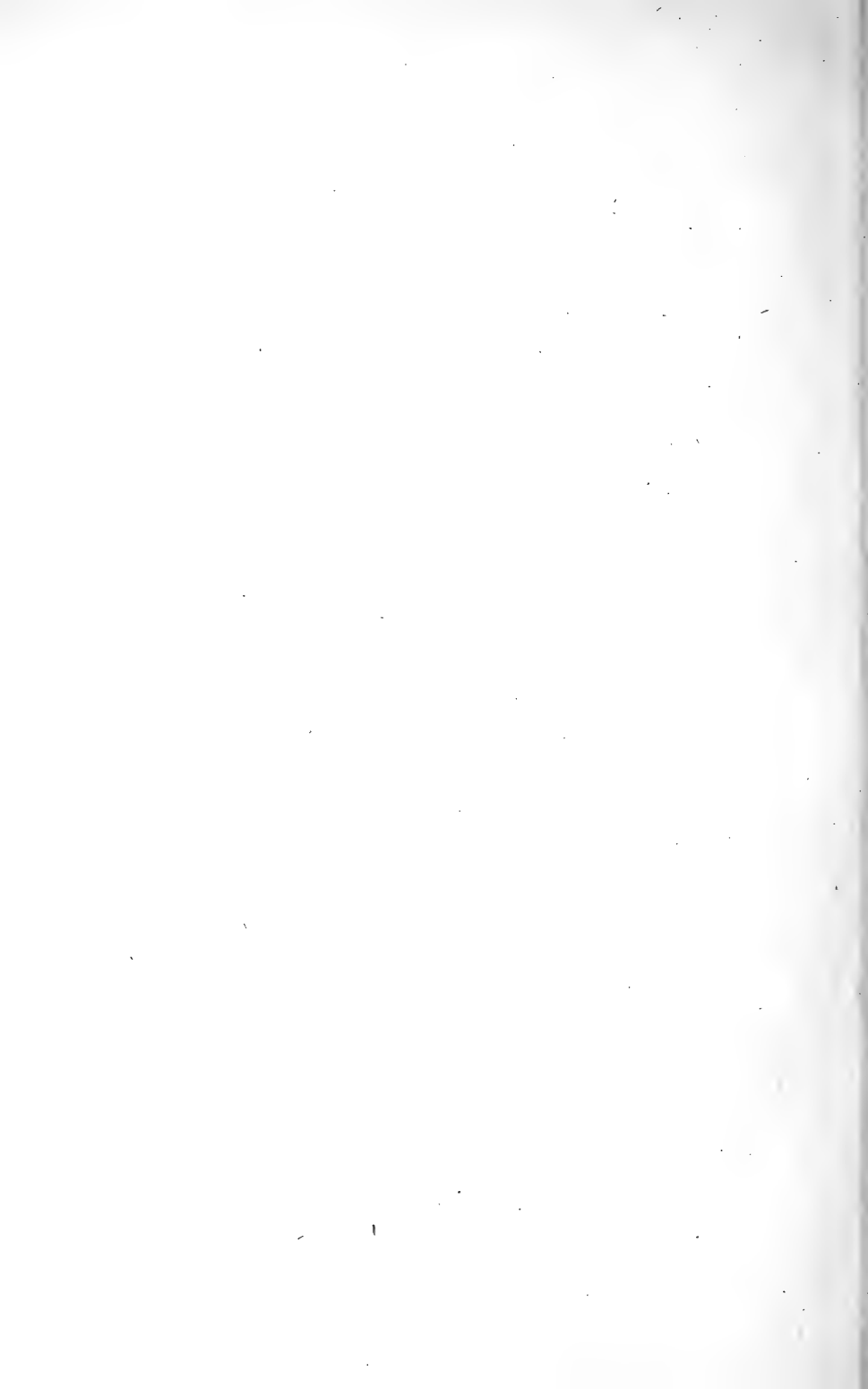
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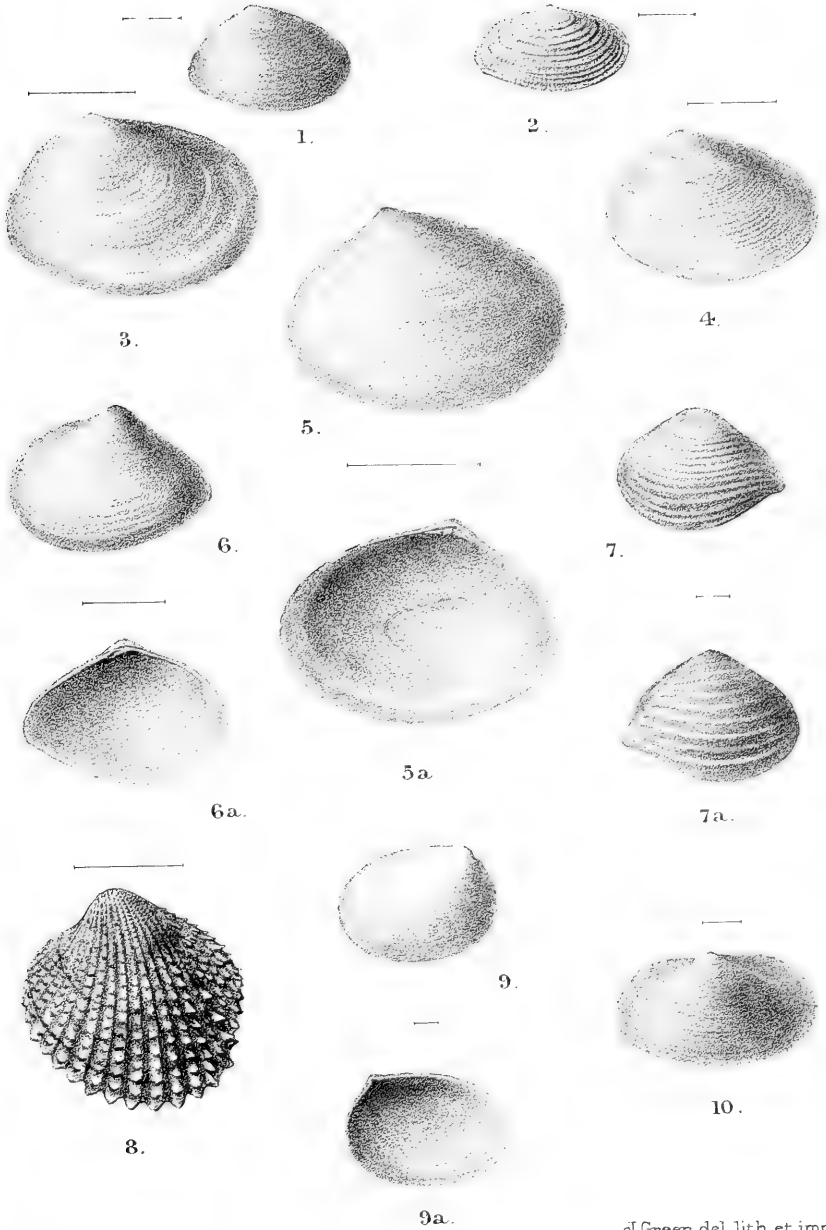


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5. The Mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea, as evidenced mainly through the Collections of Mr. F. W. Townsend, 1893-1906; with Descriptions of new Species. By JAMES COSMO MELVILL, M.A., F.L.S., F.Z.S., and ROBERT STANDEN, Assist.-Keeper, Manchester Museum.

PART II.—PELECYPODA.*

[Received September 10, 1906.]

(Plates LIII.—LVI.†)

In this, the second portion of our enumeration, over 420 species are mentioned, and, of these, more than one-sixth, say 76 species, were discovered either by Mr. Townsend or Mr. Alexander Abercrombie, and have been in greater part described by one of the present authors during the past thirteen or fourteen years. These include a considerable number of, mainly, small and abyssal forms, now to be differentiated in the subsequent pages of this paper.

In the first part of our Catalogue, a census of 935 species, all Gastropoda, excepting for about 12 or 13 Scaphopoda, was given. Five or six years having now elapsed since its publication, the number has been continually increased owing to the products of several further dredgings on the part of Mr. Townsend having been now fully worked out, and the results—at all events, so far as the new species are concerned—published in a series of articles, references to which will be given below. With these additions, the number of Mollusca as yet detected in this area is as follows:—

Cephalopoda	.....	2 ‡
Gastropoda	.....	1175
Scaphopoda	.....	15
Pelecypoda	.....	426
Total	....	1618 species.

This, we believe, already slightly eclipses the sum of the rich Mediterranean Fauna, to which it bears a considerable generic analogy, though so widely differing specifically. And, likewise, compared with Erythræan forms, it will be found, numerically, to surpass them in even still greater a degree, for hardly more than a thousand species have so far been catalogued as natives of the Red Sea, rich though that Sea be both in variety and prolific occurrence of individuals.

It must also be borne in mind that both the Mediterranean and Erythræan Seas have been far more assiduously explored than the region under discussion, and any further discoveries

* For Part I. see P. Z. S. 1901 (vol. ii.), p. 327.

† For explanation of the Plates, see p. 848.

‡ In Cephalopoda, only the genera *Nautilus*, *Argonauta*, and *Spirula* have been considered here.

will therefore almost certainly tend to the advantage and proportionate gain of the North Arabian Sea and Persian Gulf.

Numerical comparison with Adenese Mollusca.

Commander E. R. Shoplund has within the last four and a half years published a second edition of his invaluable Catalogue of Aden Shells*—all, to quote from his preface, “collected within a radius of six miles from Steamer Point, chiefly on the shores of the Inner Harbour, and from the coral brought in from Little Aden for washing lime.”

The list, as foreshadowed by one of us in a paper† giving descriptions of new Mollusca from this locality, and likewise giving a brief historic *résumé* of the Erythræan fauna, and its bibliography, has now been augmented to, roundly speaking, 750 species. Of these, about 310 seem common to Aden and the Gulf of Oman. It is not now feasible, owing to exigencies of space, to give a list of these in detail, but the following are enumerated as being of special interest.

Murex rota <i>Soub.</i> (=anatomicus, <i>Perry</i> , 1811, nom. prius.).	Cerithium clypeomorus <i>Jouss.</i>
Pleurotoma baynhami <i>Sm.</i>	— yerburyi <i>Sm.</i>
— catena <i>Reeve.</i>	Rissoina pachystoma <i>Melv.</i>
— cecchi <i>Jouss.</i>	— seguenziana <i>Issel.</i>
— pouloensis <i>Jouss.</i>	Onoba delicata <i>Phil.</i>
— variabilis <i>Sm.</i>	Turritella maculata <i>Reeve.</i>
Bullia tahlitensis <i>Gmel.</i>	Calyptrea edgariana <i>Melv.</i>
Cyllene grayi <i>Reeve.</i>	Vanikoro cancellata <i>Chemn.</i>
Nassa marratii <i>Sm.</i>	Leptothyra læta <i>Montr.</i>
— obockensis <i>Jouss.</i> (=zailensis <i>Soub.</i>).	— pilula <i>Dunker.</i>
Mitra bovei <i>Kien.</i>	Ethalia carnelata <i>Melv.</i>
— cæligena <i>Reeve.</i>	Calliostoma scobinatum <i>A. Ad.</i> (formerly considered endemic at Bombay).
— carnicolor <i>Reeve.</i>	
— fissurata <i>Lamk.</i>	Thracia adenensis <i>Melv.</i>
— pretiosa <i>Reeve.</i>	Maetra fauroti <i>Jouss.</i>
— shoplandi <i>Melv.</i>	Raëta abererombici <i>Melv.</i>
Marginella mazagonica <i>Melv.</i>	Psammobia elegans <i>Desh.</i>
Columbella popinquans <i>Sm.</i>	— occidens <i>Chemn.</i>
Scalaria decussata <i>Lamk.</i> (=kieneri <i>T. Can.</i>).	Tellina kolabana <i>Melv.</i>
Terebra nassoides <i>Hinds.</i>	— methoria <i>Melv.</i>
— pellyi <i>Sm.</i>	— micans <i>Hanley.</i>
Elusa brunneomaculata <i>Melv.</i>	— pharaonis <i>Hanley.</i>
Eulima shoplandi <i>Melv.</i>	Donax erythræus <i>Berth.</i>
Solarium regium <i>Hanley.</i>	— scalpellum <i>Gray.</i>
Conus clytospira <i>M. & St.</i>	Cumingia occatilla <i>Melv.</i>
— thomasi <i>Soub.</i>	Tivela ponderosa <i>Koch.</i>
— traversianus <i>Sm.</i>	Sunetta contempta <i>Sm.</i>
Strombus beluchiensis <i>Melv.</i>	Petricola hemprichii <i>Issel.</i>
— fusiformis <i>Soub.</i>	Crenella cumingiana <i>Dunker.</i>
Rostellaria curta <i>Soub.</i> (=curvirostris <i>Lamk.</i> , β).	Septifer excisus <i>Wieg.</i>
Cypræa lentiginosa <i>Gray.</i>	Cucullæa concamerata <i>Chemn.</i>
Cancellaria hystrix <i>Reeve.</i>	Pectunculina multistriata <i>Forsk.</i>
	Pecten layardi <i>Reeve.</i>
	— luculentus <i>Reeve.</i>
	— townsendi <i>Soub.</i>

* Proc. Mal. Soc. vol. v. part 2, pp. 177-179 (July 1902). The first edition was published in Journ. Bombay Soc. x. pp. 217-235, with addendum, *t. c.* pp. 503-504.

† Ann. & Mag. Nat. Hist. ser. 7, vol. iv. pp. 461-463; also *op. cit.* vol. vii. pp. 550-556.

There can, of course, be no doubt that these 310 species also inhabit the intermediate seas, as yet, unfortunately, but little explored, between Aden and Ras-el-Had, that wash the coasts of the Hadramaut, Dhofar, &c. It is much to be hoped that some investigator may soon turn his attention to this neglected area.

Ceylon.

With regard to Ceylon, comparison seems impossible at present, as we do not possess recent catalogues of the productions of the seas and shores of that proverbially rich island. The enumeration, compiled, we believe, by the late Mr. Sylvania Hanley with the aid of Mr. E. L. Layard, C.M.G., and published in the treatise on Ceylon by Sir J. Emerson Tennant*, is altogether out of date, as also are the slight additions made by the late Mr. A. W. Langdon to the Mollusca fauna †. The researches of the late Messrs. Hugh and Geoffrey Nevill, of Mr. J. R. Henderson and Mr. Edgar Thurston, C.M.Z.S., in the Gulf of Manaar ‡, and the cursory dredgings off Batticaloa and Humbantotte by Captain W. A. Tindall, all tend, in some small measure, to reveal what a superlatively productive region, conchologically speaking, is that of Ceylon. We may add, that the scientific appendices to the Pearl-Oyster Fishery Reports brought out by Professor W. A. Herdman, F.R.S., have likewise added to our knowledge of this fauna, as regards *Cephalopoda* (Dr. W. E. Hoyle), *Polyplacophora* (Mr. E. R. Sykes), and *Opisthobranchiata* (Mr. G. P. Farran), while the *Gastropoda* and *Pelecypoda* are being reported upon by one of us (R. Standen) in conjunction with Mr. Alfred Leicester.

Maldive and Laccadive Islands.

Mr. Edgar Smith enumerated 380 species§ as occurring in these islands, collected by the Stanley Gardiner Expedition, remarking that "this probably comprises a large proportion of the forms which occur." Only 49 of these are noted by him, in the tabular list of distribution, as occurring in the Persian Gulf. We notice, however, that *Conus maldivus* L. is not included, the name of which would incline us to the belief it had first been detected in the Maldives. *Pecten maldivensis* Sm., has also been found to occur in the Gulf; and no doubt the number of species common to both regions will be found much larger, with more detailed research. In the Pelecypoda for instance, *Semipecten forbesianus*, *Septifer bilocularis*, *Arca imbricata*, *Cardium sueziense*, *C. fornicatum*, *Venus marica*, &c., all occur in both.

Referring, cursorily, to the brief *résumé* given in our first paper || on the distribution of the chief genera of Gastropoda in the

* 'Ceylon,' vol. i. pp. 233-243 (2nd edition, 1859).

† Journ. of Conch. i. p. 71 (1874).

‡ Bull. Mus. Madras, No. 3 (1895); Journ. of Conch. ix. pp. 30, 75.

§ 'The Fauna and Geography of the Maldive and Laccadive Archipelagoes,' vol. ii. pp. 589-630, pls. xxxv. & xxxvi. (1903).

|| P. Z. S. 1901 (vol. ii.), pp. 330, 331.

Persian-Gulf region, we would say, as regards the Pelecypoda, that the most distinctive and widely-spread family appears to be the Tellinacea, between 40 and 50 species of the typical genus *Tellina* being present, several endemic and hitherto unknown, others of wide range. Veneracea are likewise plentiful, some, e. g. *Tivela ponderosa* Koch, and *Callista multiradiata* Sowb., being among the finest of their race. The only *Solenomya* is peculiar, being also an inhabitant of Patagonia. The members of the Arcacea are freely distributed, amongst them being two fine endemic *Pectunculi*, *P. maskatensis* Melv. and *heroicus* M. & St., this last now described in this paper. In Nuculidæ, *Yoldia* and *Leda* can boast of several most interesting species, *Nucula* being also present, but not to so prominent a degree. In Mytilacea, several *Modioliæ*, *Crenellæ*, &c. occur, mostly of small size, but in some variety and refinement of form.

In Aviculidæ a few striking species occur, the most notable, of course, being the local varieties of the Pearl-Oyster, an important fishery of which exists in the Persian Gulf. Among the true Oysters (*Ostrea*), some large and important forms are found, e. g., *O. cucullata* Born, and *iridescens* Gray, the latter attaining a large size. But to *O. townsendi* Melv., an endemic species discovered about ten years ago by Mr. Townsend, adhering to the telegraph-cable in the Gulf, must be given the palm, it being one of the few *Ostreae* exhibiting real beauty both in sculpture, form, and delicacy of coloration. *Pecten townsendi* Sowb., a noble species, *Vola dorotheæ* Melv., and a few deep-sea *Amussia* must not be passed without notice. *Spondylus exilis* Sowb. and *S. gloriandus* M. & St. are likewise two conspicuous endemic species, the former to some extent allied to the Mediterranean *S. gædaropus* L., though quite distinct. Indeed, close affinities with South-European forms are the characteristics of many species in this fauna, seeming to point in frequent instances to a common archaic ancestry. In the Lucinidæ, *Loripes victorialis* Melv., a most delicate milky-white transparent species, with close concentric lamellæ, is endemic; and the same may be said of the somewhat similarly ornamented *Maetrinula tryphera** Melv., from the Persian Gulf.

The Cardiacea are many in numbers, but few of conspicuous size, *Cardium fornicatum* Sowb. being perhaps the most interesting; while the smaller *C. centum-liratum* Melv., described below, is a particularly delicately-sculptured abyssal shell. Among the Myacea, *Gari* (*Psammobia*) exhibits 13 or 14 species, some endemic, all being varied in both sculpture and coloration. Some large Pholadacea occur: *Pholas bakeri* Desh. (named after the late Major Baker, the first recorder of Mollusca from Karachi, in 1850), has a wide range over the northern shores, and *Ph. orientalis* Gm. occurs with valves sometimes 8 inches in length. In the Anatinacea are one or two *Anatinae*, four

* Since this paper was written, this *Maetrinula* has been dredged by the 'Investigator' in deep waters south of the Gulf, thus extending its area of distribution.

Pandora, two *Thracia*; these last were both discovered in recent years—one by Commander E. R. Shopland at Aden, and now recorded with increased distribution in the Persian Gulf; the other, first found by Mr. A. Abercrombie, near Salsette Island, Bombay, is not yet known outside that restricted limit. Finally, among the Septibranchiata are to be seen a few *Cuspidaria* (*Nearca*). Doubtless, further deep-sea dredgings will increase the number here, the present records being somewhat below the average. Recently, Dr. Sturany has discovered in Erythraean waters no less than five species of this genus, two of which (*C. potti* and *brachyrhynchus* Stur.) are among the enumerations in the accompanying Catalogue, both antedated by the names *C. alcocki* and *approximata* E. A. Smith, having been first dredged by the s.s. 'Investigator' Expedition in the Bay of Bengal.

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[*Pecten cristatus*, sp. n., from Mussandam I.]

1905. BERGH (R.).—Die Opisthobranchiata der "Siboga" Expedition. Leiden, 1905. 248 pp., 2 plates.

1898. DALL (W. H.).—List of a Collection of Shells from the Gulf of Aden obtained by the Museum's East African Expedition. Field Mus. Zool. i. pp. 187–189.

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* Proc. Zool. Soc. 1901, ii, pp. 331–334.

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It will not be amiss here to repeat that the region embraced in this paper includes all the seas north of an imaginary straight line drawn obliquely from Cape Ras-el-Had, Arabia, near Maskat (Muscat), to Panjim in Continental India, say, from Lat. 22° 34' N., Long. 51° 48' E., to Lat. 15° 50' N., Long. 74° E.

We would also again mention the three subdivisions proposed in our Part I. as follows:—

- (1) P.G. The whole Persian Gulf, including the Gulf of Oman, with Maskat and Jask, bordered eastwardly by Long. $59^{\circ} 48' E.$
- (2) M.C. The Mekran Coast of Persia and Baluchistan, between Long. $59^{\circ} 48' E.$ and the River Hab.
- (3) I. The Coast of Continental India, from east of the River Hab, abutting on Karachi, say from Long. $66^{\circ} 40' E.$ south-eastwards to Panjim, Lat. $15^{\circ} 50' N.,$ Long. $74^{\circ} E.$

The *Classification* is that of P. Pelsener, as proposed in his 'Introduction à l'Étude des Mollusques.'

CATALOGUE OF THE SPECIES.

PELECYPODA.

Order I. PROTOBRANCHIATA.

Fam. NUCULIDÆ.

NUCULA CONSENTANEA * Melvill, sp. n. (Plate LIV. fig. 7.)

N. testa parva, solidula, pallide brunnea vel cinerea, oblique ovata, modice convexa; costulis tenuibus concentricis rugosis decorata, radiatim obscurissime striata, lunula oblonga, margine dorsali utrinque declivi, postice elongato, antice paullum arcuato; pagina interna margaritacea, margine multum crenulato; dentibus ad 15, fortibus, ultra medium fossa parva interruptis.
Alt. 5, lat. 6.50, diam. 3 (sp. maj.).

Hab. P.G. and M.C. Gulf of Oman; lat. $24^{\circ} 58' N.,$ long. $56^{\circ} 54' E.$; 156 fathoms, shell-sand. Also rarely off Charbar, lat. $25^{\circ} 10' N.,$ long. $60^{\circ} 34' E.,$ at 40 fathoms (March 1906).

Allied to *N. culebrensis* E. A. Sm., from the West Indies ('Challenger' Expedition), and *N. sculpturata* Sowb., from South Africa, the radiating and concentric sculpture being of the same character. It occurs commonly at the first locality, many examples, in various stages of growth, being quite perfect.

NUCULA LAYARDI A. Ad.

P.G. Bushire. Shaikh Shuaib Island. Gulf of Oman: lat. $17^{\circ} 18' N.,$ long. $51^{\circ} 52' S;$ dredged at 27 fathoms, mud.

M.C. Lat. $25^{\circ} 10' N.,$ long. $60^{\circ} 34' E.;$ 40 fathoms, off Charbar.

I. Karachi. 10 fathoms, mud. Bombay (A. Abercrombie)

NUCULA NUCLEUS (L.).

P.G. Bushire. With *N. layardi* A. Ad. We cannot

* *Consentaneus*, in accord, or agreement.

dissociate these Persian Gulf examples from the common European species.

NUCULA RUGULOSA Sowb.

P.G. Gulf of Oman. Lat. 27° N., long. 52° E.

Amongst shell-growth on the telegraph-cable, at 40 fathoms, mud bottom.

LEDA BELLULA A. Ad. (*Nuculana* Link.)

I. Karachi, very sparingly.

LEDA BROOKEI Hanley.

M.C. Charbar. Shell-sand; 40 fathoms.

I. Bombay (*Abercrombie*); one or two specimens only.
Distrib. Borneo.

LEDA FRAGILIS (Chemn.).

P.G. Shaikh Shuaib Island. 3 fathoms, mud and sand.

LEDA MAURITIANA Sowb.

M.C. In many soundings at from 10 to 50 fathoms, mostly on mud bottom.

I. Bombay (*Abercrombie*).

YOLDIA CLARA Melv.

P.G. Bushire. 4 fathoms, mud.

YOLDIA LEPIDULA A. Ad.

P.G. Lat. 27° 18' N., long. 51° 52' E. Dredged from muddy bottom at 27 fathoms.

I. Off Karachi. 15 fathoms, mud.

In range extending to Borneo.

YOLDIA NICOBARICA (Chemn.).

P.G. Gulf of Oman. Lat. 26° 23' N., long. 54° 53' E.; mostly at 25 fathoms.

I. Bombay (*Abercrombie*), rare.

Occurs as far south as Ceylon.

YOLDIA SEROTINA Hinds.

P.G. Gulf of Oman. Lat. 25° 58' N., long. 57° 03' E.; 55 fathoms, mud. Among shell-growth on telegraph-cable.

Ranges as far east as Borneo.

YOLDIA TENELLA Hinds.

P.G. Gulf of Oman. Lat. 24° 50' N., long. 65° 49' E.

YOLDIA TROPICA Melv.

P.G. Gulf of Oman, Maskat. 15 fathoms; large.

M.C. Lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$ 40 fathoms, off Charbar; abundant, but mostly half-valves, dead. Also in Charbar Bay at 15 fathoms.

I. Karachi. 5 fathoms; thin mud.

Fam. SOLENOHYDRE.

SOLENOHYDRA PATAGONICA E. A. Sm. (*Solemya*.)

P.G. Gulf of Oman. Lat. $24^{\circ} 49' N.$, long., $56^{\circ} 56' E.$; 225 fathoms.

The extension of range now proved to exist for this comparatively recently described species is peculiarly remarkable. Our specimens have been submitted to the author, and pronounced identical with the original gatherings off Patagonia.

Order II. FILIBRANCHIATA.

Suborder A. ANOMIACEA.

Fam. ANOMIADÆ.

ANOMIA ACHÆUS Gray.

I. Karachi. Parasitic on *Placenta*, various *Pectinidæ*, and other Mollusca.

ANOMIA (ÆNIGMA) ÆNIGMATICA Anton.

I. Karachi (*Major Baker*). Not yet recorded by Mr. Townsend. Bombay (*Abercrombie*).

PLACENTA ORBICULARIS Retz. (= *Placuna placenta* L.).

P.G. In many places: mostly on muddy banks at low water.

I. Karachi. Bombay, abundant (*A. Abercrombie*, *E. H. Aitken* and *Captain A. J. Peile*). Panjim and Goa (*Lt.-Col. H. D. Olivier*).

Largely used, both in India and China, in the manufacture of window panes, and is a general substitute for glass. It also shelters a small crab, and seed pearls are not infrequent in the species—very probably on account of the crustacean causing irritation.

Suborder B. ARCACEA.

Fam. ARCADÆ.

ARCA BISTRIGATA Dunker.

I. Karachi: found on rocks at low tide. Bombay (*Paetel*, Cat. iii. p. 211). Found there also by Mr. *Abercrombie*.

ARCA REQUIESCENS Melvill, sp. n. (Plate LIV. fig. 2.)

A. testa minuta, anguste-trapezoidea, versus medium depressa, inæquilaterali, æquivalvi, postice magis expansa; costis longi-

tudinalibus circa 28, undique cum interstitiis, pulchre squamose cancellatis, margine dorsali recto; umbonibus distantibus, paullum incurvis, margine ventrali apud medium sinuato, crenulato; cardine utrinque multi-denticulato; pagina interna alba.

Alt. 2.50, *lat.* 5, *diam.* 2.75 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

A very small, abyssal, and probably almost if not quite adult *Arca*, almost precisely a miniature replica of *A. noë* L. or its corresponding tropical ally. The form is narrowly trapezoid, posteriorly somewhat expanded, the most conspicuous feature being the marked longitudinal depression just below the umbones, beyond which, anteriorly, the form is somewhat abbreviated. All the examples we have seen are half-valves only.

ARCA (BATHYARCA) ANACLIMA* Melvill, sp. n. (Plate LIV. fig. 6.)

A. testa minuta, tenui, albo-lactea, oblique truncatula, tumida, inæquilaterali, concentrice, simul ac radiatim, undique liris tenuissimis circumcincta et cancellata, latere antico oblique arcuato, postice magis recto, margine ventrali leniter rotundato; umbonibus prominulis, area dorsali angusta; pagina interna alba, subpellucente; dentibus minutis, inconspicuis, utrinque a medio divergentibus.

Alt. 2.50, *lat.* 3, *diam.* 2.25 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, abundant. Lat. 25° 10' N., long. 60° 34' E.; 40 fathoms, rarely.

This little species, of which there were multitudinous examples dredged, but all in dissociated valves, has as its nearest ally *Scapharca inæquisculpta* E. A. Sm., from Culebra Island, West Indies, 390 fathoms, collected in Pteropod ooze by the 'Challenger' Expedition †. It is probably, according to Dr. W. H. Dall, who has kindly examined specimens, hardly adult, but abundantly differs from other species inhabiting the same region. The radiating and concentric cancellations are very beautiful, when examined with a lens of moderate power.

ARCA (SCAPHARCA) BIRLEYANA Melvill, sp. n. (Plate LIII. fig. 8.)

A. testa ovato-trapezoidea, solidula, sordide albo-cinerea, epidermide setosa ad latera præcipue tecta; valva sinistra dextram paullum superimpendente, ad regionem umbonalem planato-compressa; umbonibus ipsis parvis, latere antico abbreviato, postico recti-quadrato, margine dorsali recto, ventrali ad latus

* *ἀνάκλιμα*, a sloping forward, obliquity, from the form.

† Report 'Challenger' Exped., Zoology, vol. xiii. p. 267, pl. xvii. figs. 8, 8a.

anticum leniter rotundato; costis radiantibus pernumerosis, ad 48, nitidis, fere levibus, albis, interstitiis sub lente obscure squamatis; pagina interna alba, margine undique profunde sulcato; dentibus ad 44, interdum bifurcatis; area ligamentari angusta.

Alt. 27, *lat.* 34, *diam.* 25 mm.

Hab. Persian Gulf, Thairi (1903).

One specimen only, but in superb condition. The many uniform, close-set ribs, and peculiar flattened compression in the umbonal region, characterise this new form, which I would venture to dedicate to my friend Miss Caroline Birley, who has from the first been very interested in all that appertained to the elucidation of the Mollusca of the Persian Gulf, both recent and fossil forms.

ARCA (SCAPHARCA) CIBOTINA* Melvill, sp.n. (Plate LIV. fig. 4.)

A. testa inaequilaterali, aequalvi, transversa, antice angusta, postice expansa, alba, tenui, superficie undique delicate et arcte radiatim lirata et cancellata; margine dorsali recto, ventrali plus minus sinuato; umbonibus prominulis, contiguis, dentibus anticis 5 vel 6, posticis ad 15; pagina interna subhyalina, albo-lactea, delicata.

Alt. 5, *lat.* 8, *diam.* 2 mm.

Hab. Persian Gulf: Gulf of Oman. *Lat.* 24° 58' N., *long.* 56° 54' E.; 156 fathoms, shell-sand. Fairly abundant, but all dead shells.

This small member of the Arcacea seems distinct. We ally with it *A. culebrensis* Smith, from Culebra Island, W. Indies†. All our examples are of much the same dimensions, and probably nearly or quite adult.

ARCA (SCAPHARCA) CLATHRATA Reeve.

P.G. Gulf of Oman. *Lat.* 24° 58' N., *long.* 56° 54' E.; 156 fathoms, shell-sand.

Small imperfect specimens referred here with a little doubt. They may prove to be the allied *A. consociata* Smith (Rep. 'Challenger' Exp. xiii. p. 266, pl. xvii. figs. 7-7a), which they much resemble in size and general character.

ARCA (SCAPHARCA) INÆQUALVIS Brug.

P.G. Young examples, most probably referable to this species, have been dredged off Maskat at 15 fathoms.

I. Bombay; common and fine (*Abercrombie*). Bombay to Panjim and Goa (*Lt.-Col. H. D. Olivier*).

ARCA (SCAPHARCA) JAPONICA Reeve.

I. Bombay (*Abercrombie*).

* κίβωτος, a chest or coffer.

† Report 'Challenger' Exped., Zoology, vol. xiii. p. 268, pl. xxii. figs. 9-9b.

ARCA (SCAPHARCA) NATALENSIS KRAUSS.

P.G. Dabai, 8 fathoms.

The head-quarters of this species are, as its name implies, South African.

ARCA (SCAPHARCA) RHOMBEA BORN.

I. Bombay (*Abercrombie*).

ARCA (SCAPHARCA) RUFESCENS Reeve.

P.G. Dabai, 8 fathoms.

I. Karachi (October 1894).

ARCA (ANOMALOCARDIA) GRANOSA Lam.

I. Bombay (*Abercrombie*). A conspicuous species, common in this locality, but not yet recorded further north. Largely eaten by the natives along the Indian coast (*Captain A. J. Peile*).

PARALLELIPIPEDUM TORTUOSUM (L.).

P.G. Henjam Island; dredged at 17 fathoms, mud bottom. Dabai at 8 fathoms.

I. Karachi; at 3 fathoms, mud and loose rocks. Between Bombay and Ratnagiri (*E. H. Aitken*). Off Bombay, dredged, half-valves (*F. W. T.*), 1906.

CUCULLÆA CONCAMERATA (Chemn.).

P.G. Maskat Jask; dredged at 10 fathoms, muddy sand. 3 fathoms, sand.

BARBATIA CYMBÆFORMIS Reeve.

I. Karachi.

BARBATIA DIVARICATA Sowb. (= *obliquata* Wood).

I. Karachi. Found under rocks at half-tide (*F. W. T.* and *Major Baker*). Bombay, but rare (*A. Abercrombie*).

BARBATIA DOMINGENSIS Lam. (= *squamosa* Lam.).

P.G. Gulf of Oman; lat. 26° 50' N., long. 54° 50' E. Also Maskat, 15 fathoms. A species of increasingly wide distribution. Also dredged at 48-49 fathoms by the 'Investigator' in the Gulf of Oman.

BARBATIA ILLOTA Sowb.

P.G. Very local. Some little doubt exists as to the determination of this species. The typical *illota* are from Western Tropical America.

BARBATIA IMBRICATA (Brug.).

P.G. Henjam Island. 15 fathoms, mud.

M.C. Charbar Point. 7 fathoms.

I. Karachi.

This appears to be *B. clathrata* (Lam.).

BARBATIA LACTEA (L.).

I. Bombay (*Abercrombie*).Includes *B. zebuensis* Reeve.

Likewise native of European seas, including Great Britain.

BARBATIA NIVEA Gmel.

P.G. Dabai. 8 fathoms (1903).

BARBATIA (ACAR) AVELLANARIA* Melvill, sp. n. (Plate LIV. fig. 3.)

B. testa alba, solidula, oblonga, lateribus ambobus leniter marginem apud ventralem rotundatis, parallela, superficie omni arcte et pulcherrime cancellata, postice costis radiantibus magis prominulis, majoribus, sub lente gemmulatis; pagina intus alba, marginibus undique fimbriolatis; dentibus crassis, normalibus.

Alt. 4, lat. 7, diam. 3 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long 56 54' E.; 156 fathoms, shell-sand.

An abundant species, of compact growth, and close cancellation, excepting posteriorly, where six or seven prominent ribs extend radiately, the interstices being free and clearly defined.

BARBATIA (ACAR) GRADATA Brod. & Sowb.

P.G. Very local.

BARBATIA (ACAR) MARGARETHE Melvill, sp. n. (Plate LIV. fig. 5.)

B. testa parva, incrassata, inaequilaterali, equalvi, oblique trapezoidea, utrinque obtuse angulata, postice elongata, margine dorsali et ventrali parallelis, superficie omni arcte et pulcherrime cancellata, et radiatim regulariter imbricato-costellata; pagina intus alba: carline dentibus paucis, circa 16 (videlicet 11 posticis, 5 anticis) praedito.

Alt. 5, lat. 8, diam. 3 mm. (*sp. maj.*).,, 3, ,, 4, ,, 1.5 ,, (*sp. min.*).

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, often attached to Serpulae &c.

A highly decorated little *Acar*, we think full-grown. Allied to *A. domingensis* Lamk., but the imbricated concentric cancellations are of much finer grain and texture. At the request of Mr. Townsend we associate with this beautiful shell the name of Mrs. Margaret Whitby-Smith, who has taken much kindly interest in this and other discoveries made by him.

BARBATIA (ACAR) SCULPTILIS Reeve.

I. Karachi (*Major Baker*).* *Avellana*, a hazel-nut.

BARBATIA (ACAR) SYMMETRICA Reeve.

I. Karachi, rarely.

BARBATIA (ACAR) TENEBRICA Reeve.

I. Karachi. Also Bombay (*Abercrombie*).

N.B.—It is our belief the large *B. helblingi* Chemn. (recorded in Commander E. R. Shopland's List of Adenese Mollusca) extends its range to the Persian Gulf, though it is impossible at present to corroborate this with specimens in the collection.

PECTUNCULUS HEROICUS, sp. n. (Plate LV. fig. 1.)

P. testa magna, solida, æquivalvi, inæquilaterali, orbiculari, convexa, superficie plana, obscure longitudinaliter multiradiata, epidermide ad marginem valvarum ventralem densa, fimbriatula, nigro-olivacea; umbonibus parvis, incurvis, area ligamentari externa divisis, margine dorsali antice obliquo, postice fere recto, radiis sub lente præcipue apud umbones pulchre cancellatis, et transversim liratis; interstitiis obscurissime quadratis; pagina interna alba, nitida, margine multisulcuro, cardine regulari; dentibus ad 24 in utraque valva instructis.

Alt. 53, lat. 55, diam. 40 mm.

Hab. Persian Gulf.

A large, well-marked *Pectunculus*, allied most nearly to *P. lividus* Sow., from the Red Sea, mainly differing in being inæquilateral, the posterior dorsal margin being straight. It has, so far, only occurred very rarely.

PECTUNCULUS LIVIDUS Reeve.

I. Karachi. An Erythræan species, doubtless occurring in intermediate stations.

PECTUNCULUS STRIATULARIS Lam.

P.G. Gulf of Oman. Lat. 26° 50' N., long. 54° 50' E.; coral-sand and mud.

PECTUNCULUS TAYLORIANUS Ang.

P.G. Gulf of Oman: Maskat. 10–15 fathoms.

I. Karachi, but rarely.

PECTUNCULUS (AXINÆA) MASKATENSIS Melv.

P.G. Gulf of Oman, Maskat. 10–15 fathoms.

A finely sculptured species.

PECTUNCULUS (AXINÆA) PECTINIFORMIS Lam.

P.G. Shaikh Shuaib I.; dredged at 7 fathoms, muddy sand and loose rocks. Dabai, 8 fathoms. Gulf of Oman, at 15 fathoms beyond Maskat.

I. Karachi.

PECTUNCULUS (AXINÆA) SPURCUS Reeve.

I. Karachi. Dredged at 3-7 fathoms, mud (*F.W.T.*) (*J. O. T'cells*).

. Also reported from Gulf of Manaar, Ceylon. Originally described from Central America, and is probably a species of very wide distribution.

LIMOPSIS ELACHISTA Sturany.

Limopsis elachista Sturany, Exp. 'Pola' im Rothen Meer (1899)
Taf. iv. figs. 1-4.

P.G. & M.C. Gulf of Oman. Lat. 25° 04' N., long. 60° 20' E.; 60 fathoms. Also in abundance, lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand. Rarely off Charbar, at 40 fathoms. We are indebted to the author, Dr. R. Sturany, for the corroboration of identification.

LIMOPSIS MULTISTRATA Forskål. (*Pectunculina* D'Orb. 1844.)

I. Lat. 18° 25' N., long. 71° 45' E.; at 191 fathoms.

A large, abyssal species, finely chased and sculptured, which, originally described as Erythræan, probably will be found in intermediate stations, such as the Persian Gulf and Arabian coasts.

Suborder C. MYTILACEA.

Fam. MYTILIDÆ.

MYTILUS (CHLOROMYA) PICTUS Born (= *afes* Gmel.).

M.C. Gwadûr Beach, at low tide. These specimens belong to var. b. *taprobanensis*, a Southern form having its headquarters in Ceylon.

I. Bombay, southwards to Goa (*Lt.-Col. H. D. Olivier*).

MYTILUS (CHLOROMYA) SMARAGDINUS Chemn.

P.G. Gulf of Oman. Lat. 25° 04' N., long. 60° 20' E.; 60 fathoms.

I. Karachi.

MYTILUS VARIABILIS Krauss.

M.C. In one or two places, but rarely.

I. Karachi. Found on rocks at about high-tide mark.

Originally described from South Africa.

N.B.—*Mytilus canaliculatus* Hanley, reported by Major Baker as occurring at Karachi, is probably an erroneous record.

SEPTIFER BILOCULARIS L.

P.G. Lat. 27° N., long. 52° E.; at 40 fathoms, adhering to cable. Koweit, 10 fathoms.

SEPTIFER EXCISUS Wiegman.

I. Karachi, not commonly. Its extension of range is great, occurring as far south as Madagascar.

Mr. Jukes-Browne makes *Septifer Récluz* a subgenus of *Brachyodontes* Sw., raised by him to generic rank*.

MODIOLA ALBICOSTA Lam.† (*Volsella* Scopoli, 1777.)

P.G. Linjah. 3 fathoms, where a large bed of this species was unearthed, mostly hardly adult, and in very perfect condition.

MODIOLA AURICULATA Krauss.

P.G. Exact locality not specified, but seemingly identical with typical S. African examples.

MODIOLA ELEGANS Gray.

P.G. Shaikh Shuaib Island, off Maskat. 15 fathoms.

M.C. Charbar. 7 fathoms, sandy mud and rock.

MODIOLA FLAVIDA Dkr.

P.G. Gulf of Oman, Maskat. 10–15 fathoms, muddy sand and spongy growths.

MODIOLA MODIOLUS (L.). (*Mytilus* L. in parte.)

P.G. Jask. Dredged on Mason Shoal at 3 fathoms, coral-sand and stone bottom.

Of wide distribution, temperate and tropical. We have collected it on the shores of the United States of America.

MODIOLA RHOMBOIDEA Hanley. (*Volsella* Scop.)

P.G. Gulf of Oman, Maskat. 10 fathoms, inside sponges.

M.C. Charbar. With *M. elegans* Gray, at 7 fathoms.

BRACHYDONTES EMARGINATUS (Benson).

Modiola emarginata Benson.

I. Bombay (*Abercrombie*), but rarely.

BRACHYDONTES (HORMOMYA) KARACHIENSIS, sp. n. (Plate LIV. fig. 8.)

B. testa luteo-fusca, epidermide sordide alba partim induta, arcuato-oblonga, parva, gibboso-globosa, postice concava, antice apud umbones rotunde attenuata, superficie saepe laminis incrementalibus concentricè prædita, undique arcte radiatim ramoso-lirata; interstitiis arcissime concentricè liratulis; pagina interna pallide margaritacea, ligamento marginali, cardinali crenulato.

Alt. 7, lat. 13, diam. 7 mm.

Hab. India: Karachi; on loose stones at low water.

This species has remained long at the British Museum unnamed.

* Proc. Mal. Soc. vol. vi. p. 222.

† Three species of *Modiola*—*philippinarum* Hanley, *watsoni* Smith, and *arborescens* (Chemn.)—also a new *Crenella*, *C. persica* Smith, were lately dredged in the Persian Gulf by s.s. 'Investigator.'

Superficially it is somewhat akin to *Mytilus cubitus* Say, found by one of us on the shores of Florida several years ago, and likewise to *M. charpentieri* Dunker, from West Africa, but in our opinion is sufficiently distinct from all its congeners to merit a separate description. Mr. A. J. Jukes-Browne, to whom our thanks are due for having examined our specimens, considers it, with *M. cubitus* Say, *charpentieri* Dkr., and others formerly considered *Mytili*, as belonging to the genus *Brachyodontes* Sw., subgenus *Hormomya* (Mörch)*.

CRENELLA ADAMSIANA, nom. nov. (Plate LV. fig. 2.)

Crenella decussata A. Ad. Proc. Zool. Soc. 1870, p. 7, non Montagu.

Cryptodon decussatus Ad.

P.G. Gulf of Oman, Maskat. 15 fathoms.

M.C. Dredged in various places, at 10 to 15 fathoms.

I. Karachi.

This is not, as was thought by Dr. Arthur Adams, identical with the British and Northern Atlantic species, and therefore requires a name.

CRENELLA PRÆCELLENS Melvill, sp. n. (Plate LV. fig. 4.)

C. testa tenui, albida vel pallide brunnea, subobliqua, profunde convexa, pyriformi, superne latiore, undique radiatim pulchre tenuilirata, lineis concentricis incrementalibus fortiter prædita, antice fere recta, postice obliqua, ad marginem ventralem sensim delabente; umbonibus parvulis, linea cardinali in valva sinistra paulum prominula, dentiformi; pagina interna alba, marginibus minutissime crenuliferis.

Alt. 8, lat. 6, diam. 5 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand. Maskat, 15 fathoms.

From the last-mentioned place come small, perfect examples, pale brown in colour.

A beautiful species, the fine radiating liræ, crossed with repeated concentric incremental lines of growth, being conspicuous; the form pear-like, while within a tooth-like projection attached to the hinge-plate is noticeable in the left valve, the whole internal margin being crenulate. The valves are profoundly convex and swollen; some variation existing as regards depth and width of convexity.

MODIOLARIA CALCEATA †, sp. n. (Plate LV. fig. 3.)

M. testa parva, anguste oblongo-rhomboidæa, albida, inæquilaterali, convexa, lateribus fere rectis; umbonibus parvis, paulum incurvis, bina serie striarum radiatim disposita, antice simul ac postice, inter quas superficie concentricis incre-

* Proc. Mal. Soc. vol. vi. p. 223.

† *Calceus*, a shoe, from the very convex oblong form.

menti liris solum ornata, ligamento lineari, margine minute crenulato.

Alt. 5, *lat.* 3, *diam.* 2.75 mm.

Hab. Persian Gulf. *Lat.* 24° 58' N., *long.* 56° 54' E.; 156 fathoms, shell-sand.

Many half-valves of a small, narrowly rhomboid *Modiolaria*, bearing the characteristic generic sculpture. The ligament is linear and marginal, no tooth visible, and the interior margin is minutely crenulate. All our specimens are of much the same size, and we deem them adult.

MODIOLARIA CUMINGIANA Dkr.

I. Karachi. From 3 to 7 fathoms, amongst growth of sponges, &c. Extends in range to South Australia.

LITHODOMUS ATTENUATUS Desh.

P.G. Locality not precisely specified.

I. Karachi. Found on rocks off Beach Fort, Manora.

LITHODOMUS CINNAMOMEUS Lam.

I. Karachi, not plentiful.

LITHODOMUS MALACCANUS Reeve.

I. Karachi. A little doubt attends this identification, the specimens having been mislaid.

LITHODOMUS TOWNSENDI, sp. n. (Plate LV. fig. 8.)

L. testa parva, cylindræa, tenui, epidermide nigro-brunnea, superficie fere lævigata, antice paullulum rugulosa, postice globosa, extremitate antice producta, multum attenuata, fere caudata.

Alt. 7, *lat.* 18, *diam.* 5 mm.

Hab. Persian Gulf: Gulf of Oman, on rocky ground. *Lat.* 27° N., *long.* 52° E. 40 fathoms.

This little species, resembling a miniature *L. caudigerus* Lamk., an inhabitant of the West Indies, or *attenuatus* Desh., from Chile, differs from its congeners not only in size, but in the almost complete absence of the wrinkled anterior surface, sometimes channelled and shagreened, so usual in members of this genus. We consider it full-grown. Two examples, exactly matching each other, have as yet only occurred. It is a pleasure to associate with this the name of Mr. F. W. Townsend.

Order III. PSEUDOLAMELLIBRANCHIATA.

Fam. AVICULIDÆ.

AVICULA MACROPTERA Lam. (= *Pteria* Scop.)

P.G. Maskat. 15 fathoms.

Called "Mussel" or "Bombay Mussel."

AVICULA MARMORATA Phil. (= *Pteria* Scop.)

P.G. In two or three places found adhering in considerable clusters to the telegraph-cable, at 50-55 fathoms, mud bottom.†

N.B.—Several immature *Aviculae*, dredged at various depths, occur in the collection, but none is capable of exact identification. One is allied to *A. zebra* Reeve, and may possibly be that species.

MARGARITIFERA IMBRICATA (Reeve). (= *Meleagrina* Lam.)

P.G. Rare on the telegraph-cable.

MARGARITIFERA MARGARITIFERA (L., 1760). (= *Meleagrina* Lam.)

Var. c. *persica* Jameson.

P.G. & M.C. Generally distributed and found on most rocky patches. A curious young form occurred at Charbar, at 8 fathoms, in muddy sand.

Dr. Lyster Jameson* gives the Bahrein district in the Persian Gulf as supplying this species most copiously, and adds that it is "called 'Bombay shell' in the Pearl trade."

MARGARITIFERA MURICATA (Reeve). (= *Meleagrina* Lam.)

P.G. On the telegraph-cable, with *M. imbricata* Rve.

MARGARITIFERA VULGARIS (Schum. 1817). (= *Meleagrina* Lam.)

Avicula fucata Gould, 1850.

P.G. The "Linjah" shell of the Persian Gulf, *e. g.* at Dabai, adhering frequently to the telegraph-cable. This species, having its headquarters in the Arabian Sea, extends, according to Dr. Lyster Jameson (*l. c.* pp. 385-386) to East Africa, Malay Peninsula, Australia, and New Guinea. It is also reported from Japan and New Zealand, being one of the most variable of all the pearl-shells. *M. margaritifera* and this species are styled the Bombay and Ceylon Pearl-Oysters, respectively, by the traders.

Mr. J. Calcott Gaskin, Assistant Political Agent, Bahrein, kindly supplied the following notes, which are well worth perusal here:—

A Memorandum on the Pearl-shells and Pearl-fishing Operations in the Persian Gulf.

There are three sorts of marketable shells found in the Persian Gulf, viz. :—

The Mother-o'-Pearl

The Mussel.

The Pearl-Oyster.

Mother-o'-Pearl Shells.—The best Mother-o'-Pearl shells are found round the islands near the Persian coast, principally at Hinderabi, Shaikh Shuaib, Kais Island, and Chira on the Persian coast; some are also obtained at Das, Karunein, and Zerukah

* Proc. Zool. Soc. 1901, vol. i. p. 375.

Islands, and off the Oman coast between Ras-el-Khaima and Ghobat Ghazira. They are sought at varying depths, from a little below the surface to 18 fathoms of water, on hard mud and sandy bottom. There is no information as regards the quantity annually exported, but it may be stated that it is small, and probably about 120 to 150 tons. The shells brought up weigh from $\frac{1}{2}$ lb. to 2 lbs. each, and are sold from 4*d.* to 8*d.* per lb. according to quality and the supply and demand. Pearls are very seldom found in these shells, but when they do occur they are generally large and of a fine quality.

Mussel-Shells.—The banks off the coast between Ras-el-Khaima and Ghobat Ghazira produce the most and largest mussel-shells in the Gulf. The best qualities, however, obtain round the islands of Hinderabi, Shaikh Shuaib, and Kais. The mussel is plentiful also round Drijina and Arzana Islands. They are procured at the same depths as the Mother-o'-Pearl shells, and on similar bottoms. The annual export of this description of shell is about 400 to 500 tons. They weigh from 5 to 20 lbs. per hundred, and are generally disposed of at Linjah and Dalma Island. Those brought to Bahrein are sold from 10*s.* to 15*s.* per 60 lbs. Pearls are but rarely obtained in this shell.

Pearl-Oyster.—The richest Pearl-Oyster banks are situated round the northern and eastern coasts of the Bahrein Islands. The next in importance are those off the Katar coast, and there are also numerous other banks between Koweit and Bahrein, and south of Katar to Ras-el-Khaima. A few unimportant banks also exist along the Persian coast. The best quality of pearl-oyster shells are secured from the banks immediately north of Bahrein known as the "Adan," and are sold by the rice or coffee bag, according to agreement, which on the average hold 140 lbs. and 175 lbs. respectively, of uncleaned shells. The "Adan" shells weigh from 4 lbs. to 7 $\frac{1}{2}$ lbs. per 100, and fetch in Bahrein from 2*s.* to 4*s.* per bag of 140 lbs. Those from other banks weigh from 3 to 5 $\frac{1}{2}$ lbs. per 100, and are sold locally from 1*s.* 8*d.* to 3*s.* 6*d.*, according to the state of the London market. They are procured at the same depths as the other shells, on coral-rock and hard mud bottoms. It is estimated that about 2000 tons of oyster-shells are shipped annually to London and elsewhere. The Persian Gulf pearl-oyster shells are known under the name of "Linga shells" in the London market, owing to the first shipments from the Gulf having been made from the port of Linga (Linjah). They are scraped and sorted, the smallest sizes being thrown out before shipment, and on the average lose about 35 per cent. of the original weight in the process.

No reliable statement can be made as regards the average number of pearls found in a given quantity of shells, as no statistics on the subject are available. According to the Trade reports the value of pearls exported is about twenty times greater than that of the shell. This comparison is, however, unreliable owing to the fact that the greater portion of the oyster-shells are thrown

back into the sea by the divers for want of room on board the diving craft, as well as to avoid the evil effects from the putrefying oysters.

The European market prices of the various qualities of the three descriptions of shells named, are best obtainable in London.

The Mother-o'-Pearl and Mussel are sought after for the sake of the shell alone, but the Pearl-Oyster is gathered for the pearls, and the shell only considered as a by-product.

The most primitive methods are adopted in the diving operations, and no modern appliances are used or allowed by the tribes. The banks on the Arab side of the Gulf are the common property of the Arab tribes inhabiting that region, and are open to all comers so long as the same methods as are adopted by the Arabs are employed. The banks near the Persian coast and islands are claimed by Persia. The diving craft are generally equipped by the owners, and the results of the operations are shared by the owner and crew in proportions laid down by custom. The owner receives 20 per cent. of the nett earnings and 80 per cent. is divided between the crew, each diver receiving three shares and each rope-puller and extra man two shares. Occasionally men may be engaged for a round sum from Rs. 100 to Rs. 200 for the season, but these are generally indifferent divers who cannot obtain advances from their first employers.

It is difficult for new-comers to obtain the services of good divers owing to the system in vogue, which practically makes this class of men slaves to the masters of the pearling boats. The men's earnings are in the majority of cases insufficient to keep them all the year round, and consequently they take advances from their masters year after year to such an extent that they can never repay their debt, and when a diver elects to engage himself to another boat the owner of the latter has to pay up the debt due to the former master, should he engage him.

The Pearl-shell and Pearl-fishing season commences in the second week of May, and terminates in the third week of September generally, and Arabs, Negroes, and Persians are usually employed in the operations. The loss of life from sharks is said to be very small. The divers, however, suffer from chest diseases, and their average life is shorter than that of people occupied in other industries.

The value of the Pearls exported from the Persian Gulf during 1901 is estimated at over three-quarters of a million sterling (£750,000).

(Signed) J. CALCOTT GASKIN,
Assistant Political Agent.

Bahrain, 5th May, 1902.

Note by Mr. F. W. Townsend on Mr. Gaskin's report.

"I have at odd times during the last twelve years done a considerable amount of dredging off the coast of Hinderabi, Shaikh Shuaib, and Kais Islands, chiefly on the southern side, in from

5 to 20 fathoms, but have never found a single specimen of the true Mother-of-Pearl shell, and very few, not more than a couple of dozen altogether, of the small Pearl-Oyster, which I take to be the same species as that of which rich beds are mentioned as existing to the northward of the Bahrein Islands. In November 1903 I dredged many of the small pearl-oysters off the coast from Ras-el-Khaima and Abu Thabi, but did not get a single specimen of the large mussel, though I saw many sacks of it at Dabai ready for export. It occurs very rarely on the old telegraph-cable, while the small *A. marmorata* is an abundant form.

"The 'rope-pullers' mentioned (in Mr. Gaskin's report) are, I believe, the men who pull the baskets of oysters up from the bottom when they have been filled.

"When they so place them, at the same time the divers also include a great many other shells, notably *Pecten crassicostatus*, *townsendi*, *Spondylus exilis*—this in all stages of growth and coloration, from light orange to deep purple—*Cypræa*, e. g., *lenticinosa*, *fimbriata*, and *turdus*, also a species of *Trochus*, probably *T. fultoni*. All these, and others, I have myself found frequently in large numbers among the refuse thrown out of the pearl-boats, after they have been hauled up on the beach at the end of the working season."—F. W. T.

PERNA ROSTRATA Schum. (= *isognomon* Klein).

P.G. General. Found on coral-reefs at low tide.

PINNA BICOLOR Chemn.

P.G. On telegraph-cable.

PINNA (ATRINA) NIGRA Chemn.

P.G. & M.C. Local, and occasionally dwarfed, when the shell-substance becomes considerably thickened.

I. One specimen alone recorded from Bombay (*Abercrombie*).

PINNA (ATRINA) VEXILLUM Born.

I. Karachi. Dredged at 3 fathoms, mud.

MALLEUS NORMALIS Lamarck.

P.G. Maskat, 15 fathoms.

Fam. OSTREIDÆ.

OSTREA BICOLOR Hanl.

I. Bombay (*Abercrombie*).

OSTREA CRENULIFERA Sowb.

I. Bombay (*Abercrombie*).

OSTREA CUCULLATA Born.

P.G. On telegraph-cable in two or three situations.

OSTREA IMBRICATA Lam.

P.G. & M.C. Very general, often found growing in colonies on the telegraph-cable, between 30 and 55 fathoms, mud.

OSTREA IRIDESCENS Gray.

P.G. On telegraph-cable, attaining a very large size.

OSTREA (ALECTRYONIA) TOWNSENDI Melv.

P.G. At the entrance of the Gulf, the finest examples adhering to the telegraph-cable. Since this species was described (Mem. Manch. Soc. vol. xlii. (1898) No. 4, p. 27, pl. ii. fig. 14), Mr. Townsend has forwarded many examples, mostly adhering in threes and fours together, from near Shaikh Shuaib Island and elsewhere. It is probably generally distributed; though somewhat local, and is undoubtedly, as already mentioned in our introductory remarks, probably the most beautiful and symmetrical species of Oyster known, both as regards shell-texture and delicate coloration.

Fam. PECTINIDÆ.

AMUSSIUM CADUCUM E. A. Smith.

I. & P.G. Karachi. Also dredged in the Gulf of Oman, 667-811 fathoms, by s.s. 'Investigator' (E. A. Smith).

Originally described from the Philippines (Rep. 'Challenger' Exped., xiii. Lamellibr. p. 309, pl. xxiii. figs. 1-1c).

AMUSSIUM FORMOSUM Melvill, sp. n. (Plate LV. fig. 7.)

A. testa parva, tenuissima, albida, subpellucida, inequivalvi; valva sinistra majore, fere levi, costulis radiantibus evanidis, auriculis inequalibus, pulchre in utraque valva cancellatis; valva dextra sub lente concentrice delicatissime lirata; pagina interna costis ad 10-12 instructa, haud ad marginem valvæ sinistrae productis.

Alt. 9, *lat.* 8.50, *diam.* (*valvæ sinistrae maj.*) 1 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms.

Allied to *A. siebenrockii* Sturany, but much smoother, with rudimentary radiating ribs only; there is also no sign of cancellation on the left valve; the right valve is much the smaller, and is microscopically concentrically lirated. The internal white ribs, ten to twelve in number, are not produced to the ventral margin, as is the case in *A. siebenrockii*.

Many examples, but mostly in imperfect condition.

AMUSSIUM SIEBENROCKII Sturany.

Amussium siebenrockii Sturany, Exped. S.M. Schiff 'Pola' in das Rothe Meer (1899), p. 15, Taf. iv. figs. 5-8.

P.G. Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand. Some specimens prettily marked with opaque white and fawn-colour.

AMUSSIUM STEINDACHERI Sturany.

Amussium steindachneri Sturany, Exped. S.M. Schiff 'Pola' in das Rothe Meer (1899), p. 15, Taf. iv. figs. 9-12.

P.G. With the preceding; both equally abundant, mostly dissociated valves.

Also in the Gulf of Oman. Lat. $25^{\circ} 19' N.$, long. $55^{\circ} 10' E.$, at 140 fathoms; and lat. $24^{\circ} 54' N.$, long. $37^{\circ} 35' E.$, 205 fathoms.

In both these last localities the specimens were large, perfect, and highly coloured. We are indebted to the author (Dr. Rudolf Sturany, of Vienna) for confirming our views as to these two very interesting *Amussia*, first described from the Red Sea.

SEMIPECTEN FORBESIANUS (Ad. & Reeve).

Hemipecten forbesianus Ad. & Rve. Voy. of 'Samarang.'

I. Angrias Bank, in Bombay (*Capt. Tindall*). Also occurring in the Laccadive and Maldivé Isles (*Stanley Gardiner*).

This shows an extension of range.

PECTEN CRASSICOSTATUS Sowb. (*Chlamys* Bolten, 1798.)

P.G. Mussandam. Among large boulders at low tides, rarely.

Some authors propose to adopt Bolten's name now for the well-known cognomen *Pecten*, reserving this latter for the section *Vola* Klein.

PECTEN EOUS* Melvill, sp. n. (Plate LV. fig. 9.)

P. testa parva, perlævi, hyalina, albo-lactea, subdiaphana, fere rotunda, valva dextra magis convexa, sub lente obscure concentrico-striata; auriculis in sinistra subæqualibus, lævibus; pagina interna hyalina, lævi.

Alt. 3.75, lat. 4, diam. 1.50 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. $24^{\circ} 58' N.$, long. $56^{\circ} 54' E.$; 156 fathoms, shell-sand.

M.C. Lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$; 40 fathoms.

Of the same alliance as *P. vitreus* Chemn. and *P. subhyalinus* Smith ('Challenger' Rep., vol. xiii. Lamell. p. 304, pl. xxii. figs. 2, 2a); but is smaller than either of these species, convex, perfectly smooth excepting for very obscure incremental concentric liræ (visible only with aid of a lens) on the left valve, the auricles being quite smooth; within, it is subhyaline and smooth. Both right and left valves were equally abundant in the above dredgings, but no perfect specimen has yet been seen. One example from the latter locality exhibits slight traces of rufous coloration.

PECTEN FLABELLOIDES Reeve.

I. Karachi.

PECTEN LAYARDI Reeve.

I. Karachi.

Extending southward to Ceylon and westward to Aden (*Commander E. R. Shopland*).

* *Eous*, eastern.

PECTEN LUCULENTUS Reeve.

I. Karachi, rarely.

PECTEN MALDIVENSIS E. A. Smith.

Pecten maldivensis E. A. Smith, Fauna & Geogr. of Maldives & Laccadive Archipelagoes, vol. ii. part 2, p. 622, pl. xxxvi. figs. 19, 20.

P.G. No particular situation given. One example only.

A beautiful little species, first discovered during the Stanley Gardiner Expedition to the Laccadive Isles.

PECTEN MINIACEUS Reeve.

P.G. Gulf of Oman, Maskat. 10 fathoms, coral-sand.

PECTEN PLICA L.

P.G. Gulf of Oman, Maskat. 10 fathoms, coral-sand.

I. Karachi, not infrequent.

PECTEN PSEUDOLIMA Sowb.

P.G. Koweit, 10 fathoms.

A vermilion-hued shell, somewhat like a highly-coloured *P. varius* L.

PECTEN RETICULATUS Reeve.

P.G. Gulf of Oman, Maskat. 10 fathoms, coral-sand.

So far, one example only has occurred.

PECTEN SENATORIUS Gmel.

P.G. Lat. 26° 10' N., long. 52° 50' E.; 70 fathoms. Dabai, 8 fathoms. These last very brightly-coloured varieties.

I. Karachi, not infrequent. Bombay (*Abercrombie*).

PECTEN SINGAPORINUS Sowb.

I. Bombay (*Abercrombie*).

PECTEN THYRIDEUS * Melvill, sp. n. (Plate LV. fig. 10.)

P. testa fere rotunda, delicatissima, alba; valva sinistra paullulum convexa, pulcherrime clathrata, lamellis numerosis concentricis costulisque circa viginti radiantibus, interstitiis quadratis, fenestratis, levibus; auriculis subaequalibus; pagina interna diaphana, levigata.

Alt. 4, *lat.* 4, *diam.* 1·25 mm. (*sp. maj.*).

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

A most delicate little *Pecten*, of which all the specimens we have seen are dissociated valves. It is of the same character and alliance as *P. clathratus* v. Mart. †, from Christmas Harbour, Kerguelen Island ('*Challenger*' Expedition), but the radiating ribs

* *θυρίς*, εἶδος, from the latticed cancellations.

† Sitzungsber. d. Gesellsch. naturf. Freunde, Berlin, 1881, p. 79. Also *vide* Rep. '*Challenger*' Exp. vol. xiii. p. 305, pl. xxii. figs. 4, 4a.

and concentric lamellæ are stronger proportionately. Within, the surface is quite smooth.

PECTEN TOWNSENDI Sowb.

Pecten townsendi G. B. Sowerby, Proc. Malac. Soc. Lond. vol. i. p. 216, pl. xiii. fig. 10 (1894).

P.G. Off Mussandam, on the telegraph-cable at 50 to 55 fathoms, and in several other places in the Gulf, unparticularised.

I. Karachi, found at very low tides amongst rocks. From this locality came the type, now in the collection of Mr. J. J. MacAndrew.

A magnificent species, allied to *P. crassicosatus* Sowb. and *P. nobilis* Reeve, known by its zigzagged and variegated style of painting.

PECTEN (VOLA) DOROTHEÆ Melvill, sp. n. (Plate LIV. fig. 1.)

P. testa magna, suborbiculata, æquilaterali, inæquivalvi, solidulâ; valva dextra multum convexa, sinistram omnino superinpendente, sinistra ipsa concava; costis radiantibus 17-18 utraque valva prædita, his dextræ valvæ plus minus levibus, albocarnæis, nitidulis, longitudinaliter leniter bi- vel trisulculosis, interstitiis sub lente transversim squamo-liratis, ad latera spiraliter rubro paucistrigata, illis sinistræ valvæ, simul ac interstitiis, arctissime concentricè striato-liratis, superficie omni fusco-rubescente, concava, versus umbonem solum lævi, nitida, hic illic sparsim præcipue ad umbonem lineis fulgetrinis nigro-rufis irregulariter ornata, costis quam in dextra angustioribus; auriculis fere æqualibus, latis; pagina interna alba, nitida, versus umbones solum pallide ochracea.

Alt. 50, *lat.* 57, *diam.* 20 mm.

Hab. P.G. Dabai.

Chiefly characterised by the smoothness of the right valve, the ribs being already cut into deep interstices, slightly 2-3-sulcate, while the fellow-valve is concave, dark unicolorous fuscous-red, smooth; and the equally smooth umbo, in the neighbourhood of which are zigzag sharply-drawn lines of dark brown, few in number. The whole of the surface of this valve is clearly concentrically striate-lirate; the auricles are subequal.

Allied to *P. jacobæus* L., *sinensis* Sowb., and *keppelianus* Sowb. I am much indebted to Mr. G. B. Sowerby for having examined this new form, and given his pronouncement thereupon. Named in honour of my youngest daughter, Dorothea Melvill.

PECTEN (VOLA) FILOSUS Reeve.

P.G. Kharag Island; 3 fathoms, sand. Gulf of Oman, Maskat; 10 fathoms, muddy sand.

PECTEN (VOLA) PYXIDATUS Born.

P.G. Gulf of Oman, Malcolm Inlet (Kubbat or Ghobat Ghazira). Single valves only, at 24-26 fathoms. Maskat; 15 fathoms, perfect but young.

Fam. SPONDYLIDÆ.

SPONDYLUS EXILIS Sowb.

Spondylus exilis G. B. Sowerby, Proc. Malac. Soc. Lond. vol. i. p. 280, pl. xviii. fig. 14 (1895).

P.G. Found adhering to the telegraph-cable, 50 fathoms, mud bottom.

I. Karachi, on rocks. Identical specifically with, but differing in depth of coloration from Persian Gulf examples.

Allied to *S. gædaropus* L., the well-known Mediterranean species.

SPONDYLUS GLORIANDUS, sp. n. (Plate LIII. fig. 1.)

S. testa oblique ovata, haud multum crassa, aurantia vel albo-carnea, apud umbones puniceo-suffusa; umbonibus acutis, prominulis; costis tenuissimis, numero circa 50, irregularibus, squamis parvis vel spinulis tenuibus, longis, simpliciter præditis; auriculis parvis.

Alt. $3\frac{1}{2}$, lat. $3\frac{3}{4}$, diam. $2\frac{1}{2}$ unc. (*sp. maj.*).

„ $2\frac{1}{4}$, „ $2\frac{1}{2}$, „ $1\frac{3}{4}$ „ (*sp. min.*).

Hab. Persian Gulf, off Dabai (1903): on telegraph-cable that had been left undisturbed for several years. Near Mussandam, at 50 to 55 fathoms.

A particularly delicate and beautiful species, variously, though not very highly, coloured, with orange, pale carneo, or white, with dark pink suffusion at the umbones. The outer spines are long, thin, simple, and tapering; the many fine longitudinal ribs, about fifty altogether, are ornamented with more abbreviated spines or squamæ; these spines are most pronounced and conspicuous around the ventral margin or the posterior edge of the left valve; the auricles are small. One distinctive character is its oblique form, showing greater expansion posteriorly, the general shape being oval.

S. exilis Sowb., also endemic in these seas, has its spines thicker and far more foliaceous, the ribs fewer and coarser, than is the case with *S. gloriandus*.

SPONDYLUS NICOBARICUS Chemn.

I. Bombay (*Abercrombie*). Imperfect valves only.

SPONDYLUS RUBICUNDUS Reeve.

I. Bombay (*Abercrombie*).

[PLICATULA DEPRESSA Lam.

I. Karachi (*Major Baker*). A species of the New World, and here inserted with much doubt. It may be the next species, to which it is allied.]

PLICATULA PERNULA Melv.

P.G. Malcolm Inlet. 24 fathoms, mud.

PLICATULA RAMOSA Lam.

P.G. In one or two soundings at 30–35 fathoms, mostly on rock-basis.

LIMEA JUGLÄNDULA Melvill, sp. n. (Plate LV. fig. 5.)

L. testa minuta, æquilaterali, subovata, concava, solida; costis radiantibus crassis circa 17–18, simul ac liris concentricis squamoso-fimbriatulis arctissime spiräliter prædita, interstitiis simili modo liratis; umbonibus prominulis, involutis; dentibus utrinque numero circa 10; pagina interna alba, haud multum nitida, margine crenulato.

Alt. 3·50, lat. 3, diam. 3 mm. (*sp. maj.*).

Hab. P.G. and M.C. Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms. Mekran Coast. Lat. 25° 10' N., long. 60° 34' E.; 40 fathoms.

Abundant in shell-sand, ranging from 1·50 to 3 mm. in diameter. All the examples found were dead, but clean and perfect half-valves. The form is almost equilateral, very convex, and nut-like, hence the specific name proposed, being the diminutive of *juglans*, a walnut. Superficially it is finely but closely radiately ribbed and spirally squamulate, the scaly fimbriations being concentric and extending uniformly over the whole surface. Teeth almost straight, ten on each side of the ligament. It is very like *Lima torresi* Sm. in general appearance, but smaller, and may possibly prove to be a local race of *Limæa pectinata* Ad., an Erythræan species.

Fam. LIMIDÆ.

LIMA ARCUATA Sowb.

M.C. Charbar. 7 fathoms, rocky bottom.

LIMA FRAGILIS Gmel.

P.G. Maskat. 5–10 fathoms.

Mostly very delicate, and with the radiating striæ more numerous than in the typical form, as compared with specimens in the British Museum (Nat. Hist.).

LIMA (LIMATULA) LEPTOCARYA Melv.

P.G. Maskat, 10 fathoms. Gulf of Oman, lat. 25° 04' N., long. 60° 20' E.; 60 fathoms.

Order IV. EULAMELLIBRANCHIATA.

Suborder A. SUBMYTILACEA.

Fam. CARDITIDÆ.

CARDITA ANTIQUATA Lam.

P.G. Dabai, 8 fathoms.

M.C. Generally distributed at 5–10 fathoms, on sandy mud near rocky patches.

I. Bombay, frequent (*Abercrombie*). Southwards to Ratnagiri and Goa (*Lt.-Col. H. D. Olivier*).

CARDITA CANALICULATA Reeve.

P.G. Gulf of Oman, Maskat.

I. Karachi.

Usually found at 5-10 fathoms, coral-sand bottom.

CARDITA ECHINARIA, sp. n. (Plate LVI. fig. 8.)

C. testa aequivalvi, solidiuscula, trapezoidea, albo-rufa, antice declivi, postice subquadrata, margine dorsali fere recto, ventrali rotundato; umbonibus contiguus, lunula parva, cordata; costis numerosis, circa 23, breviter echinatis, spinulis postice interdum longioribus; cardine normali; pagina interna alba, margine crenifero.

Alt. 1.50, lat. 1.50, diam. 1 mm.

Hab. P.G. Dabai.

A small species with clearly-cut ribs, shortly spined or echinate, quadrate in form, somewhat resembling *C. aculeata* Poli, from the Mediterranean, but far more squarrosely truncate. Although not bearing an unfamiliar "facies," it seems to have been hitherto unnoticed.

CARDITA CUMINGI Desh.

P.G. Locality not specified. This insertion is made with some slight doubt, and more specimens are required for confirmation.

CARDITA TANKERVILLEI Rve.

I. Karachi. Mentioned in Major Baker's list but not yet found by Mr. Townsend.

MYTILICARDIA CALYCVLATA (L.).

P.G. Gulf of Oman, but not general.

M.C. Charbar, 7 fathoms, on rock.

I. Ratnagiri (*Abercrombie*). Panjim and Goa (*Lt.-Col. H. D. Olivier*).

A Mediterranean species.

MYTILICARDIA DISTORTA Reeve.

P.G. Exact locality doubtful. A common species in Erythrean waters.

MYTILICARDIA FFINCHI Melv.

P.G. Occasionally at 30 fathoms. Thairi, 10 fathoms. Also near Maskat, Gulf of Oman, at 10 fathoms, coral-sand bottom.

Very distinct in form from, though allied to, *M. crassicostata* Lam., mentioned as from Karachi in Major Baker's list. It seems highly probable *M. finchi* was the species then noticed.

MYTILICARDIA GUBERNACULUM Reeve.

P.G. Gulf of Oman, local. Near Jask, dredged at 7 fathoms, amongst loose rocks and sandy mud.

MYTILICARDIA VARIEGATA (Brug.).

I. Karachi. At half-tide among rocks.

Fam. CRASSATELLIDÆ.

CRASSATELLA INDICA E. A. Smith.

P.G. Near Dabai, and in deeper water in the Gulf of Oman.

CRASSATELLA PICTA Ad. & Reeve.

P.G. & M.C. At intervals, and occurring mostly singly, not common.

CRASSATELLA RADIATA Sowb.

P.G. Gulf of Oman, Maskat; 15 fathoms, muddy sand. A larger variety occurs, lat. $26^{\circ} 50' N.$, long. $54^{\circ} 50' E.$; 10 fathoms, sand.

N.B.—*Crassatellites omanensis* Smith, from 230 fathoms in the Gulf of Oman, was acquired during the 'Investigator' Expedition's recent cruise.

Fam. CYPRIDIDÆ.

ISOCARDIA (MEIOCARDIA) CUMINGII A. Ad.

P.G. Gulf of Oman. Lat. $25^{\circ} 23' N.$, long. $58^{\circ} 36' E.$, 40 fathoms; lat. $25^{\circ} 04' N.$, long. $60^{\circ} 20' E.$, 60 fathoms; and lat. $24^{\circ} 58' N.$, long. $56^{\circ} 54' E.$, 156 fathoms: shell-sand.

ISOCARDIA (MEIOCARDIA) LAMARCKII Reeve.

P.G. Rare; one or two valves.

LIBITINA SOLENOIDES Reeve (= *Cypricardia* Lamarck, 1819).

I. South of Bombay, near Ratnagiri (*Lt.-Col. H. D. Olivier*). Perhaps only a variety of the next species.

LIBITINA VELLICATA Reeve.

P.G. (*Major Baker*.)

I. Karachi. On rocks at low tide off Beach Fort, Manora. Bombay (*Abercrombie*).

BASTEROTIA ARCUA Melv.

I. Karachi. 3 fathoms, mud and sand.

A very distinct species the valves being of a remarkably profound arciform depth.

Fam. LUCINIDÆ.

LUCINA BOREALIS (L.).

P.G. Small, and highly coloured. Almost certainly a tropical variety of this widely-distributed British and European species.

LUCINA DENTIFERA Jonas.

P.G. Gulf of Oman, in several places, especially at Malcolm Inlet (Kubbat or Ghobat Ghazira), 24 fathoms, mud. Often

adhering to the telegraph-cable, at about 40 fathoms, and common in deep-sea soundings taken in lat. $24^{\circ} 55' N.$, long. $57^{\circ} 59' E.$, 220 fathoms.

M.C. Off Charbar, at 40 fathoms, in shell-sand, in all stages of growth.

LUCINA PAMELA, sp. n. (Plate LV. fig. 6.)

L. testa suborbiculari, parva, cinereo-albida vel fusciscente, tenui, laminis concentricis irregularibus ornata, antice rotundato-expansa, subrostrata, postice paullulum truncata; umbonibus conspicuis, prominulis, contiguus; lunula parva, cordiformi; pagina intus alba, cardine normali.

Alt. 5, *lat.* 6, *diam.* 2.50 mm.

Hab. Persian Gulf: Koweit, 10 fathoms. Gulf of Oman: lat. $24^{\circ} 58' N.$, long. $56^{\circ} 54' E.$; 156 fathoms.

A small species with very pronounced and conspicuous umbones, irregularly concentrically laminated over the whole surface. From the Gulf of Oman only came dead half-valves; these, however, were identical with the few perfect examples dredged off Koweit.

LUCINA (CYCLAS) SEMPERIANA Issel.

P.G. & M.C. Found very generally at from 3 to 10 fathoms. Especially abundant in shell-sand dredged off Charbar; lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$, 40 fathoms, many being very perfect examples.

I. Karachi, 15 fathoms. Off Bombay, in shell-sand (1906), imperfect.

LUCINA (CODAKIA) ANGELA Melv.

M.C. Lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$; 40 fathoms, off Charbar. Also at Gwadûr, on hard sandy mud, dredged at 8 fathoms.

Allied to *L. fibula* Reeve and *L. pecten* Lamarck.

LUCINA (CODAKIA) EXASPERATA Reeve.

I. Karachi. Found on mud, close to rocks. Also a native of Western Tropical America.

LUCINA (CODAKIA) FIBULA Reeve.

P.G. Shaikh Shuaib Island.

I. Bombay (*Abercrombie*).

Very widely distributed throughout the Tropics.

LUCINA (CODAKIA) RUGIFERA Reeve.

M.C. Charbar. Usually on rocks covered with but a thin layer of sandy mud.

LORIPES VICTORIALIS (Melv.).

Cryptodon victorialis Melv. Ann. & Mag. Nat. Hist. (7) vol. iv. p. 98, pl. ii. figs. 9, 9 a (1899).

Loripes victorialis (Melv.), E. A. Smith, Ann. & Mag. Nat. Hist. (7) vol. xviii. p. 256 (1906).

P.G. Malcolm Inlet, at 24 fathoms.

M.C. Lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$; 40 fathoms, off Charbar.

I. Karachi, rarely.

A very beautiful and delicate concentrically lamellate shell, varying in the number of the lamellæ, and not yet found in prime condition.

DIPLODONTA ALATA Ad. & Reeve (= *Mysia* Leach)*.

M.C. Exact locality unknown.

DIPLODONTA GENETHLIA Melv.

P.G. Kais (or Gais) Island, 7-10 fathoms. Maskat, 15 fathoms.

DIPLODONTA HOLOSPHÆRA Melv.

P.G. Gulf of Oman, lat. $27^{\circ} N.$, long. $52^{\circ} E.$ Imbedded in rocks at 40 fathoms.

I. Karachi. At very low tides.

A peculiarly spheroid species.

DIPLODONTA INDICA Desh.

I. Bombay (*Abercrombie*; *Lt.-Col. H. D. Olivier*).

DIPLODONTA RAVEYENSIS Sturany.

Diplodonta raveyensis Sturany, Exped. 'Pola' in das Rothe Meer, p. 31, Taf. vi. figs. 8-11 (1899).

P.G. & M.C. Gulf of Oman, lat. $24^{\circ} 58' N.$, long. $56^{\circ} 54' E.$; 156 fathoms. Lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$; 40 fathoms, off Charbar.

DIPLODONTA ROTUNDATA Turton.

M.C. General; usually in 5-10 fathoms, sandy mud.

I. Karachi. Rarely, and imperfect condition, at Bombay (*Abercrombie*).

DIPLODONTA SPILERICULA Desh.

P.G. & M.C. Occasionally dredged at 5-7 fathoms, but always local.

FELANIA DIAPHANA Gmel.

I. Karachi. Dredged at 5 fathoms, sandy mud.

PYTHINA PAULA A. Ad. (*Mylitta* D'Orb.)

Var. *peculiaris* A. Ad.

M.C. Off Charbar, lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$; 40 fathoms.

I. Off Bombay, in shell-sand, 1906 (*F. W. T.*).

By some authors included in the genus *Tellinaya* Brown.

* *Cryptodon omanensis* Smith has been (October 1906) described (Ann. & Mag. Nat. Hist. ser. 7, vol. xviii. p. 257) from 230 fathoms in the Gulf of Oman ('Investigator').

MONTACUTA OBLIQUANS Melvill, sp. n. (Plate LVI. fig. 9.)

M. testa minima, vitrea, albo-lactea, tenuissima, levi, lineis incrementalibus sub lente striatula, multum obliquante, antice compresso-rotundata, postice ellipsoidea; umbonibus parvis; dentibus cardinalibus duobus contiguis, lateralibus, præcipue posticis, paullum eleratis, elongatis, cicatricibus muscularibus bene impressis; pagina interna alba, semidiaphana; sinu palliali lato.

Alt. 2, *lat.* 3, *diam.* 1.50 mm.

Hab. P.G. Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms.

M.C. Very rarely off Charbar at 40 fathoms.

A very small, smoothish, very oblique species, of which several examples occurred among shell-sand.

Fam. ERYCINIDÆ.

KELLIA LEUCEDRA* Melvill, sp. n. (Plate LIII. fig. 3.)

K. testa globulosa, albo-lactea, tenui, levissima, subpellucida, æquicalvi, inæquilaterali, multum convexa; umbonibus parvis, nitidis, contiguis, latere antico paullulum curto, postico leniter ad marginem ventralem rotundato, intus pagina albo-lactea, haud nitente; dentibus cardinalibus duobus sinistrae valvæ prominulis, contiguis, dextra cardinaliter unidentata, dente brevi crasso, dente laterali in valva utraque; ligamento interno.

Alt. 15, *lat.* 15, *diam.* 10 mm.

Hab. Persian Gulf, Fao. Rarely, on the telegraph-cable, at 17 fathoms; mud bottom, with growth of algæ.

A very globular, smooth, milky-white, delicate and non-pellucid species, the affinities of which seem more with *Kellia* than with *Diplodonta*.

KELLIA REVIMENTALIS† Melvill, sp. n. (Plate LIII. fig. 4.)

K. testa tenuissima, parva, subhyalina, albo-lactea, oblonga, superficie undique sub lente delicatissime concentricè lirata, interstitiis longitudinaliter ruguloso-liratis, margine dorsali utrinque leniter deflexo, centrali recto, lateribus ambobus rotundatis; umbonibus parvis, acutis, prominulis; ligamento interno, submarginali; dentibus duobus, uno laterali; pagina intus alba, margine undique minute crenulato.

Alt. 3, *lat.* 6, *diam.* 1.5 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

A remarkable hyaline species, with finely concentrically-lirated valves and crenulated margin. Only a few specimens occurred, and with it were fragments of another allied species, hardly in a condition to describe.

* λευκός, ἔδρα.

† *Revimentum*, a fringe, from the margin.

KELLIA SUBORBICULARIS Montagu.

M.C. Local; not seeming to differ from the European species, which is of extraordinarily wide distribution, being even recorded from Antarctic regions.

N.B.—A *Lepton* sp. has occurred in shell-sand from Bombay (F. W. T. 1906), and Charbar at 40 fathoms, but in too imperfect condition to differentiate.

Fam. GALEOMMIDÆ.

SCINTILLA CALLIPAREJA Melv.

P.G. Gulf of Oman. On telegraph-cable, lat. 27° N., long. 52° E., 40 fathoms.

A delicate subhyaline *Scintilla*, of a pale blush-rose tint.

SCINTILLA LAYARDI Desh.

M.C. Charbar and Ras Ormara. Dredged at 2–7 fathoms, mud.

SCINTILLA PULCHRA Melvill, sp. n. (Plate LVI, fig. 10.)

Sc. *testa tenuissima, hyalina, oblonga, fere æquilaterali, subangusta, margine dorsali, simul ac ventrali, parallelis, rectis; umbonibus centralibus, nitidis, acutis, prominulis; dentibus cardinalibus et lateralibus perobscuris, minutis; pagina intus hyalina; margine undique pulchre et minute crenulato.*

Alt. 3, lat. 6, diam. 1.75 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

A most fragile and delicate shell, which with a little diffidence we refer to *Scintilla*; the general facies is of that genus, the delicately-crenulated margin being peculiar, though also being a feature of *Kellia revimentalis*, described in this paper. None of our specimens is in first-class condition.

Suborder B. TELLINACEA.

Fam. TELLINIDÆ.

TELLINA (?TELLINELLA) ASMENA* Melvill, sp. n. (Plate LVI, fig. 2.)

T. *testa transversim elongata, delicatula, fere æquilaterali, subpellucida, omnino albida, concentricè costata, costis ad 9–10, interstitiis pulcherrime et arcte longitudinaliter undique liraculis; umbonibus acutis vix prominulis; margine ventrali postice rotundato, antice sinuato-declivi, dorsali utrinque æqualiter declivi, postice parvum excavato, latere postico subrostrato et sinuato; dentibus normalibus; pagina intus alba.*

Long. 8, alt. 5, diam. 2 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

A small *Tellina* with peculiar sculpture, most nearly allied to

* ἄσμερος, glad, joyous.

T. murrayi Smith* from Cape York, Australia, at 155 fathoms (by a curious coincidence the same depth of sounding). Indeed, we were at first inclined to consider them both identical. The author, however, of *T. murrayi* convinced us that while similar in texture, pattern, and size, it differed in form, being more nearly equilateral, the umbones in our species also less prominent though acute, while the posterior portion of the dorsal margin in *T. murrayi* is more decidedly excavate. Half-valves only occurred, some of them in quite fresh condition. All are of much the same size, and we do not think the species could attain much larger dimensions than those given.

TELLINA (TELLINELLA) CRUCIATA Spengl.

P.G. Shaikh Shuaib I. From 10 fathoms, coral-sand.
Hardly adult, but beautiful examples.

TELLINA (TELLINELLA) DISSIMILIS Desh.

P.G. Gulf of Oman, Maskat. 5 fathoms.

TELLINA (TELLINELLA) INFLATA Chemn.

P.G. Gulf of Oman, Maskat. 10 fathoms, mud.

I. Bombay southward to Goa (*Lt.-Col. H. D. Olivier*).

TELLINA (TELLINELLA) KOLABANA Melv.

I. Bombay (*Abercrombie*). Recently likewise recorded from Aden (*Commander E. R. Shopland*).

TELLINA (TELLINELLA) PHARAONIS Hanl.

P.G. Gulf of Oman, Maskat. 10 fathoms, mud and sand.

TELLINA (TELLINELLA) RASTELLUM Hanl.

P.G. Gulf of Oman, Maskat. Dredged in 10 fathoms, muddy sand, with the preceding species (*T. pharaonis* Hanl.).

TELLINA (TELLINELLA) RUGOSA Born.

I. Karachi.

TELLINA (TELLINELLA) VIRGATA L.

Var. *jubar* Hanl. (sp.).

P.G. Shaikh Shuaib I., at low tide.

TELLINA (TELLINELLA) VULSELLA Chemn.

M.C. Local along the coast.

TELLINA (MÆRA) ACTINOTA Melv.

P.G. Gulf of Oman, Maskat. 10 fathoms, coral-sand.

TELLINA (MÆRA) LECHRIOGRAMMA Melv.

M.C. Generally dispersed at 5-15 fathoms all along the coast.

I. Karachi. Bombay (*Abercrombie*).

Likewise extending its range to Aden (*Shopland*).

* Rep. 'Challenger' Exped., Zoology, vol. xiii. pp. 98, 99 pl. iii. figs. 8, 8 b.

TELLINA (MCERA) METHORIA Melv.

M.C. Local, but abundant where occurring, from 2 fathoms, mud.

TELLINA (MCERA) MIRACYLLIUM*, sp. n. (Plate LVI. fig. 4.)

T. testa oblonga, pallide carnea vel delicatissime punicea, vel interdum, cinereo-albescente, postice abbreviata, antice late rotundata, inaequaliterali, aequaliter, undique concentric tenuissime striatula, convexa; margine dorsali antice leniter declivi, postici multo brevioris, ventrali oblongo-rotundato; umbonibus parvis, contiguis; dentibus cardinalibus duobus, parvis, lateralibus elongatis; pagina interna alba, interdum pallide ochraceo-suffusa.

Alt. 8. lat. 11, diam. 4.50 mm.

Hab. Persian Gulf. Shaikh Shuaib Island; 10–15 fathoms (1898). Koweit; 10 fathoms (1901).

Allied to *T. lechriogramma* Melv., *semen* Hanley, and *dibuta* E. A. Smith †; and to this last, a native of Cape York, N.E. Australia, it seems to approximate most nearly. Our species would seem to be of stouter build, the posterior dorsal slope not being so markedly oblique. In the first-named ally (*lechriogramma*) the concentric lines are more slanting, as the name denotes.

TELLINA (MCERA) OBTUSALIS Desh.

I. Karachi.

TELLINA (MCERA) PYGMEA Phil.

P.G. & M.C. Dredged in several places in 5–20 fathoms, mud.

The discovery of this species is particularly interesting, as being a native of Europe, including Great Britain and the Mediterranean Sea.

TELLINA (MCERA) RHOMBOIDES Quoy.

P.G. Gulf of Oman, Maskat. Dredged at 10 fathoms, muddy sand.

TELLINA (MCERA) ROSAMUNDA, sp. n. (Plate LVI. fig. 1.)

T. testa parva, nitidissima, late carnea vel ochracea, oblonga, valde inaequaliterali, postice abbreviata, antice leniter elongata, undique arcte et subtilissime concentric striata; dentibus cardinalibus duobus contiguis, lateralibus conspicuis, elongatulis, praecipue postice, pagina interna nitida, pallide carnea.

Alt. 4, lat. 6, diam. 2 mm.

Hab. Persian Gulf (no particular locality given).

The small size will distinguish from its allies this shining, brightly-coloured little species, of which we have seen several examples, all precisely alike both in size and the two shades of

* μετράκιλλον, a child.

† Rep. 'Challenger' Exped., Zoology, vol. xiii. p. 108, pl. iv. figs. 7-7 b.

coloration as above given. It is akin to *T. obtusalis* Desh., *semen* Hanley, *pygmaea* Phil., and *leckeriogramma* Melv., most or all of which occur likewise in the same region. Also near *T. malaccana* Sowb., but differing in the quality of the concentric striae and in coloration. Two half-valves of what is probably this species also occurred in the Gulf of Oman at 156 fathoms in shell-sand.

TELLINA (MGERA) SEMEN Hanley.

P.G. Gaïs (or Kais) Island; 14 fathoms. Jask, at the borders of the Mekran Coast; 26 fms., mud. Gulf of Oman, lat. 26° N., long. 52° 50' E., and in two or three other soundings at various depths. Varying according to depth in coloration of shell from straw-colour or pale pink merging into white. Usually on mud or muddy-sand bottom.

M.C. Charbar; 5 fms., mud and sand. Beyond Jask; 3-8 fms. Gwadûr, Ormara, &c., general.

I. Karachi.

TELLINA (ARCOPAGIA) CAPSOIDES Lam.

I. Karachi (*J. W. T. & Major Baker*). Bombay (*Abercrombie*). Bombay southward to Goa (*Lt.-Col. H. D. Olivier*).

TELLINA (ARCOPAGIA) CONCENTRICA Gould.

I. Karachi. On mud-flats at low tide.

TELLINA (ARCOPAGIA) HABROTIMA Melv.

I. Angriâs Bank, Arabian Sea (*Captain Tinsall*).

TELLINA (ARCOPAGIA) ISSELI H. Ad.

P.G. Shaikh Shuaib I.; on mud-flats, but rarely noticed. Maskat; 10 fathoms, coral-sand bottom, more frequently. The shell is sometimes unicolorous, but commonly faintly radiate. Also Gulf of Oman, lat. 26° 6' N., long. 50° 52' E.; 15 fms., coral-sand.

M.C. Off Charbar, lat. 25° 10' N., long. 60° 34' E.; 40 fathoms, dead shells.

An Erythraean species.

TELLINA (ARCOPAGIA) NUX Hanley.

I. Off Karachi; at 15 fathoms, mud.

TELLINA (ARCOPAGIA) PERPLEXA Hanley.

I. Karachi. On mud-flats at low tide.

TELLINA (ARCOPAGIA) SAVIGNYI A. Ad.

P.G. Gulf of Oman, Maskat. At about 10 fathoms, amongst loose stones and sandy mud, very abundant.

Originally described from Erythraean examples.

TELLINA (ARCOPAGIA) SCOBINATA L.

I. Karachi.

TELLINA (ARCOFAGIA) SIAMENSIS v. Mart.

I. Karachi. On mud-flats at low tide.

TELLINA (ANGULUS) IRIDESCENS Bens.

I. Karachi. At 5 fathoms, near rocks, on muddy sand.

TELLINA (ANGULUS) NITENS Desh.

P.G. Gulf of Oman, near Jask. 3-5 fathoms, sandy mud.
Probably extending to M.C., Jask being just on the boundary.

TELLINA (ANGULUS) RUBELLA Desh.

I. Karachi. Dredged at 3-5 fathoms, mud. Bombay
(*Abercrombie*).

TELLINA (ANGULUS) RUBRA Desh.

I. Bombay (*Abercrombie*).

TELLINA (ANGULUS) SERICATA Melv.

P.G. Gulf of Oman, Maskat. 10 fathoms.
Also recorded by Dr. R. Sturany as *Erythraean* (Exped. S.M.
Schiff 'Pola' in das Rothe Meer, p. 24, 1899).

TELLINA (ANGULUS) TICAONICA Desh.

P.G. Gulf of Oman. Lat. $24^{\circ} 55' N.$, long. $57^{\circ} 59' E.$;
87 fathoms.

TELLINA (ANGULUS) UNIFASCIATA Sowb.

Lat. $18^{\circ} 58' N.$, long. $71^{\circ} 45'$. Rare.

TELLINA (TELLINIDES) EMARGINATA Sowb.

P.G. Gulf of Oman, Linjah.

TELLINA (TELLINIDES) OPALINA Chemn.

M.C. One example only. Locality not exactly recorded.

TELLINA (TELLINIDES) OVALIS Sowb.

P.G. Gulf of Oman, Maskat. Dredged at 10 fathoms, muddy
sand; lat. $24^{\circ} 55' N.$, long. $57^{\circ} 59' E.$, 87 fathoms.

I. Karachi.

TELLINA (TELLINIDES) SINUATA Spengl.

I. Bombay (*Abercrombie*). Ratnagiri to Goa (*Lt.-Col. H. D.
Olivier*).

TELLINA (TELLINIDES) THYMARES Melv.

M.C. Charbar. 5 fathoms.

I. Bombay (*Abercrombie*).

TELLINA (TELLINIDES) TRUNCATULA Sowb.

P.G. Gulf of Oman, Jask. From 4 fathoms, mud and sand.

TELLINA (TELLINIDES) VESTALIS Hanley.

I. Karachi. Dredged at 3 fathoms.

TELLINA (TELLINULA) CLAUDIA Melvill. (Plate LVI. fig. 3.)

T. testa delicata, papyracea, albo-vitrea, equivalvi, compressa, antice late rotundata, postice brevior; umbonibus minutis, contiguus; dentibus cardinalibus duobus in utraque valva prædita, dente laterali antico obscuro; pagina interna alba, linea pallidi conspicua.

Alt. 10, *lat.* 14, *diam.* 3 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 25° 19' N., long. 50° 10' E.; 140 fathoms.

A delicate, thin, compressed species, somewhat intermediate in appearance between *T.* (*Arcopagna*) *savignyi* A. Ad., also found in the same seas, and *T.* (*Tellinula*) *tenuis* Don. = *exigua* Poli.

TELLINA (PERONÆA) ERYTHRÆENSIS H. Ad.

P.G. Jask. From 3 fathoms, mud.

TELLINA (PERONÆA) MICANS Hanley.

M.C. Half-valves common off Charbar at 40 fathoms.; lat. 25° 10' N., long. 60° 34' E. Referred to *Psammobia* by E. A. Smith (Ann. & Mag. N. H. ser. 7, xviii. p. 260), judging from Persian Gulf examples, dredged by s.s. 'Investigator,' at 31 fathoms.

I. Lat. 19° 30' N., long. 71° 43' E. Dredged at 30 fathoms upwards, in soft mud, but not common.

TELLINA (METIS) ANGULATA Chemn.

I. Karachi (*Major Baker*). Bombay (*Abercrombie*). Bombay to Ratnagiri and southwards to Goa (*Lt.-Col. H. D. Olivier*).

TELLINA (METIS) LACUNOSA Chemn.

I. Karachi. On mud-flats at low tide.

TELLINA (METIS) TURGIDA Desh.

I. Karachi. Very rare on mud-flats; up to the present only one live and one dead example have been collected.

MACOMA ALA Hanley.

I. Karachi. At low tide on mud-flats. Bombay, common (*Abercrombie*).

MACOMA BLAINVILLEI Desh.

I. Karachi. At 5 fathoms, on muddy sand near rocks.

MACOMA BRUGUIERII Hanley. (*Gastrana* auct.)

I. Bombay (*Abercrombie*). Thence southwards to Panjim and Goa (*Lt.-Col. H. D. Olivier*).

MACOMA SYNDESMYOIDES, sp. n. (Plate LVI. fig. 5.)

M. testa delicatula, albo-lactea, papyracea, subpellucida; valva sinistra planiore, expansa, dextra magis convexa, postice oblongo-orata, antice leviter truncatula; umbonibus minutis, contiguis, margine ventrali obliquante; dentibus cardinalibus in valva utraque duobus contiguis prædita, lateralibus obscuris vel absentibus.

Alt. 12·50, lat. 17·50, diam. 4 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

Abundant in the above locality, in company with *Syndesmya cistula* (also described in this paper), from which it has to be carefully sorted, as the two are, superficially, very similar.

MACOMA TRUNCATA JOUSS.

I. Bombay (*Abercrombie*).

? CÆDALINA ASIATICA MELV.

P.G. Gulf of Oman, Maskat. 10 fathoms.

M.C. Charbar. 3-7 fathoms. Small examples.

This is a doubtful species, and probably not of the genus to which it was, temporarily, assigned. It may be a *Scintilla*, allied to *S. layardi* Desh., or perhaps a variety of that species.

TELLIDORA PELYANA H. AD.

P.G. (*Pelly*.) At 40 fathoms, exact locality not specialised (*F. W. T.*).

I. Karachi. At 3 fathoms, in mud and amongst stones and rocks; uncommon.

GASTRANA GUINÆICA (CHEMM.) (= *abildgardiana* SPENGL.)

I. Karachi. Mostly on flats to the south-east, on mud bottom.

LUCINOPSIS ELEGANS H. AD.

P.G. Gais (or Kais) Island. 14 fathoms, among broken shells and corals.

Fam. SCROBICULARIIDÆ.

SEMELE CORDIFORMIS SOWB. (*Amphidesma* LAM.)

M.C. Charbar. 3 fathoms, sand.

I. Karachi. On mud-flats at low tide. Bombay, abundant and fine in mud (*Abercrombie*). Ratnagiri to Goa (*It.-Col. H. D. Olivier*).

SEMELE CRENATA AD. & ANGAS.

I. Karachi. Only in poor condition, and therefore inserted with some doubt.

SEMELE REGULARIS E. A. Smith.

I. Bombay (*Abercrombie*). Likewise in very poor condition, but agreeing with Australian examples of *regularis* in the British Museum (Nat. Hist.).

CUMINGIA OCCATILLA Melv.

Cumingia occatilla Melv. Ann. & Mag. N. H. ser. 7, vol. vii. p. 555, pl. ix. fig. 5.

M.C. Near Charbar.

Also from Aden (*E. R. Shopland*).

SYNDESMYA CISTULA Melvill, sp. n. (*Syndosmya* auct.) (Plate LVI. fig. 6.)

S. testa albo-lactea, tenui, semipellucida, nitida, ovato-trigona, transversim elongata, fere aequaliterali, inaequivalvi; valva sinistra magis convexa, postice prolongata, attenuata, antice rotundata, margine dorsali utrinque leviter declivi; umbonibus acutis, prominulis, ligamento interno; cardine foveam obliquam praebente, dente cardinali centrali, parvo, interdum bifido; pagina intus albo-lactea, nitente.

Alt. 8, *lat.* 10, *diam.* 5 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

Fairly frequent, but in imperfect condition. The valves are unequal, the left being far more convex. In general aspect not unlike the British species *S. prismatica* Mont. or *S. opalina* Hinds, occurring at Bombay. *Abra*, the generic term applied by Dr. Leach in 1818, does not seem to have been properly characterised.

SYNDESMYA OPALINA Hinds.

I. Bombay (*Abercrombie*).

In range extending to Japan.

N.B.—*Abra maxima* (Sowerby) was dredged by the s.s. 'Investigator' at 1000 fathoms off the Mekran Coast, and at 1299 fathoms in the Gulf of Oman.

FAM. DONACIDÆ.

DONAX (HECUBA) SCORTUM L.

M.C. Charbar.

I. Karachi, upon Manora beach. Bombay (*Abercrombie*). Bombay southwards to Goa (*Lt.-Col. H. D. Olivier*).

Mr. Townsend especially signalises finding a young specimen which shows much beauty of concentric lamellation. This is probably *D. pubescens* L., now considered a variety of *scortum*.

DONAX (SERRULA) APERITTUS Melv.

I. Karachi.

Also recently recorded from Aden (*Shopland*).

DONAX (SERRULA) DYSONI Desh.

I. Bombay (*Abercrombie*).

Var. *incarnatus* (sp.) Sowb.

I. Bombay, with the type.

DONAX (SERRULA) CLATHRATUS Desh.

M.C. Ormara. Dredged at 2 fathoms, sand.

DONAX (SERRULA) NITIDUS Desh.

M.C. In one or two places, local, at 3-7 fathoms, sand.

I. Karachi. 5 fathoms, sand.

DONAX (SERRULA) TOWNSENDI Sowb.

Donax townsendi Sowb. Proc. Mal. Soc. Lond. i. p. 161, pl. xii. fig. 23 (1894).

P.G. Without details of locality.

I. Karachi. Found on the beach from 6 inches to a foot below the surface (*F. W. T.*).

DONAX (MACHLERODONAX) SCALPELLUM Gray.

I. Karachi (*Major Baker*).

Also noticed at Aden (*Shopland*).

DONAX (LATONA) ABBREVIATUS Lamk.

I. Bombay (*Abercrombie*). Bombay southwards to Goa and Panjim (*Lt.-Col. H. D. Olivier*). Much eaten in India (*E. H. Aitken*).

DONAX (CAPSELLA) OWENI Gray.

I. Karachi. Dredged at 5 fathoms, sand. Also not uncommonly on wet sand at extremely low tides.

Fam. CARDILIIDÆ.

*CARDILIA SEMISULCATA Lamk.

P.G. Gulf of Oman. Lat. 26° 10' N., long. 52° 50' E.; 33 fathoms, sand and rocks. Also lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand. Of very rare occurrence, and the few specimens obtained are by no means perfect, being only single valves, though quite characteristic. Showing extension of range westward, Port Blair, Andaman Isles, being its nearest habitat.

* Mr. Edgar Smith (Ann. & Mag. Nat. Hist. (7) vol. xviii. p. 260, October 1906) notes one specimen alone dredged by R.I.M.S. 'Investigator' off Port Blair at 100 fathoms, and gives as its known localities South Australia (*Lamarek*), Straits of Malacca (*Deshajes*), China (*Sowerby*), Japan (*Lischke*), Philippine Isles (*Cuming in Mus. Brit.*).

Fam. MESODESMATIDÆ.

ERVILIA SCALIOLOA Issel.

P.G. Kais Island, 7-15 fathoms; Shaikh Shuaib Island, 12 fathoms; Bahrein Isles.

Gulf of Oman. Lat. $24^{\circ} 58' N.$, long. $56^{\circ} 54' E.$; 156 fathoms, shell-sand. Small, but well coloured and perfect examples; while two unicolorous perfect shells occurred in shell-sand off Charbar at 40 fathoms. These may perhaps belong to a different species.

ERVILIA PERPUREA Desh.

P.G. Henjan Island, 10 fathoms.

One or two specimens determined as *E. scaliola* were, perhaps, more nearly referable to this Erythrean species.

MESODESMA (PAPHIA) BAHREINENSE, sp. n. (Plate LIII. fig. 7.)

M. testa alba, levigata, subtrapezoidæa, inæquilaterali, antice rotunde elongata, postice truncatula; unbonibus parvis, contiguis, ligamento interno; dentibus cardinalibus, simul ac lateralibus, magnis, crassis; pagina interna alba, nitida, impressione musculari conspicua; linea palliali sinuata.

Alt. 18, lat. 25, diam. 10 mm.

Hab. Bahrein Isles, Persian Gulf.

This species has been very closely compared with all the other known forms of *Paphia*, and assimilates most closely to *P. glabrata* Desh., differing mainly in the posterior region, the margin being more decidedly truncate.

Fam. MACTRIDÆ.

MACTRA ACHIATINA Chemn. (= *aspersa* Dkr.).

I. Angrias Bank (*Capt. Tindall*).

MACTRA APHIRODINA Desh.

P.G. Gulf of Oman, Jask. Dredged at 5-10 fathoms, mud and sand.

MACTRA CORNEA Desh.

I. Karachi. Bombay (*Abercrombie*).

MACTRA FAUROTII JousS.

I. Karachi. Dredged at 5 fathoms, sand.

MACTRA GLABRATA L.

I. Karachi. With the last-mentioned, at same depth (5 fathoms).

MACTRA LUZONICA Desh.

I. Bombay (*Abercrombie*), abundant. Also we have seen specimens from Madras (*Henderson*) and Calcutta (*Lady Herschel*).

MACTRINULA PLICATARIA (L.).

I. Bombay, but rarely, and mostly in imperfect condition (*Abercrombie*).

MACTRINULA TRYPIERA Melv.

P.G. Hinderabi I. 35 fathoms, mud.

M.C. Charbar. 15 fathoms; one specimen. 40 fathoms; broken shells, common.

A most delicate species, of which but very few examples have, so far, been found. It has been recently dredged by the 'Investigator' at 35 fathoms, also in the Persian Gulf*.

RAËTA ABERCROMBIEI Melv.

I. Bombay (*Abercrombie*).

A particularly delicate and beautiful shell, belonging to a very restricted genus, the type of which (*R. canaliculata* Say) was noticed some years ago by one of us particularly abundant in Charleston Harbour, South Carolina. About fourteen species have been described, one most recently by Dr. R. Sturany as *R. bracheon* †, from the Red Sea.

STANDELLA (MEROPE) ÆGYPTIACA Chemn.

I. Karachi (*Major Baker*).

STANDELLA (MEROPE) CAPILLACEA Desh.

M.C. Astola Island, at 10 fathoms, on rocks towards the south.

I. Karachi. In peat-mud on Manora, west beach, all dead but perfect specimens. Bombay (*Abercrombie*) southwards to Goa and Panjim (*Olivier*). Juvenile examples differ very much from the adult in greater definiteness of striation.

STANDELLA (MEROPE) PELLUCIDA Chemn.

I. Bombay (*Abercrombie*), extending southwards to Ratnagiri.

This species, in common with the preceding (*capillacea*), sometimes attains considerable dimensions, say $4'' \times 2\frac{1}{2}''-3''$.

ANATINELLA CANDIDA Chemn.

I. Between Bombay and Ratnagiri (*E. H. Aitken*).

Suborder C. VENERACEA.

Fam. VENERIDÆ.

Section i. *Cytherea* Lamarck.

TIVELA PONDEROSA Koch.

M.C. Charbar. 7 fathoms.

I. Karachi. Living amongst loose wet sand, a few inches below the surface, at low tides.

* E. A. Smith, Ann. & Mag. Nat. Hist. ser. 7, vol. xviii. p. 260 (1906).

† Expedition S.M. Schiff 'Pola' in das Rothe Meer 1895-96 und 1897-98. Zool. Ergebnisse, Lamellibranchiaten von Dr. Rudolf Sturany (Wien, 1899), Taf. iii. figs. 1-6.

[TIVELA TRIGONELLA Lamk.

I. Karachi (*Major Baker*). An Antillean species: we have seen no Eastern specimens.]

MERETRIX IMPUDICA Chemn.

Var. *castanea* Lamk.

„ *morphina* Lamk.

I. Bombay (*Abercrombie*), abundant. Not yet recorded further north; though southwards it has been noticed, mainly in the var. *castanea*, to range from Bombay to Ratnagiri, Goa, and Panjim (*Lt.-Col. H. D. Olivier*). In India this species is largely eaten (*E. H. Aitken*).

MERETRIX PETECHIALIS Lamk.

I. Bombay (*Abercrombie*).

Although by many malacologists still left distinct, *petechialis* is most probably an extreme form of *impudica*.

MERETRIX TUMIDA Sowb.

Meretrix (Caryatis) tumida Sowb. Proc. Malac. Soc. Lond. i. p. 280, pl. xviii. figs. 12, 13 (1895).

I. Karachi.

A distinct species, discovered by Mr. Townsend in 1893.

MERETRIX ZONARIA Lamk.

I. Karachi.

Also probably a variety of *impudica*, though in typical condition seeming distinct. Mr. Alexander Abercrombie, who collected multitudinous examples of most of the varieties in Bombay, informs us that, in his opinion, even the most distinctly marked forms have intermediates, binding them to typical *impudica*.

CALLISTA FESTIVA Sowb.

P.G. Jask.

I. Karachi. Dug out of mud, at low tide, or at the sides of creeks which intersect mud-flats.

CALLISTA BELCHERI Sowb.

P.G. Shaikh Shuaib I. Gulf of Oman, Malcolm Inlet (Kubbat or Ghobat Ghazira); 24 fathoms, mud.

CALLISTA ERYCINA (L.).

I. Between Bombay and Ratnagiri (*E. H. Aitken*).

CALLISTA FLORIDA Lam.

I. Karachi.

CALLISTA HAGENOWI Dkr.

P.G. Dabai, in various stages of growth A handsome species.

CALLISTA MULTIRADIATA Sowb.

P.G. Jask. On mud-flats at low tide. Maskat, 10-15 fathoms.

Akin to *C. erycina* L. Not, so far, noticed north of Bombay. A very fine species.

CALLISTA PHASIANELLA Desh.

P.G. Gulf of Oman. 10 fathoms, muddy sand. Near Maskat at 40 fathoms, exceptionally fine and large.

M.C. Fairly general.

1. Karachi. At 3-7 fathoms, on hard muddy sand.

CALLISTA UMBONELLA Lamk.

P.G. Jask. In sand on banks of creek. This is a species of remarkably wide distribution.

CARYATIS PUDICISSIMA E. A. Smith.

Cythera (Caryatis) pudicissima E. A. Smith, Ann. & Mag. N. H. ser. 6, vol. xiv, p. 169, pl. v. figs. 3, 4 (1894).

P.G. N. coast of Henjam Island, at 10 fathoms.

Gulf of Oman. In two or three places, in various stages of growth. Also half-valves dredged at various depths, 60-150 fathoms. Likewise recorded by Mr. E. A. Smith as dredged at 230 fathoms by R.I.M.S. 'Investigator' in the Gulf of Oman (Ann. & Mag. N. H. (7) vol. xviii, p. 260, 1906).

M.C. In coarser condition at Charbar Bay. 15 fathoms. Also lat. 25° 10' N., long. 60° 34' E., 40 fathoms.

LIOCONCHA ARABICA (Chemn.).

P.G. Shaikh Shuaib I.

1. Karachi. In sand at low tide, just below the surface, and close to the water's edge.

LIOCONCHA CALLIPYGA Born.

P.G. Gulf of Oman, Jask. 3 fathoms, sand.

1. Karachi, with *L. arabica*, in identical situations.

LIOCONCHA HEBREA Lamk.

P.G. Gulf of Oman, Muskat. Dredged at 10 fathoms, muddy sand bottom, with occasional stones and rocks intervening.

LIOCONCHA PICTA Lamk.

P.G. Gulf of Oman, Maskat. With *L. hebraea* in the same situations and depth.

1. Karachi.

CRISTA DIVARICATA (Chemn.).

P.G. Generally distributed.

1. Karachi. In sand by the water's edge, just below the surface, at extreme low tide.

CRISTA PECTINATA (L.).

P.G. Generally distributed; at about 7 fathoms, rock and sand. Shaikh Shuaib I., very fine.

CIRCE CORRUGATA (Chemn.).

P.G. Gulf of Oman. Maskat.

M.C. General: usually at 5-20 fathoms, on sandy mud, close to rocks.

CIRCE NANA Melv.

P.G. Gulf of Oman. Lat. $26^{\circ} 10'$ N., long. $52^{\circ} 50'$ E.; sand and coral-rock.

Allied to some forms of *C. sulcata* Gray, e. g. *Artemis* Desh.

CIRCE SCRIPTA (L.) (= *personata* Reeve).

P.G. Gulf of Oman, Maskat. Dredged at 5 fathoms, mud bottom.

M.C. Charbar. At 3 fathoms, sand.

Var. *fulgurata* Reeve (sp.).

P.G. With the type; but in deeper water, 30-35 fathoms.

I. Bombay southwards (*Lt.-Col. H. D. Olivier*).

CIRCE SULCATA Gray.

P.G. Gulf of Oman, Maskat. At 37 fathoms.

I. Angrias Bank (*Captain Tindall*).

Section ii. **Venus L.**SUNETTA CONTEMPTA E. A. Smith. (*Meroë* Schum.)

I. Bombay (*Abercrombie*). Bombay southwards to Ratnagiri (*Lt.-Col. H. D. Olivier*).

SUNETTA EFFOSSA Hanley.

I. Bombay (*Abercrombie*), southward to Goa (*Olivier*). Karachi (*Major Baker*).

SUNETTA BEANS Wood.

I. Bombay, abundant (*Abercrombie*).

SUNETTA KURACHENSIS Sowb.

Sunetta kurachensis Sowerby, Proc. Mal. Soc. Lond. i. p. 216, pl. xiii. fig. 1 (1895).

I. Karachi. A fine new form, found upon sand-banks, which are only uncovered at spring tides, just below the surface (*P. W. T.*).

SUNETTA MEROË (L.) (= *picta* Schum.).

P.G. Dabai, 8-10 fathoms.

SUNETTA SOLANDRI Gray.

I. Karachi (*Major Baker*).

Bombay, collected by Mr. Abercrombie; who remarks that, from an examination of a large quantity of perfect specimens, the conclusion may with some certainty be arrived at that *S. hians* Wood, and probably also *contempta* Smith, are but extreme forms. We can endorse this opinion, but perhaps it is simpler, at present, to catalogue them separately, the extremes being at all events distinct, and many malacologists holding a different opinion.

TAPES (TEXTRIX) MALABARICA (Chemn.).

I. Karachi (*Major Baker*) (*F. W. T.*). On mud flats at low tide. Bombay (*Abercrombie*), common and fine. Southward to Ratnagiri, Panjim and Goa (*Olivier*). Much eaten by the natives in India (*E. H. Aitken*).

TAPES (TEXTRIX) SULCOSA Phil.

I. Karachi (*Major Baker*).

According to Commander E. R. Shopland this species occurs at Aden, so it is curious that its occurrence in intermediate stations has not yet been put on record.

TAPES (TEXTRIX) TEXTRIX (Chemn.).

M.C. Fairly general. Usually dredged at between 5-40 fathoms. Charbar Bay, 15 fathoms.

I. Karachi. Bombay (*Abercrombie*), common.

TAPES (TEXTRIX) UNDULATA Reeve.

P.G. Gulf of Oman, Jask. Found at 3-6 fathoms, sandy mud.

M.C. Charbar. 3-5 fathoms, mud.

By some authors esteemed but a variety of the last (*T. textrix*).

TAPES (PAREMBOLA) CORRUGATA Desh.

I. Karachi. Young examples alive amongst mud and algae on rocks: only dead adult specimens noticed.

TAPES (PAREMBOLA) DESHAYESI Hanley.

P.G. Gulf of Oman, Maskat.

TAPES (PAREMBOLA) OBSOLETA (Chemn.).

I. Karachi.

TAPES (PAREMBOLA) TURGIDA Lamk.

I. Between Bombay and Ratnagiri (*E. H. Aitken*). Extending in range to Australia.

TAPES (AMYGDALA) FLORIDA Lamk.

I. Karachi. Dredged at 5 fathoms, sand.

Allied to *T. lata* Poli, a Mediterranean species.

TAPES (AMYGDALA) INDICA Hanley.

I. Karachi. Bombay (*Abercrombie* and *Lt.-Col. Olivier*).

TAPES (AMYGDALA) ONCODES Mely.

I. Karachi. Common, but local, and mostly found on the edge of mud-flats, and best obtained by digging at low tide.

Mr. G. B. Sowerby considers this a *Petricola*, and as such enters it in his 'Catalogue of Pelecyopoda.'

TAPES (HEMITAPES) COR Sowb. (*Chione cor* Sowb.)

I. Karachi (*Major Baker*). There is one large gibbous shell in the Townsend collection, from the same locality, probably referable here also.

TAPES (HEMITAPES) FLAMMEA Gmel., var. RADIATA Gmel.

I. Bombay. Much eaten by the natives (*E. H. Aitken*).

TAPES (HEMITAPES) ORIENTALIS Reeve.

I. Karachi. Bombay (*Abercrombie*).
Considered by Pictel a variety of *T. recens* Chemm. from Coromandel Coast. Edible.

TAPES (HEMITAPES) MARMORATA Lamk. (= *radiata* auct., in part).

I. Bombay (*F. W. T.* and *Abercrombie*).

Found on mud, at low tide. Adult examples to a great extent have the normal taper-form, becoming, like the aptly named *T. pinguis*, remarkably gibbous.

TAPES (HEMITAPES) PINGUIS (Chemm.). (= *Chione* auct.)

I. Karachi (*F. W. T.* and *Major Baker*). Bombay (*Abercrombie*).
Bombay to Ratnagiri and southwards (*Olivier*). On mud-flats at low tide. Much eaten in India (*E. H. Aitken*).

TAPES (HEMITAPES) RIMULARIS Lamk.

I. Karachi. With the preceding.

By some authors considered a variety only of the British and Mediterranean *T. virgineus* L.

ANAITIS CALOPHYLLA Hanley.

P.G. Dabai, rare.

Common in some parts of the Indian Ocean: nearly allied to the next species.

ANAITIS FOLIACEA Phil.

P.G. Gulf of Oman. Dredged in several localities from 5 to 20 fathoms.

I. Karachi.

ANAITIS ISABELLINA Phil.

I. Bombay, rare (*Abercrombie*). Perhaps best treated as a variety of *A. foliacea*. Typical *isabellina* is Australian.

ANAITIS TIARA Dillwyn.

P.G. Dredged in one or two places at 5–50 fathoms, in sandy mud or pure sand bottom.

CHIONE ARAKANENSIS Nevill.

P.G., Gulf of Oman, & M.C. In many places, almost universal, at 5–25 fathoms.

I. Karachi. Dredged at 5 fathoms, mud and shingle.

CHIONE COSTELLIFERA Ad. & Rve.

P.G. Gais (or Kais) Island. At 10 fathoms, coral-sand.

CHIONE DECLIVIS Sowb.

P.G. Infrequent at Maskat. 10–35 fathoms.

CHIONE IMBRICATA Sowb.

I. Karachi. Dredged at about 5 fathoms, muddy or pure sand. Bombay. In shell-shingle, Malabar Point, and elsewhere near the Harbour. The most abundant mollusk noticed, single valves strewing the shore in many places (*Abercrombie*).

CHIONE HYPOPTA Sturany.

Chione hypopta Sturany, Exped. S.M. Schiff 'Pola' in das Rothe Meer (1899), p. 27, Taf. vii. figs. 10–14.

I. Angrias Bank (*Captain Tindall*).

We are indebted to the author of the species for having confirmed our identification. A small but handsome species, brightly coloured, allied to *C. scabra* Hanley.

CHIONE LAMARCKI Gray.

P.G. Dabai, 8–10 fathoms. Gulf of Oman, Maskat. Dredged at 10 fathoms, muddy sand.

CHIONE LAYARDI Reeve.

P.G. Local. A Ceylonese species, which will probably be found to extend all along our area.

CHIONE MARICA (L.).

P.G. Without precise locality. One or two examples only.

CHIONE MEKRANICA Melv.

M.C. Near Charbar, rarely.

CHIONE RETICULATA (L.).

P.G. Mussandam. Found at low tide, just below the surface of the sand.

CHIONE SCABRA Hauley.

P.G. Shaikh Shuaib Island. Gulf of Oman, lat. 26° 3' N., long. 52° 22' E. 36 fathoms, mud-bottom.

Showing much variety of coloration. This mollusk needs further study. It is possible two species are at present included under the name "*scabra*," even after the differentiation of the nearly allied *C. hypopta* Sturany.

DOSINIA ALTA Dkr. (*Artemis* Poli.)

I. Karachi. On mud-flats at low tide.

DOSINIA ANGULOSA Phil.

I. Karachi (*Major Baker*).

DOSINIA EXASPERATA Phil.

M.C. A dead specimen only was dredged off Pasni.

I. Karachi (*Major Baker*).

DOSINIA GLOBA (A. Ad. MS.) Melv.

I. Karachi. On mud-flats at low tide. Bombay (*Abercrombie*), not very common.

In Melvill and Abercrombie's List this is called *gibba* Adams, but neither *gibba* nor *globa* was ever described by Dr. Arthur Adams, and these therefore stand as mere "nomina nuda." The species was given due notice and a full description drawn up for the first time in 1897 (*vide* Mem. Manch. Soc. vol. xli. part 3, p. 22, pl. 7, fig. 35).

DOSINIA HISTRIO Gmel.

P.G. Dabai, 8-10 fathoms. Gulf of Oman, Maskat, 10 fathoms. Kubbat Ghazira or Malcolm Inlet, at 24 fathoms, mud bottom, and in several other places contiguous. It seems one of the most widely dispersed of the *Dosinia*.

I. Karachi.

DOSINIA PROSTRATA (L.).

I. Bombay (*Abercrombie*). Only observed after rough weather.

DOSINIA PUBESCENS Phil.

M.C. Only in immature condition.

I. Bombay (*Abercrombie*). Common in all stages of growth.

DOSINIA RUSTICA Römer.

P.G. Gulf of Oman, Jask. Dredged at 8 fathoms, sandy-mud bottom.

I. Bombay (*Abercrombie*).

DOSINIA SALEBBOSA Römer.

M.C. Charbar. 15 fathoms; rare.

Originally described from Malacca.

DOSINIA SUBROSEA Gray.

I. Karachi (*Major Baker*). We believe this to be a New Zealand species, and therefore insert its occurrence as above with some doubt, not having been able to examine the Karachi specimens.

CLEMENTIA PAPYRACEA Gray.

I. Bombay (*Abercrombie*). Very rare.

We have examined the imperfect specimens, and, though smaller than the type, consider that they belong to this species, though they may be referred also to a near ally *C. cumingi* Desh., an Erythrean mollusk. Another, *C. vitrea* Chemn., is reported as Ceylonese. The few described *Clementiæ* are very nearly allied.

VENERUPIS MACROPHYLLA Desh.

I. Karachi. In sandstone off Beach Port, Manora. Bombay (*Abercrombie*),

VENERUPIS MONSTROSA (Chemn.).

I. Karachi. With the preceding.

VENERUPIS PULCHERRIMA Reeve.

M.C. Near Charbar. A single juvenile valve, probably best referable here.

VENERUPIS OBESA Desh.

M.C. Ormara. 2 fathoms.

Fam. PETRICOLIDÆ.

PETRICOLA BIPARTITA Desh.

I. Bombay (*Mus. Brit.*).

PETRICOLA GRACILIS Desh.

M.C. In two or three places, not specified.

I. Karachi; dead specimens only, dredged on mud. Between Bombay and Ratnagiri (*E. H. Aitken*).

PETRICOLA HEMPRICHI Issel.

I. Karachi.

An Erythrean species, whence the types were obtained.

PETRICOLA PHOLADIFORMIS Lamk.

I. Karachi.

A species of the Atlantic Coasts of North America, which is becoming naturalised in Great Britain and other places in Europe. It remains to be seen whether it will perpetuate itself easily in tropical waters.

PETRICOLA SERRATA Desh.

I. Karachi.

CHORISTODON LAPICIDUM (Chemn.).

P.G. Gais (or Kais) Island; sand, 10 fathoms. Koweit, 15 fathoms. Gulf of Oman: Maskat; coral-rock and sand, 7 fathoms. Also reported from Aden (*Shoptland*).

Fam. GLAUCOMYIDÆ.

GLAUCOMYA CEREÆ Reeve. (*Glaucanome* Gray.)

I. Bombay, in brackish water (*Abercrombie*).

Suborder D. CARDIACEA.

CARDIUM AUSTRALE Sowb. (= *pulchrum* Rve.).

P.G. Gulf of Oman, Maskat. 5-10 fathoms, sandy mud near rocks. With the type occasionally occurs the variety *C. tenuicostatum* Lamk. (sp.).

CARDIUM (TRACHYCARDIUM) ASSIMILE Rve.

P.G. Exact locality not recorded.

I. Karachi (*Major Baker*).

CARDIUM (TRACHYCARDIUM) ELONGATUM Brug.

P.G. Not uncommon at 10 fathoms, in sandy mud.

CARDIUM (TRACHYCARDIUM) IMPOLITUM Sowb.

I. Karachi (*Major Baker*).

CARDIUM (TRACHYCARDIUM) LACUNOSUM Rve.

P.G. Gulf of Oman, Maskat. 10-15 fathoms; in both juvenile and adult condition. A very widely distributed species.

CARDIUM (TRACHYCARDIUM) MACULOSUM Wood.

P.G. Gulf of Oman. Near Maskat at 10 fathoms, sand. Also lat. 26° 50' N., long. 54° 50' E., and lat. 25° 23' N., long. 58° 36' E.; 40 fathoms.

CARDIUM (TRACHYCARDIUM) RUBICUNDUM Reeve.

P.G. Dredged at 3-10 fathoms, sandy mud.

No precise locality given.

CARDIUM (TRACHYCARDIUM) RUGOSUM Lamk. (= *flavum* L. in pt.).

P.G. Rarely.

I. Between Bombay and Ratnagiri (*E. H. Aitken*). "Much eaten, and the shells burnt to make lime for 'Supari'" (*E. H. A.*).

CARDIUM (TRACHYCARDIUM) VERTEBRATUM Jonas.

P.G. Dabai, 8-10 fathoms.

CARDIUM (ACANTHOCARDIA) ASIATICUM Chemn. (= *coronatum* Spengler).

I. Karachi (*F. W. T.* and *Major Baker*; the latter as *fimbriatum* Wood). Bombay (*Abercrombie*). Bombay Harbour, southwards to Ratnagiri, Panjim, and Goa (*Lt.-Col. H. D. Olivier*).

After detailed examination of many examples in all stages of growth, it is the opinion of Mr. Alexander Abercrombie that *coronatum* Spengler is synonymous.

CARDIUM (ACANTHOCARDIA) EXOCHUM* Melvill, sp. n. (Plate LIII. fig. 6.)

C. testa parva, inaequilaterali, fere rotunda, pallide straminea vel salmonæa; valvis convexis, æqualibus, solidulis; umbonibus obliquis contiguis vix prominulis, latere antico rotundato, postico obscure quadratulo, salmonæo-tincto, margine ventrali rotundato, dorsali utrinque leniter deflexo; costulis radiantibus numero ad 35, pulcherrime et arcte imbricato-squamosis, interstitiis sub lente angustissimis, unisulciosis, duobus dentibus cardinalibus in utraque valva prædita, lateralibus parvis; pagina interna alba, postice salmonæo-tincta, margine pulchre serrulato.

Alt. 9, lat. 8, diam. 8 mm.

Hab. P.G. Thairi.

Allied to the larger *C. sueziense* Issel, but more globular and highly coloured, and with close imbricating scales. Also resembling somewhat in form, though not altogether in sculpture, the recently described *C. gilchristi* Sowb.†, from South Africa. The squamæ are all of the same character, closely imbricated and latticed. In form it is roundly convex, peculiarly stained both without and within posteriorly with salmon-pink, being a most refined and delicate species.

CARDIUM (ACANTHOCARDIA) OMANENSE Melvill, sp. n. (Plate LIII. fig. 5.)

C. testa parva, fere rotunda, inaequilaterali, albida; umbonibus subprominulis, elevatis, contiguis; valvis subconvexis, æqualibus, solidis, lateribus antice, simul ac postice, rotundatis, latere postico superne obscure quadratulo, costis radiantibus ad 25, crassis, nodulis squamosis conspicuis præditis, interstitiis angustissimis, sub lente cancellatis; pagina interna alba, cardine normali.

Alt. 5, lat. 5.50, diam. 3 mm. (sp. maj.).

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, shell-sand.

A small species, with ribs coarse proportionately speaking to the

* *εζοχος*, prominently distinguished.

† 'Marine Investigation in South Africa.' Mollusca by G. B. Sowerby, p. 11, pl. vii. fig. 1.

size of the shell, each rib being ornamented with distinct scaly nodules, these not being in the least imbricate. Only imperfect specimens, but presumably adult, occurred.

CARDIUM (ACANTHOCARDIA) PALLIDUM Reeve.

I. Karachi (*Major Baker*).

CARDIUM (? ACANTHOCARDIA) SUEZIENSE Issel.

P.G. Koweit, 10 fathoms. Gulf of Oman, Maskat; 10 fathoms, coral-sand.

M.C. Charbar Bay; 3 fathoms, mud.

I. Angrias Bank (*Capt. W. A. Tindall*).

CARDIUM (CERASTODERMA) LATUM Born.

I. Karachi (*P. W. T. and Major Baker*). Upon rocks at low tide. Bombay (*Abercrombie*).

CARDIUM (CERASTODERMA) PULCHRUM Hinds.

P.G. & M.C. Here and there quite commonly distributed.

CARDIUM (SERRIPES) MUTICUM Rve.

P.G. Gulf of Oman, Jask. Dredged in sandy mud at 3-10 fathoms.

CARDIUM (PAPYRIDEA) PAPYRACEUM Chemil.

P.G. Gulf of Oman, Jask.

M.C. Charbar, 2 fathoms.

I. Karachi. 15 fathoms, mud; *in statu juvenili*.

CARDIUM (LEVICARDIUM) AGRANTIACUM Ad. & Rve.

P.G. No precise station given.

CARDIUM (? FRAGUM) CENTUMLIRATUM Melvill, sp. n. (Plate LIII fig. 2.)

C. testa alba, delicata, paullo inequilaterali, aequali, subglobosa, radiatim arcuissime et tenuissime multum-lirata, liris irregulariter squamato-spinosis et granulosis; spinulis granisque majoribus cum minoribus saepe alternantibus; umbonibus prominulis, margine dorsali utrinque leniter deflexo, latere antico rotundato, postico paululum quadratulo, margine centrali rotundato; pagina interna alba, margine tenui sulcoso; cardine normali, dentibus duobus cardinalibus subdistantibus in valva utraque, lateralibus parvis inconspicuis.

Alt. 21, *lat.* 21, *diam.* 14 mm. (*sp. maj.*).

Hab. Persian Gulf: Gulf of Oman. Lat. 24°, 58' N., long. 56°, 54' E.; 156 fathoms. Also off Mussandam, 50 fathoms.

M.C. Very rare off Charbar, at 40 fathoms.

Several valves of a charming and most delicate white shell, the very fine and elaborate radiating sculpture being almost too minute for a comprehensible description. The liris are over one

hundred in number, closely running together, every third or fourth row possessing larger spinose excavated squamæ; many of them slightly curved at the apex, others erect, straight; these spines are much worn off towards the umbones. The form of the shell is almost identical with that of the much smaller *C. (Fragum) torresi* E. A. Sm., from the Torres Straits*, but the sculpture is quite different. Smaller examples, hardly adult, exist in greater or less degree in the shell-dredging at 15 fathoms in the Gulf of Oman. The larger examples come from Mussandam. It seems also allied to *C. (Fulvia) peramabilis* Dall, Bull. Mus. Comp. Zool. Harvard (1885-6), p. 269, pl. iv. fig. 7: described by Dr. Dall as one of the most exquisite and elegant shells known. And *C. 100-liratum* must rival this when in its complete beauty, but, unfortunately, no absolutely perfect specimen has yet been obtained.

HEMICARDIUM (CTENOCARDIA) ADAMSI Reeve.

P.G. Gulf of Oman, Maskat. Dredged at 10 fathoms, sandy-mud bottom.

HEMICARDIUM (CTENOCARDIA) FORNICATUM Sowb.

P.G. Gulf of Oman, Maskat. At 15 fathoms, fine, handsome, and not infrequent.

An Erythrean species, very beautiful. Allied in form to *speciosum* Ad. & Rve., but of different texture and arrangement of scaly lamellæ or spinelets.

HEMICARDIUM (LUNICARDIA) AURICULA Forsk.

P.G. Gulf of Oman, Maskat. 10 fathoms. We place here, provisionally, a solitary and imperfect specimen, the only one received. As it is an Erythrean species, and likewise occurs commonly in the Gulf of Manaar, further south, it is most probably a true inhabitant of the region now under treatment.

Fam. TRIDACNIDÆ.

TRIDACNA CROCEA Lamk.

P.G. Juvenile examples only. Exact locality not defined.

Fam. CHAMIDÆ.

CHAMA FRAGUM Reeve.

P.G. Found once or twice on the telegraph-cable at from 30-55 fathoms.

CHAMA MACROPHYLLA Chemn.

P.G. Gulf of Oman. We have carefully compared the only example with the British Museum series, and cannot find any species nearer than the West Indian *macrophylla*.

* Rep. 'Challenger,' Zool. vol. xiii. p. 164, pl. viii. figs. 4, 4a.

I. Bombay (*Abercrombie*). The same remarks apply to these specimens.

N.B.—Two or three other members of this family occur, but, being encrusted with nullipores, &c., afford almost insuperable difficulties in attempting their classification.

Suborder E. MYACEA.

Fam. I. PSAMMOBIDÆ.

GARI BICARINATA (Desh.). (= *Psammobia* Lank.)

P.G. No special locality given.

GARI BIPARTITA (Phil.) (= *cœrulescens* Lank.)

M.C. Charbar.

GARI ELEGANS (Desh.).

P.G. Shaikh Shuaib I., 10 fathoms, mud and sand. Gulf of Oman, Maskat, 10 fathoms, mud and broken coral.

I. Karachi. 5 fathoms.

GARI ERASMA Melv.

P.G. Gais (or Kais Island), 7–10 fathoms. Gulf of Oman, Maskat, 10 fathoms. A small, but elaborately sculptured species.

GARI MALACCANA (Reeve).

I. Bombay (*Abercrombie*).

GARI MARMOREA (Desh.).

P.G. Gulf of Oman, Maskat. 15 fathoms, coral-sand.

I. Angrias Bank (*Captain W. A. Tindall*).

GARI MODESTA (Desh.).

P.G. Locality doubtful. An Australian species.

GARI OCCIDENS (Chemn.).

P.G. Gulf of Oman, Maskat. Dredged at 10 fathoms, sandy mud.

GARI ORNATA (Desh.).

P.G. Gulf of Oman, Maskat. With the preceding.

GARI PALLIDA (Desh.).

P.G. Shaikh Shuaib I., 7–10 fathoms. Gulf of Oman, Maskat; dredged at 10 fathoms, sandy mud.

M.C. Charbar Bay. 10 fathoms.

I. Karachi.

By some this species is considered synonymous with *G. malaccana* Rve.

GARI PRESTANS (Desh.).

P.G. Gulf of Oman. Lat. $26^{\circ} 50'$ N., long. $54^{\circ} 51'$ E. 10 fathoms, sand.

GARI PULCHELLA (Lamk.).

P.G. Gulf of Oman, Maskat. Dredged at 10 fathoms, sandy mud and stones.

GARI PULCHERRIMA (Desh.).

P.G. Gulf of Oman, Maskat; rarely.

GARI SIMPLEX (Sowb.).

I. Karachi. 4 fathoms, sandy mud.

SOLETELLINA ATRATA Desh. (*Psammotwa* Lamk. in pte.)

I. Bombay (*Abercrombie*).

SOLETELLINA BLANFORDI Hanley.

I. Karachi. On mud-flats at spring tides.

SOLETELLINA DIPHOS (L.).

I. Karachi (*Major Baker* and *F. W. T.*). Found in mud at very low tide. Between Bombay and Ratnagiri (*E. H. Aitken*).

SOLETELLINA VIOLACEA Lamk.

I. Karachi (*Major Baker*).

ASAPHIS DEFLORATA L. (= *Capsa rugosa* Lamk.).

P.G. Jask, and probably general along M.C.

I. Karachi. Very fine coloured varieties. Bombay (*Abercrombie*), only dead examples.

Fam. LUTRARIIDÆ.

LUTRARIA PLANATA (Chemn.).

I. Bombay (*Abercrombie*); rare.

CECELLA TRANSVERSALIS Desh.

I. Bombay (*Abercrombie*); fairly frequent.

Fam. MYIDÆ.

CORBULA BROOKEANA Hanley.

P.G. Gulf of Oman. At 248 fathoms, mud bottom.

CORBULA CUNEATA Hinds.

P.G. Gulf of Oman, Maskat. Dredged at from 5 to 20 fathoms, mud bottom.

CORBULA ERYTHRÆENSIS H. Ad.

P.G. Many dead examples dredged at 40 fathoms, mud.

M.C. Off Cape Monze. Dredged at 60 fathoms.

I. Karachi.

CORBULA MODESTA Hinds.

P.G. Linjah, Kais and Shaikh Shuaib Islands.

M.C. In several places from 3-10 fathoms, mostly sand bottom.

I. Karachi. Bombay (*Abercrombie*). Ratnagiri, and further southwards. It was dredged off Quilon, Malabar Coast, beyond our limit, by Captain Tindall, of s.s. 'Patrick Stewart.'

CORBULA PERSICA Smith.

Corbula persica E. A. Smith, Ann. & Mag. Nat. Hist. ser. 7, xviii. p. 262 (1906).

P.G. 47 fathoms ('*Investigator*'). Gulf of Oman: lat. 24° 58' N., long. 56° 54' E.; 156 fathoms, in shell-sand. Also M.C., lat. 25° 10' N., long. 60° 34' E., 40 fathoms.

A small species, allied to *C. philippii* E. A. Sm.

CORBULA RUGIFERA H. Ad.

I. Karachi.

CORBULA SUBQUADRATA Melvill, sp. n. (Plate LVI. fig. 7.)

C. testa parva, ovata, inaequali, inaequilaterali, antice rotundata, postice producta, subquadrato-angulata; valvis concentric levicostatis, superficie alba, nitida, margine dorsali utrinque leniter declivi, postice elongatulo, quadratulo, interdum nasuto, ventrali paullum sinuato; umbonibus incurvis, haud multum prominulis, crassiusculis; pagina interna alba; dente cardinali normali, prominente.

Alt. 3, lat. 4.50, diam. (valva dextræ) 1.50 mm.

Hab. Persian Gulf: Gulf of Oman. Lat. 24° 58' N., long. 56° 54' E.; 156 fathoms.

I. Bombay (*Abercrombie*); nearly always imperfect, in shell-sand.

The specimens from the Gulf of Oman seem only to differ from those from further south in being slightly smaller, the dimensions given above being taken from Bombay examples, in which place it seems local, but common where it occurs. A few Omanese examples are perfect, showing the left valve smaller than its fellow, the form subquadrate, the posterior side elongately produced and finely squarely truncate; the superficial concentric ribs are about 12 in number, more than is found in the nearly allied *C. modesta* Hinds, with which this may have been confounded occasionally.

CORBULA SULCULOSA A. Ad.

P.G. Shaikh Shuaib Island. Gulf of Oman, Maskat; 10 fathoms, muddy sand bottom.

CRYPTOMYA PHILIPPINARUM A. Ad.

I. Bombay (*Herford* and *Abercrombie*). Only dead shells, but referred here with some degree of assuredness.

Fam. SOLENIDÆ.

SOLEN BREVIS Hanley.

I. Bombay (*Abercrombie*). Southwards to Ratnagiri (*Lt.-Col. H. D. Olivier*).

SOLEN CORNEUS Lamk.

I. Karachi. Found upon mud-flats, common.

SOLEN TRUNCATUS Sowb.

I. Karachi, rare. Bombay (*F. W. T.* and *Abercrombie*), abundant.

N.B.—The species of *Solen* are known as “Chirpal” in India, and eaten (*E. H. Aitken*).

CULTELLUS CULTELLUS (L.).

P.G. Gulf of Oman, Maskat.

M.C. Often dredged at about 8–10 fathoms, muddy sand and rocks.

MACLERA ALBIDA Dkr. (*Siliqua* Mhlfd.)

I. Bombay, not common (*Abercrombie*).

MACLERA POLITA Wood.

I. Karachi (*F. W. T.* and *Major Baker*). Between Bombay and Ratnagiri (*E. H. Aitken*). Also occurring at Aden.

MACLERA RADIATA (L.).

M.C. Local.

I. Bombay (*F. W. T.*). To Ratnagiri (*E. H. Aitken*).

SOLENOCURTUS COARCTATUS (Gmel.). (*Solecortus* Blainville.)

M.C. Lat. 25° 10' N., long. 60° 34' E.; 40 fathoms, off Charbar. Also noted by the ‘Investigator’ in the Gulf of Oman at 37–40 fathoms (*E. A. Smith*).

SOLENOCURTUS EXARATUS Phil.

I. Bombay (*Abercrombie*); rare.

Fam. GASTROCHLÆNIDÆ.

GASTROCHLÆNA MYTILOIDES Lamk.

P.G. Shaikh Shuaib I. In coral.

Suborder F. PHOLADACEA.

Fam. PHOLADIDÆ.

PHOLAS (DACTYLINA) DACTYLUS L.

I. Karachi. In peat-sand off Mareh Fort, Manora.

PHOLAS (DACTYLINA) ORIENTALIS Gmel.

I. Karachi. With the preceding, but not equally abundant. Large numbers of single valves occur off the Hajanora mouth of R. Indus, the largest measuring over 7 inches in length.

PHOLAS (BARNEA) BAKERI Desh.

I. Karachi (*Major Baker*). Bombay (*Abercrombie*), common, but usually imperfect. Bombay Harbour, southwards to Ratnagiri (*Olivier*).

MARTESIA STRIATA (L.).

I. Bombay (*Abercrombie*).

Suborder G. ANATINACEA.

Fam. ANATINIDÆ.

ANATINA LABIATA Rve.

I. Bombay (*Abercrombie*). Found in some quantity amongst seaweed cast up by a storm; otherwise rarely met with, perhaps because of its extreme fragility.

Bombay Harbour, southwards to Ratnagiri (*Lt.-Col. H. D. Olivier*).

ANATINA SUBROSTRATA Lamk.

M.C. Charbar. 10 fathoms; rarely.

PERIPLOMA INDICUM Melv.

P.G. Gulf of Oman, Jask. 4-6 fathoms, sand and mud.

THRACIA ADENENSIS Melv.

P.G. Gulf of Oman. Lat. 24° 55' N., long. 57° 59' E.

The type was described (Ann. & Mag. Nat. Hist. ser. 7, vol. i. p. 206, pl. xii. fig. 16) from Aden, among Commander E. R. Shopland's collections. Its occurrence so far north shows a most interesting extension of range. It was found also in Erythraean collections made by the 'Pola' Expedition (Dr. Rudolf Sturany).

THRACIA SALSETTENSIS Melv.

I. Bombay (*Abercrombie*).

One of the most beautiful additions to this fauna, and ranking

among the larger species of the genus. It is so fragile, however, as not to bear much handling, and this may in some measure account for its having been so long unnoticed and undescribed. Only single valves have hitherto been met with. We hope soon to see some dredged and perfect specimens. It only occurs after storms, which would imply that it is a deep-water shell, and probably lives in thick mud.

Fam. PANDORIDÆ.

PANDORA CEYLANICA Sowb.

P.G. Gulf of Oman, Jask.

PANDORA CUMINGI Hanley.

P.G. Shaikh Shuaib I. 10 fathoms, mud and sand.

PANDORA FLEXUOSA Sowb.

P.G. & M.C. Dredged commonly at from 5–10 fathoms, sand.

I. Karachi. At the same depth.

Bombay (*Abercrombie*). Disconnected valves very abundant in shell-shingle.

PANDORA NASUTA Sowb.

P.G. Gulf of Oman, Jask.

M.C. Widely distributed.

I. Karachi.

Fam. VERTICORDIIDÆ.

VERTICORDIA DESHAYESIANA Fischer.

P.G. Gulf of Oman. Lat. $24^{\circ} 58'$ N., long. $56^{\circ} 54'$ E.; 159 fathoms, shell-sand.

One half-valve, extracted by Mr. E. R. Sykes, seems to be the young of this species, after a close comparison. The ribs are thick and beautifully scaly-imbricate, however, the form being practically the same.

VERTICORDIA MULTICOSTATA A. Ad.

P.G. Gulf of Oman. Lat. $24^{\circ} 58'$ N., long. $56^{\circ} 54'$ E.; 156 fathoms, shell-sand.

Several specimens, identified with a little doubt; indeed, it may be an undescribed, nearly allied form. Adams's type came from Japan.

VERTICORDIA sp.

P.G. Gulf of Oman. Lat. $25^{\circ} 10'$ N., long. $60^{\circ} 34'$ E.; 40 fathoms.

Very likely an undescribed form.

Order V. SEPTIBRANCHIATA.

Fam. CUSPIDARIIDÆ.

CUSPIDARIA APPROXIMATA Smith.

Cuspidaria approximata E. A. Smith, Ann. & Mag. Nat. Hist. ser. 6, vol. xviii. p. 373 (1896).

P.G. Gulf of Oman, Maskat; 10–15 fathoms, not scarce. Also lat. $24^{\circ} 49' N.$, long. $56^{\circ} 56' E.$; 225 fathoms.

I. Lat. $15^{\circ} 25' N.$, long. $71^{\circ} 45' E.$; 240 fathoms.

This is probably synonymous with *C. brachyrhynchus* Stur. (1899).

CUSPIDARIA ALCOCKI Smith.

Cuspidaria alcocki E. A. Smith, Ann. & Mag. Nat. Hist. ser. 6, vol. xiv. p. 170, pl. v. fig. 8 (1894).

Cuspidaria potti Sturany, Exped. S.M. Schiff 'Pola' in das Rothe Meer (1899), p. 10, Taf. i. figs. 10–16.

P.G. Gulf of Oman. Lat. $25^{\circ} 30' N.$, long. $57^{\circ} 30' E.$; 85 fathoms. Lat. $25^{\circ} 51' N.$, long. $56^{\circ} 54' E.$; 156 fathoms.

M.C. Lat. $25^{\circ} 10' N.$, long. $60^{\circ} 34' E.$; 40 fathoms off Charbar; not infrequent in shell-sand.

Small examples, apparently not full-grown, have so far only been obtained in this latter locality. When adult, this is one of the most beautiful of the genus.

CUSPIDARIA ELEGANS Hinds.

P.G. Gulf of Oman. Lat. $24^{\circ} 58' N.$, long. $56^{\circ} 54' E.$; 156 fathoms.

Only in imperfect condition, and very rarely occurring.

We expected fully that the deep seas of the Gulf of Oman would have yielded more interesting *Cuspidariæ* than has yet been found to be the case. Dr. Sturany, for instance, described five species from the Red Sea ('Pola' Expedition), two of which only are in our gatherings. In all other families and genera the results, we consider, come quite up to the highest expectations.

In conclusion, we would express our best acknowledgments to all those who have in one way or another, through so many years, assisted us in the preparation of this Catalogue; and would primarily mention Mr. Edgar A. Smith, I.S.O., Mr. Ernest R. Sykes, F.L.S., the late Dr. W. T. Blanford, F.R.S., Dr. W. Healey Dall, Dr. Rudolf Sturany, Mr. Stephen Pace, F.Z.S., Mr. A. J. Jukes-Browne, F.G.S., Mr. G. B. Sowerby, F.L.S., Mr. A. Abercrombie, Mr. Hugh Fulton, Mr. J. Wilfrid Jackson, Commander E. R. Shopland, Lt.-Col. H. D. Olivier, Miss Maud Olivier, Captain A. J. Peile, Mr. E. H. Aitken, Mr. E. Comber,

and especially Mr. F. W. Townsend, who, not content with giving most clear particulars and explicit data with all his many discoveries, also wrote out a preliminary list, which has proved of much service.

It will be desirable that a supplement treating of the 'Addenda' and 'Emendanda' should some day be issued, as, since October 1901, the date of publication of the first portion of this Catalogue, over 250 species, many of them new to science, have been brought to light from these seas. Such interesting species, for instance, as *Rimula cumingi* A. Ad., *Pleurotoma navarchus* M. & S., *Cancellaria antiquata* Hinds, *Conus (Conorbis) coromandelicus* Smith, *Terebra fuscocincta* Smith, *Trichotropis pulcherrima* M. & S., *Homalaxis cornu-ammonis* M. & S., *Berthais intertexta* M. & S., many *Scalarie*, and still more *Pleurotomidæ*, are among those to be enumerated, whenever such a work is taken in hand.

EXPLANATION OF THE PLATES.

PLATE LIII.

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| <p>Fig.</p> <p>1. <i>Spondylus gloriandus</i>, p. 811.</p> <p>2. <i>Cardium (Fragum) centum-liratum</i>, p. 839.</p> <p>3, 3 a. <i>Kellia leucedra</i>, p. 817.</p> <p>4, 4 a. „ <i>revimentalis</i>, p. 817.</p> <p>5. <i>Cardium (Acanthocardia) omacense</i>, p. 838.</p> | <p>Fig.</p> <p>6. <i>Cardium (Acanthocardia) crochum</i>, p. 838.</p> <p>7. <i>Mesodesma (Paphia) bahreinense</i>, p. 827.</p> <p>8, 8 a. <i>Arca (Scapharca) biriciana</i>, p. 794.</p> |
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PLATE LV.

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PLATE LVI.

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November 27, 1906.

HOWARD SAUNDERS, Esq., F.L.S., Vice-President,
in the Chair.

The Secretary read the following report on the additions that had been made to the Society's Menagerie in October 1906:—

The registered additions to the Society's Menagerie during the month of October were 159 in number. Of these 55 were acquired by presentation and 23 by purchase, 63 were received on deposit, and 18 were born in the Gardens. The total number of departures during the same period, by death and removals, was 164.

Amongst the additions special attention may be directed to:

A specimen of Jamrach's Mangabey (*Cercocebus jamrachi*) from Lake Mweru, new to the Collection, deposited on Oct. 31st.

A specimen of Sharpe's Wood-Owl (*Syrnium nehalae*) from Lagos, presented by Dr. Strachan, C.M.G., on Oct. 11th.

Two specimens of Mayer's Pigeon (*Nesoenas mayeri*) from Mauritius, new to the Collection, presented by Lt.-Col. Manders, R.A.M.C., F.Z.S., on Oct. 13th.

Mr. E. T. Newton, F.R.S., exhibited the leg-bones of two Foxes that had been caught in snares. The wire in each case had cut through the skin and was drawn tight round the bone which in course of development had grown over the wire and enveloped it.

The following papers were read:—

1. On some Habits of the Lesser Horseshoe Bat (*Rhinolophus hipposiderus*). By T. A. COWARD, F.Z.S.

[Received July 23, 1906.]

On several occasions I have visited the limestone caves at Cefn in Denbighshire and Tremeirchion in Flint, in order to observe the habits and obtain specimens of the Lesser Horseshoe Bat, *Rhinolophus hipposiderus* (Bechstein), or *Rhinolophus hipposiderus minutus* (Montagu) as segregated by Mr. Knud Andersen (1). Always a delicate bat when removed from its natural haunts, the Lesser Horseshoe seldom lives in captivity for more than a few days, and this is especially the case when it is taken from hibernacula. The species in many cases appears to occupy different retreats in summer and winter, and even if the same caves are used during the months in which the animal is active and those in which it is usually supposed to be dormant, the parts of the caves tenanted may differ. Professor J. R. Kinnahan (2) found

Lesser Horseshoe Bats in caves in Co. Clare in March and April, where Mr. Foot had previously taken them in March, but in the August following Mr. Foot's visit he failed to find any in the Ballyallia cave. The Rev. H. A. Macpherson (3), having advertised for bats, received from Mr. Mitchell some Greater Horseshoes (*Rh. ferrum-equinum*), which he had taken from a Devonshire cavern. Mr. Mitchell took these bats in August, and remarked, when he forwarded them to Macpherson:—"The bats seem to prefer the mouth of the caves to the interior parts, for, although I went in a great distance, I failed to see a single bat beyond a certain limit, *i. e.* where the daylight failed absolutely." "Early in spring I could go down and pick off as many as I could carry away whereas now, as soon as I entered the cave, they began to fly from one part of the cave to the other." Although Mr. Mitchell attributed this shyness to the bats having been disturbed by the lights and noise of visitors, it seems probable that the summer haunts of the bats were nearer the entrance than their winter retreats, for the Lesser Horseshoes at Cefn and elsewhere are found at a great distance from the entrance in winter. On September 24th, 1903, some were taken in a cave at Tal-y-bont, Carnarvonshire (4), but it is impossible to say if the bats had retired to this cave for the winter, or had occupied the place during the summer months.

In 1903 I visited the Tremeirchion cave on July 29th, and on August 15th, in the company of Mr. Robert Newstead, the caves at Cefn; we failed to find a single bat in either favourite winter resort. On November 18th we found that large numbers of Lesser Horseshoes were in the caves, but they were even then undoubtedly not in deep sleep; two were actually flying in the passages when we first noticed them, and three others took flight before we could touch them. In one particular water-worn hole, which contained no cracks in which bats could lurk unseen, and which was empty in August, eleven bats were hanging. The temperature of the caves on that day, several yards from the entrance, was 46° F., and the activity of the bats may be explained by this; for Dr. N. H. Alcock and Mr. C. B. Moffat (5) conclude that in the case of the Long-eared Bat (*Plecotus auritus*), "hibernation . . . is repeatedly interrupted, and, apparently, this is liable to occur whenever the thermometer rises above 46° F." On December 2nd, 1905, we found the bats less active, but three were sleeping so lightly that they were roused either by the light or heat of a candle, or the noise made in attempting to focus a camera in order to obtain a photograph. Two woke up and flew without being touched, and the third was on the point of flying when we captured it.

On other visits in December, March, and April, I have found the bats plentiful but apparently in deeper sleep; it was possible to pick them from the walls and hold them in the hand for some time before they became restless. In April 1897, Mr. Newstead found that "the bats were hibernating, but awoke on the slightest

provocation," when the temperature in the cave was slightly above 48° F. twenty yards from the entrance (6). It is, however, difficult to say what is hibernation and what merely diurnal sleep. The summer diurnal sleep of bats is profound, and the phenomena incidental to hibernation are present during normal sleep—the heart's action and respiration are hardly perceptible and the temperature falls considerably. A sleeping bat in summer is almost as cold and lifeless as a bat which is hibernating, and is frequently as difficult to rouse.

If then these bats, during at any rate the earlier months of their retirement, are not in a profound winter sleep, do they occasionally go out to feed or procure food in the caverns? If the latter is the case, what is their mode of feeding? The first question we are as yet unable to answer; we have no certain information about the duration of their activity in the summer months, but we have reason to believe that in the winter months, the months during which the bats occupy the winter retreats (I prefer this term to hibernacula), food is taken.

Prof. Kinahan (2), in Vigo cave, on April 1st found two bats which had not been in the same positions on March 22nd; and, as already mentioned, we found the bats at Cefn on November 18th so lively that they flew before being touched. Hardly without exception the bats captured at Cefn and Tremeirchion defecated when thoroughly awake; and two captured in March and chloroformed at once, had fecal matter in the intestine, and one had half-digested matter in its stomach. On the floor of the caves beneath hanging bats, and below certain cracks in the limestone which we could not reach into or examine, were quantities of excrement. In August this excrement was dry and mouldy, but in March, April, and November it was undoubtedly fresh, and in the last-named month there was certainly more fresh excrement than in the earlier months.

In winter there is an abundance of insect-life in the caves: two moths (*Scotosia dubitata* and *Gonoptera libatrix*) hibernate in the caverns, and a large number of small Diptera rest upon the walls, some being apparently in a comatose state, others flying at once towards our candles. A large cave-haunting spider (*Meta menardi*) is also abundant. Some of the bats' excrement collected in April and examined by Mr. Newstead (6), "showed that they had been feeding, almost exclusively, upon the smaller species of Lepidoptera," but there were fragments of other insects. From this we should conclude that in April the bats had been outside the caves, though they had not changed their retreats. Subsequently Mr. Newstead found the remains of Diptera and one fragment of a leg apparently of the spider *Meta menardi*, which certainly must have been taken in the cavern itself. Mr. Mitchell informed the Rev. H. A. Macpherson (3) that there were heaps of refuse near the mouth of the cave in which he obtained the Greater Horseshoe Bats, which contained partly-eaten cockchafers, dor-beetles, scavenger-beetles, and other Coleoptera, as well as

moths' wings. Mr. J. G. Millais (7), after stating that the Greater Horseshoe does not devour all its food whilst on the wing, "but conveys some to its diurnal resting-place," where it consumes it "while clinging to the walls or rocks," adds that "Mr. A. G. Berry tells me that he has swept up a dustpanful of moths' wings and beetle-cases, the discarded remains of a night's foray, from beneath the sleeping-place of a cluster of these bats." Both these cases refer to the habit of the bats during the period of activity, but they show that the animals do not always, at any rate, feed as the Noctule and certain other species do, whilst upon the wing.

A female Lesser Horseshoe, which I obtained in December 1905, having snatched a mealworm from my hand, flew with it to the wall, hung by her feet to the picture-rail, and consumed the mealworm when at rest. I repeated the experiment two or three times, and found that she always settled before devouring the worm, a habit which is not constant in other species, though occasionally resorted to. I have found that a Long-eared Bat will devour a mealworm when on the wing or when hanging, the latter being the unusual method. As I was able to make this Horseshoe fly only a few times—four, I think—it would be unwise to say that the species never feeds upon the wing.

The use of the interfemoral membrane in the *Vespertilionidae* has been demonstrated on several occasions. When an insect, large and powerful in proportion to the size and strength of the bat, has been captured, the bat thrusts its head beneath its belly, into a receptacle or pouch formed by the interfemoral membrane when the tail is bent forwards beneath the body. Against this membrane the insect can be pushed and held until a firm grip is secured by the bat's jaws, an action which varies in duration of time according to the size of the insect, but is usually accomplished in an instant. Having secured a firm grip of its prey, the bat withdraws its head with great rapidity from the pouch, and masticates the insect openly. Naturally it is exceedingly difficult to see anything of the *modus operandi* when the bat is feeding in a free state on the wing; but when the animals are fed in captivity the habit is so constant, that we can only suppose that it is a natural and ordinary method, and not a trick acquired in captivity.

Gilbert White (8) says:—"I was much entertained last summer with a tame bat, which would take flies out of a person's hand. If you gave it anything to eat, it brought its wings round before the mouth, hovering and hiding its head in the manner of birds of prey when they feed." Many writers since, who have watched bats feeding in captivity, have been influenced by this idea; for example, the Rev. J. G. Wood says of a Long-eared Bat (9):—"It seized the meat with a sharp snap, retreated to the middle of the cage, sat upright, thrust its wings forward to form a kind of tent, and then, lowering its head under its wings, disposed of the meat unseen." W. Bingley (10), referring to "The Common or Little

Bat," which may have been a *Pipistrellus* or a *Myotis*, having given his captive a "flesh-fly" too large for admission into its mouth, remarks:—"The animal, raising itself somewhat higher than usual on its fore legs, bent its head with great dexterity under its belly, and forced the insect into its mouth, by thrusting it, from side to side, against that part of the membrane which extended betwixt the two hind legs. I cannot be mistaken in this particular; for, during the life of the animal, the experiment was often repeated. The manœuvre was, however, never practised, except where the fly was too large to be managed with facility by the jaws and tongue alone. This confirms what Mr. White has said respecting the actions of a tame bat that he saw eat; but it leads us to a very different mode of accounting for them." Bingley adds, in a footnote, that "by the word *hovering*, Mr. White seems to mean a kind of tremulous motion which is to be remarked in the animals during this process."

Mr. Charles Oldham (11 & 12), after making careful observations on a number of different species of *Vespertilionidae*, was the first to explain the true meaning of the habit. The bat, when fed in an unnatural position—standing on a flat surface—pushes forwards the arms, supporting itself on the carpi, and slightly unfolds the wings; when it has secured its food it depresses its head, moving it downwards towards the tail, which is curved beneath it, and the head is thus hidden by the interbrachial membrane, giving origin to the "tent" idea of White and others.

In the *Rhinolophidae*, owing to the shortness of the tail and the consequent small interfemoral area, coupled with the fact that the tail is usually recurved over the back, this action is apparently impossible; but in *Rh. hipposiderus*, at any rate, a similar method of securing the prey is resorted to, the interbrachial membrane being used instead of the interfemoral.

In December 1905 I kept a couple of Lesser Horseshoes alive for several days, feeding them chiefly on mealworms, which are doubtless larger than the insects they habitually feed upon. When I kept this species before, I several times noticed that when an insect struggled in the bat's mouth, the bat bent its head downwards as if about to push the insect into a pouch; but one of these two bats, a female, actually made use of the interbrachial membrane. Having taken the worm from my fingers, she thrust her head well beneath her body and pushed the captive against the membrane, close to the flank and just anterior to the femur. In order to see the action better, I allowed the bat to hang from my open hand, her feet clinging to my first finger. I could then see the head and worm distinctly through the membrane, especially as she remained in the doubled-up position on one or two occasions for a period of several seconds. The membrane was pushed into the shape of a bag, an efficient substitute for the interfemoral pouch. The bat did not invariably use one side, and on one occasion she held the worm against her belly.

When a worm was offered to her she snatched it fiercely,

fluttering her wings at the same time with a tremulous motion, entirely different from the struggles of a bat which is striving to escape from the hand which holds it. Then, with rapid movements of the jaws, accompanied by a nervous trembling of the head, she bit the worm along its entire length, passing it through her mouth, thus paralysing the captive. The head of the mealworm was rejected, and when this had been severed from the body, the remainder was eaten slowly, though the movement of the bat's jaws was rapid. The horny caudal extremity of the mealworm was also rejected; this and the head usually remained sticking to or near the bat's lips, and were wiped off against the bat's body. Neither foot nor thumb was used in order to get rid of these particles.

We thus see that we have several facts which, though not founded on a sufficient number of observations to form conclusive evidence, suggest points of interest in the study of the species.

1. The Lesser Horseshoe—and the same is true of many other species—usually occupies different retreats in summer and winter, and where the same caves are used at both seasons retires further into the recesses during the colder months.

2. During the earlier period of occupation of the winter retreats, sleep is not profound—not indeed to be described as hibernation in the accepted meaning of the word.

3. During a portion at any rate of this period the bats feed—presumably in the caves.

4. The food is, in certain instances, consumed when the animal is at rest and not upon the wing.

5. Although unable to make use of the interfemoral membrane, after the manner of other bats, the species so far shares or retains the habit that it makes use of the interbrachial membrane for the same purpose.

Whether this last trait is the survival of a habit, or is the first step towards a more perfected habit in bats with more fully developed membranes, is a point on which I am not prepared to dogmatise. We must first learn if the short upturned tail is rudimentary, or if the animal gains any advantage through the degeneration of that appendage. Mr. R. Newstead (6) suggests that when the bat is hanging at rest, the tail and the inferior surface of the membrane form a “deep, narrow trough: an excellent apparatus to carry off any drops of water that might fall upon it from the roof of its habitat.” The spots, however, which are chosen by the bats are usually in dry parts of the caves. The tail is carried erect when the bat is climbing—the Lesser Horseshoe cannot walk on a flat surface; and I feel certain that it was carried in this position in flight by my captives. Mr. Oldham observes (12) that “the legs showed very distinctly against a white ceiling when viewed from below, but this was possibly due to the shortness of the tail, and not to its being erect or recurved”; but though the legs certainly were distinct, they appeared to me to be slightly flexed and not fully extended;

the bent legs would be consistent with the upturned tail, of which I could see no sign from below.

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11. Zoologist, 1899, pp. 49-53.
12. Zoologist, 1899, pp. 471-474.

The Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland in the Years 1901 and 1902.—On some Species of *Solenidæ*. By EDGAR A. SMITH, I.S.O., F.Z.S., and H. H. BLOOMER.

[Received October 5, 1906.]

MACHA PHILIPPINARUM Dkr.

Macha philippinarum Dunker, Proc. Zool. Soc. 1861, p. 424.

Solecortus philippinarum Sowerby in Reeve's Conch. Icon. vol. xix. pl. iii. fig. 12; Clessin, Conch.-Cab. p. 90, pl. xxi. fig. 8 (copy of Sowerby).

Hab. Wasin I., 10 fathoms.

One specimen, shell only.

This species belongs to the same group of Solenidæ as the Mediterranean *Solen strigilatus* of Linné, which formed the type of Section B of Blainville's genus *Solecortus* (1824)*. His section A had for type *Solen radiatus* Linn., which belongs to the genus *Siliqua* Mühlfeld (1811)†. It therefore seems advisable to place the present species under the genus *Macha*, which was described by Oken in 1835‡ for the reception of *Solen strigilatus*. Hermannsen § quotes *Macha* as described by Oken in 1815; but I have searched in vain in the 'Lehrbuch'¶ for any mention of this genus, which should therefore date from 1835.—E. A. S.

* Diet. Sci. Nat. vol. xxxii. p. 351.

† Mag. Gesell. Naturf. Freunde, Berlin, 1811, p. 44.

‡ Allgem. Naturg. vol. v. pt. 1. p. 298.

§ Indiciis Gen. Malac. vol. ii. p. 1.

¶ Lehrbuch d. Naturg. vol. iii.

SOLENE CORNEUS Lamarck?

Solen corneus Lamk.; Delessert, Recueil, pl. ii. figs. 2 a, 2 b; Philippi, Abbild. vol. iii. p. 44, pl. ii. fig. 2; Sowerby in Reeve's Conch. Icon. vol. xix. pl. iv. fig. 19, pl. vii. fig. 18 b; Clessin, Conch.-Cab. p. 9, pl. iii. figs. 8, 9.

Hab. In fairly firm sand, halfway down the shore in Chuaka Bay, Zanzibar Island (*Crossland*); Java (*Lamarck*); Rea Sea (*Philippi*); Japan, Philippine Islands (*Dunker*).

I do not feel quite certain with regard to the identification of Mr. Crossland's specimens, nor is it certain that the several shells depicted by Delessert, Philippi, Sowerby, and Clessin really belong to the same species. The form figured in the 'Conchologia Iconica' most nearly resembles the Zanzibar shells, none of which, however, is so large, the longest specimens being only 55 millims. in length. They may, however, be only immature examples.—E. A. S.

The species differs from *S. vagina* in the following particulars:—

The animal curves a little dorsally. Its length, measuring from the anterior end of the anterior adductor muscle to the posterior end of the proximal portion of the siphon, is only 42 mm., and its depth 8 mm. It is therefore not so deep or so wide as *S. vagina*.

The forward projection of the ventral part of the anterior portion of the mantle-lobes is slightly more pronounced, but the grooves in which lie the constricted anterior parts of the shell are not quite so deep.

The proximal portion of the siphon is externally smooth and not ridged dorso-ventrally like *S. vagina*. The anterior adductor muscle is longer, but not so wide. The foot is rounder and the distal portion larger. Internally the alimentary canal is similar, with the exception of the stomach. The œsophageal and cardiac divisions are smaller and the pyloric division is larger. The cæcum of the crystalline style leaves the stomach on the antero-ventral side of the pyloric division.—H. H. B.

SOLENE ACINACES Hanley?

Solen acinaces Hanley, Proc. Zool. Soc. 1843, p. 101; Sowerby in Reeve's Conch. Icon. vol. xix. pl. vii. fig. 34; Clessin, Conch.-Cab. p. 33, pl. xiii. fig. 3 (copy of Sowerby).

Hab. Zanzibar Island.

This species presents the following differences from *S. vagina*:—

The animal measures in length from the anterior end of the anterior adductor muscle to the posterior end of the proximal portion of the siphon 42 mm., and it is 10 mm. in depth. It is curved outwardly on the dorsal surface, and has a corresponding curve inwardly on the ventral surface. The conscreted portion of the ventral edge of the mantle-lobes is very broad, much more so than in *S. vagina*. The anterior adductor muscle is not so wide. The distance from the posterior side of the posterior

adductor muscle to the posterior edge of the proximal portion of the siphon is greater, though the retractor pedis posterior muscle is shorter. The retractor pedis anterior muscles are a little shorter and their bifurcations are hardly discernible. The free portion of the siphon is large, the inhalent chamber being much larger than the exhalent one. The siphonal valves are also strongly developed. The length of the free portion of the siphon, however, cannot be ascertained as a part of it is missing. The distal is deeper than the proximal half of the foot, and more resembles that of *Ensis ensis*. Regarding the alimentary canal there is relatively a greater difference. The oesophageal and cardiac divisions are smaller. The central division (or cavity receiving the small bile-duct) is situated more anteriorly. The pyloric division is larger. The cæcum of the crystalline style is situated on the ventral side of the stomach, and the distal portion of it gradually curves towards the dorsal surface of the pedal cavity. The intestine leaves the stomach more anteriorly, makes a number of loops in and anteriorly to the liver, and passes to the distal end of the cæcum of the crystalline style before returning along the right lateral side of the same.—H. H. B.

It is with some hesitation that I have determined the single specimen at hand as belonging to *Solen acinaces* of Hanley. It agrees in regard to the general curve of the shell and the anterior truncation and posterior end of the valves, also in respect of the colour and periostracum. It is smaller than the type, being only 2 inches in length and 11 millims. in breadth, and, at this age, looks rather more slender. However, having only a single shell to judge from, it is impossible to say whether this apparent slenderness would prove to be a constant character. The uncertainty of the identification is increased by being unable to compare it with the type of the species, which is only known to me by the description and figure. Mr. Crossland observed that the foot, in life, was flat and tongue-shaped, and that by rapid beating of it from side to side, the animal swam round a basin in which he had placed it so actively, that the siphonal or posterior end of the shells protruded from the water.—E. A. S.

SOLENS SLOANII Gray.

Solen sloanii Gray, MS. Brit. Mus.; Hanley, Cat. Biv. Shells, 1843, pp. 12 and 336, pl. xi. fig. 18; Sowerby, Conch. Icon. vol. xix. pl. iii. fig. 10; Hedley, Proc. Linn. Soc. N. S. Wales, vol. xxiv. p. 432 (notes on animal).

Solen versicolor Philippi, Abbild. vol. iii. p. 43, pl. ii. fig. 3 (1848).

Solen philippianus Dunker, MSS.; Sowerby, Conch. Icon. fig. 13.

Hab. Wasin I., 10 fath. (*Crossland*); Port Jackson ('*Challenger*'). One valve only.—E. A. S.

3. The Duke of Bedford's Zoological Exploration in Eastern Asia.—II. List of Small Mammals from Korea and Quelpart. By OLDFIELD THOMAS, F.R.S.

[Received October 9, 1906.]

After the completion of the magnificent Japanese collection which formed the subject of the first paper of the present series*, Mr. M. P. Anderson went in August 1905 to the Island of Quelpart, and from there to Korea, where he spent the autumn and early winter.

Owing, however, to various local difficulties and to the unfavourable nature of the country, he was not able in Korea to make anything like a complete collection; the species he obtained, although represented by no less than 130 skins, numbering only 9, mostly Mice and Shrews; so that the present must be looked upon as merely a preliminary contribution to our knowledge of Korean Mammals. But such species as he did get are of much interest, and no less than four of the nine are new. Later on it is to be hoped that he may revisit Korea, and, finding some locality less barren or less cultivated, he may be able to get a more complete representation of the fauna.

The most interesting of the new species is the handsome red-backed Vole, *Craseomys regulus*, which represents in Korea the Japanese species *C. bedfordiae* and *andersoni*. Of the Muridae, *Micromys speciosus* is present and dominant, as in Japan, but instead of having as a companion the little *M. geisha*, the place of the latter is taken by an immigrant from further west, a mouse of the *M. agrarius* type, not found in Japan.

With regard to Quelpart, that island has hitherto been a *terra incognita* to mammalogists, as to most other zoologists, and from its size and position seemed likely to contain a varied and interesting fauna. It has therefore been a great disappointment to find that it possesses almost no mammals, as may be gathered from the following extract from a letter of Mr. Anderson:—

“The island is most interesting, but the number of mammals is very small. I was only able to secure a mouse and a weasel. There exist besides a deer, a boar, and a badger, which I hunted perseveringly, but was unable to get. There is no hare or rabbit in the island, no marten, no squirrel, no wolf or fox, no bear, though the last has been stated to be there. No signs of moles or shrews were found. No form of wild-cat is known.”

From so good and experienced a collector as Mr. Anderson this verdict may be accepted as final.

The species obtained were *Putorius sibiricus* and *Micromys agrarius manchuricus*, the presence of the latter giving emphatic evidence of the Korean rather than Japanese relationship of the Quelpart fauna, such as it is.

* P. Z. S. 1905, vol. ii. pp. 331-363.

No specimens at all had ever been received from Quelpart, while with regard to Korea, five skins from Seoul, presented in 1891 by Mr. C. W. Campbell, and a few odd specimens collected by Mr. J. Kalinowski and presented in 1894 by the Branicki Museum, Warsaw, comprised the whole of the mammals that our National Museum had previously had from that country. The present series, presented as before by the Society's President to the Museum, is therefore an accession of particular value.

1. *SOREX ANNEXUS*, sp. n.

♀. 699, 708. Min-gyong, 110 miles S.E. of Seoul. 1300'.

"Under mossy stone among thick bushes."—*M. P. A.*

A small Shrew of the *S. minutus* group.

Size about as in *S. araneus*. Fur fine and soft; hairs of back, in winter specimens, about 6 mm. in length. General colour above dark brown; the back and sides uniform, without distinctly darkened dorsal area. Under surface grey faintly washed with drab, the bases of the hairs slaty. Upper surface of hands and feet brownish white. Tail very thinly haired, brown above, rather paler below.

Skull and teeth, in comparison with those of *S. macropygmaeus* Miller, as indicated below.

Dimensions of the two specimens, measured in the flesh:—

	Head & body. mm.	Tail. mm.	Hind foot. mm.	Ear. mm.
699 (Type)	59	37	13	8.5
708	60	40	12	8

Skull (of type)—greatest length 17.8 mm.; basal length 15.4; greatest breadth 8.8; palatal length 7.3; length of upper tooth-series 7.7; breadth outside molars 4.3.

Hab. As above.

Type. Adult female. B.M. No. 6.12.6.12. Original number 699. Collected 10 December, 1905.

In describing this Shrew the only species that seem to need comparison with it are *S. macropygmaeus* Miller* and *S. buxtoni* Allen †, the former from Petropaulski, Kamtchatka, the latter from Gichika, N.W. of Kamtchatka. Although convinced of its distinctness from either, the descriptions did not enable me to define it satisfactorily, and I therefore sent it to Mr. Gerrit Miller, and he has been good enough to give me the following note about it:—

"I find that the Korean Shrew is a very different animal from *Sorex macropygmaeus*. Its skull differs conspicuously from that of the Kamtchatkan animal in its much flatter brain-case and broader interorbital. In the type of *macropygmaeus* the depth of the brain-case is 5 mm., while its greatest width is 8.4 mm.

* Proc. Biol. Soc. Wash. xiv. p. 158 (1901).

† Bull. Amer. Mus. N. H. xix. p. 181 (1903).

In number 699 I make the same measurements 4·4 mm. and 8·8 mm. respectively. Lacrymal breadth 3·2 mm. in *macropygmaeus*, 3·7 in *annexus*. I should not have the least hesitation in separating the animals on these characters. In addition the palate is wider and the molars larger and less heavily pigmented in No. 699; unicuspid longer and lower than in *macropygmaeus*, their proportional sizes about the same. Externally the animals show no special differences, though in the Korean species the feet seem rather heavier, and the colour throughout is a clearer, more greyish brown."

With regard to *S. buxtoni*, it is said by Dr. Allen to be a member of the *S. araneus* group, and in any case its locality is so close to that of *S. macropygmaeus* and so far from that of *S. annexus*, that its identity with the latter seems out of the question.

It is to be noted that while in No. 699 the upper unicuspid teeth decrease evenly in size backwards, in No. 708 the fourth is distinctly larger than the third, thus furnishing another instance of the instability of the relative sizes of these teeth as a distinguishing character.

2. CROCIDURA LASIURA Dobs.

♂. 728. 10 miles N. of Taiku. Southern Korea.

♂. 686, 652, 658, 659, 683, 674, 695, 663, 682, 673, 685.

♀. 651, 681. Min-gyong, 110 miles S.E. of Seoul, Korea.

♂. 641. Tong-pok, 60 miles N.E. of Mokpho, Korea.

These specimens agree fairly well with Dobson's description, and as he himself assigned a Korean example to his species, of which the type was from the Ussuri, I have little doubt about the determination.

Four adult specimens from Min-gyong measure :—

	Head & body.	Tail.	Hind foot
	mm.	mm.	mm.
♂	83	40	15
♂	79	40	15
♀	76	38	14
♀	73	35	13·5

No. 641, captured October 18, is in the short dark summer pelage; all the rest are in the greyer winter coat.

3 CROCIDURA (C.) COREÆ, sp. n.

♂. 742. 10 miles N. of Taiku, Southern Korea.

♂. 671, 676, 684, 693, 694. ♀. 657, 669, 672, 691, 705. Min-gyong, 110 miles S.E. of Seoul, Korea.

♀. 616. Mok-pho.

A small species with the bristles of the tail unusually numerous.

Size much smaller than in *C. lasiura*, found in the same localities. Fur, in winter coat, about 5 mm. in length on the

back. General colour above greyish brown, something between "broccoli-brown" and "grey no. 5" of Ridgway, intermixed with the usual silvery gloss characteristic of northern *Crocivure*. Under surface drabby whitish, lighter than in the Japanese *C. asi-nezumi*. Upper surface of hands and feet greyish white. Tail of medium length, the usual short hairs clothing it thickly, while the long bristle-hairs are unusually numerous and continued nearly to the tip. Its colour is brown above, whitish below. No trace of a lateral gland perceptible on any of the specimens, but all were taken in winter, when it is usually less conspicuous.

Skull short, broad and low. Second and third upper unicuspid subequal, both in height and cross-section, the former about level with the well-developed anterior basal cusp on the carnassial.

Dimensions of the type, measured in the flesh:—

Head and body 58 mm.; tail 37; hind foot 11.5; ear 9.

Skull—extreme length from condylion to front face of incisors 17.5 mm.; basal length 15.1; greatest posterior breadth 8.2; interorbital breadth 4; front of i^1 to back of m^3 7.8; tip of i^1 to tip of p^4 4.

Dimensions of four other specimens:—

		Head & body. mm.	Tail. mm.	Hind foot. mm.
♂	.....	58	38	13
♂	.....	55	35	12
♀	.....	58	37	11
♀	.....	60	36	12

Type. Adult male. B.M. No. 6.12.6.27. Original number 671. Collected at Min-gyong, 28 November, 1905.

This little Shrew is very like *C. lasiura*, but is only about half the bulk. From the Japanese *C. asi-nezumi*, perhaps its nearest ally, it may be readily distinguished by its smaller size, shorter tail, and whiter belly.

4. PUTORIUS SIBIRICUS Pall.

(♂) Fusan, Korea. (Skin purchased in market.)

♂. 627-629. ♀. 623-626. Quelpart Id., 3000', September.

It is exceedingly difficult to make out the races of these Asiatic Minks, owing to their variability in colour, their seasonal change, and considerable sexual difference in size. The Japanese *P. itatsi* is really scarcely more than a subspecies of the mainland form, while I see no reason to distinguish in any way the examples obtained by Mr. Anderson in Quelpart. They are, however, all in the dull summer pelage, while specimens in that coat are almost entirely absent from our mainland and Japanese series.

The Fusan skin is in the winter coat, and is almost as yellow as true Siberian examples.

5. *MICROMYS SPECIOSUS PENINSULÆ*, subsp. n.

♂. 688, 696, 713, 714, 723. ♀. 655, 677, 700, 709, 716. Min-gyong, 110 miles S.E. of Seoul. 1200'.

♂. 724, 729, 730, 732, 733, 738. ♀. 725. 10 miles N. of Taiku, S. Korea. 1000-1300'.

Like true Japanese *M. speciosus*, but with longer and more hairy tail.

General appearance of winter specimens quite as in Japanese examples. Fur soft and fine, quite without spines; hairs of back about 9-10 mm. in length. General colour above pale rufous-fawn, the dorsal area finely lined with black. Lips, cheeks, and whole of under surface white; the hairs slaty for their basal halves. Ears brown. Upper surface of hands and feet silvery white. Tail averaging longer than in true *speciosus*, generally longer than the head and body, well-haired to the tip, the hairs practically hiding the scales; white on the sides and below, the brown of the upper surface narrowed to a line rarely attaining 2 mm. in breadth: in true *speciosus* the brown covers the whole upper surface of the tail; tip occasionally pencilled with white. Mammæ 2-2=8.

Skull and teeth as in *speciosus*, except that the palatine foramina are usually rather shorter, more open, and with more smoothly-rounded edges, and the bullæ average smaller.

Dimensions of four specimens, measured in the flesh:—

	Head & body. mm.	Tail. mm.	Hind foot. mm.	Ear. mm.
♂. 696	107	111	23·5	15
♂. 723	100	109	24	16
♀. 716	106	111	24	15·5
♀. 709 (Type).	109	108	24·5	16

Skull (of type)—greatest length 29 mm.; basilar length 23; greatest breadth 14·1; interorbital breadth 4·2; breadth of brain-case 12·2; palatal foramina 5·6 × 2·3; length of upper molar series 4.

Type. Female. B.M. No. 6.12.6.45. Original number 709. Collected 12 December, 1905.

This Mouse shows such evident signs of relationship to the Japanese *M. speciosus* that I have little doubt that in summer, like its island ally, it acquires a spiny coat.

I am well aware that most modern mammologists would call this animal a species, and not merely a subspecies, both on grounds of distribution and constancy of characters. But it appears to me one of the cases where the immense convenience of showing by the name the exact alliance of the animal should override theoretical definitions as to what are "species" and what "subspecies." In the genus *Micromys*, with its six well-defined and distinct "good species" (in the old sense), from two to four of them present in every locality between Ireland and Japan, a binomial term such

as *Micromys peninsulae* would give no indication of the relations of the animal; while treating it as a subspecies shows at once of which of the six widely-distributed species it is a local representative.

6. MICROMYS AGRARIUS MANTCHURICUS Thos.

♂. 612. Fusan, S. Korea. 150'.

♂. 613, 615, 634. ♀. 614. Mok-pho. 200'.

♂. 636, 637, 638, 644, 645, 646, 647, 648. ♀. 635, 639, 640, 642, 643. Tong-pok, 60 miles N.E. of Mok-pho. 500'.

♂. 665, 670, 678, 679, 680, 707. ♀. 649, 650, 654, 662, 664, 666, 667, 668, 687. Min-gyong, 110 miles S.E. of Seoul. 1000'.

♂. 727, 735, 736, 744. ♀. 726, 731, 734, 743. Near Taiku, S. Korea. 1200'.

♂. 620, 628, 630, 631. ♀. 618, 621, 622, 624, 625, 632. Quelpart Id. 3000-4500'.

The extraordinary variation in this species renders its determination very difficult, and I use the above name only provisionally. For, on the one hand, further Manchurian material may bring out some difference between the Korean and Manchurian forms, and on the other it is possible that both will prove indistinguishable from the Chinese *ningpoensis*.

In the present fine series, examples are to be found with strongly marked dorsal stripe and others almost or quite without it. In general colour, also, some are strongly rufous while others are grey.

In character of fur we find here again, as in *M. speciosus*, the characteristic of the summer coat being spinous, while that of the winter is quite soft; and to this rule no exception occurs among the present series.

There does not appear to be any difference between the specimens from Quelpart and those from the Korean mainland—a somewhat remarkable fact, considering the distance out to sea at which the island is situated. The occurrence of this species, which is wholly absent from any part of Japan, is conclusive evidence of the Korean rather than Japanese character of the Quelpart fauna.

7. MICROMYS MINUTUS USSURICUS B. Ham.

♂. 656. Min-gyong, 110 miles S.E. of Seoul. 1000'.

♂. 737. ♀. 721. 10 miles N. of Taiku, S. Korea.

These specimens agree with the type from the Ussuri in the small size of their teeth as compared with the Japanese *M. m. japonicus*. They vary, however, a good deal in colour.

8. CRASEOMYS REGULUS, sp. n.

♂. 661, 689, 692, 697, 703, 704, 710, 711, 715. ♀. 653, 660, 675, 690, 698, 701, 702, 706, 712. Min-gyong, 110 miles S.E. of Seoul. Alt. 1100-1300 ft.

♂. 722, 739, 740, 741. 10 miles N. of Taiku. Alt. 1200 ft.

“Trapped in mossy talus overgrown with bushes.”

“From burrow in barley-field on dry hillside.”

Size large, scarcely less than in *C. bedfordiae* and *andersoni*. Fur (in winter) 8–9 mm. in length on the back. General colour above coarsely-lined cinnamon-brown in most specimens, but darkening in old individuals to a rich and beautiful cinnamon-rufous or hazel of unusual intensity. Sides paler, without marked line of demarcation from either back or belly; under surface broadly washed with pinkish buff, the bases of the hairs slaty as usual. Glandular patches present on flanks, but not conspicuous. Forehead lined cinnamon-brown. Ears well-clothed with rufous hairs. Upper surface of hands and feet buffy whitish. Tail shorter than in the Japanese species above referred to, well-haired, sharply bicolor, brown above darkening terminally to black, cream-buff below. Mammæ 2—2=8.

Skull, as compared with that of *C. andersoni*, more thickly built throughout, the brain-case higher and rounder, and the interorbital region broader. Palatal foramina long, rather narrow, reaching back very nearly to the level of the front of m^1 . Posterior nares of typical *Erotomys*-pattern; but the ridge that runs forwards in continuation of the pterygoid processes is unusually sharply developed as it approaches the overhanging palatal ledge. Bullæ large and rounded.

Incisors broad and heavy in old specimens. Molars of normal pattern; the degree to which enamel-spaces are confluent is variable, as usual in this group. Last lobe of m^3 sometimes elongated, sometimes quite short.

Dimensions of the type, measured in skin:—Head and body 116 mm.; tail 45; hind foot 18.5; ear 13.

Skull—greatest length 27.1 mm.; basilar length 24; zygomatic breadth 15; length of nasals 8.3; interorbital breadth 4; height from alveolus of m^2 to supraorbital edge 8.2; diastema 7.9; palatal foramina 5.3×1.5 ; length of upper molar series (crowns) 6.1.

Four other specimens measure as follows:—

	Head & body. mm.	Tail. mm.	Hind foot. mm.	Ear. mm.
♂	108	42	18	13
♂	102	37	18.5	13
♀	111	42	19	12.5
♀	110	47	19	13

Type. Old male. B.M. No. 6.12.6.89. Original number 661. Collected 25 November, 1905, at Min-gyong.

When in the fully-developed rufous pelage, this fine species surpasses any known member of the group in the richness of its body-colour; and at all stages it may be readily recognised by its proportions and cranial characters.

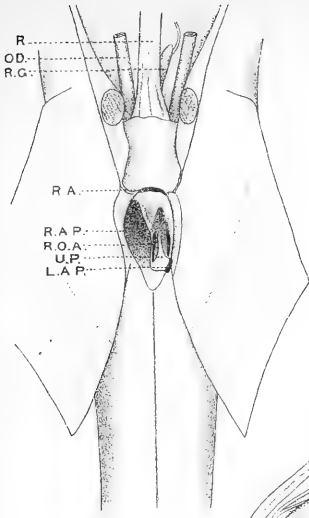


Fig. 1.

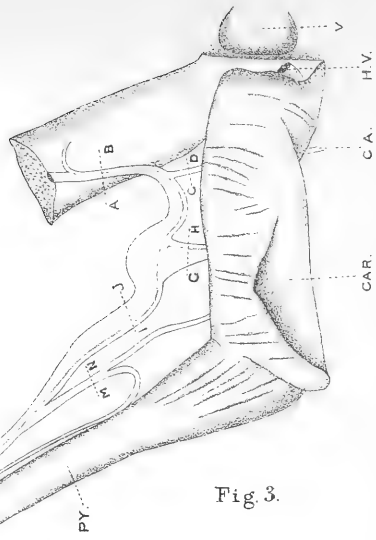


Fig. 3.

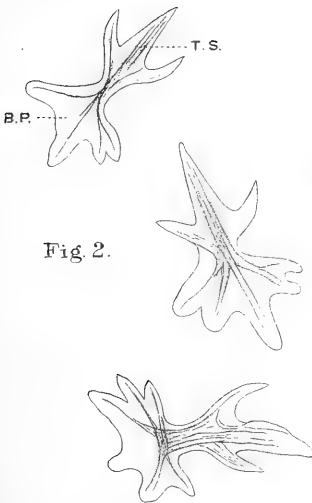


Fig. 2.

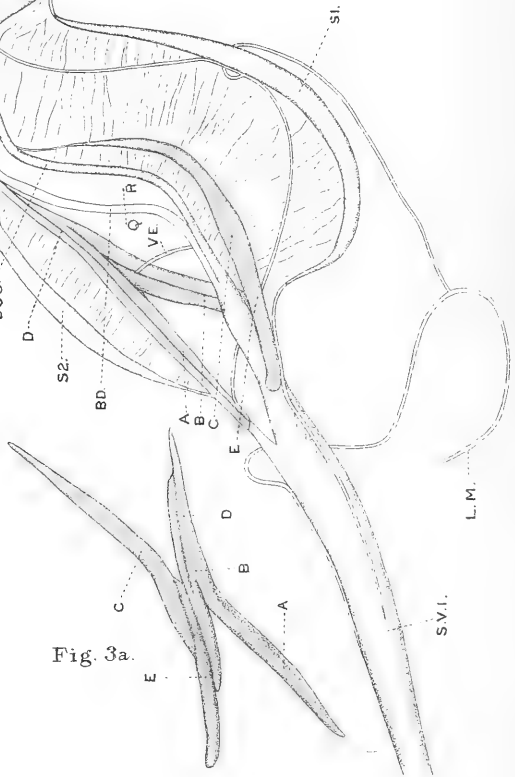


Fig. 3a.



Fig. 4.

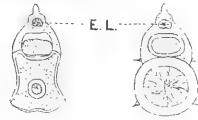
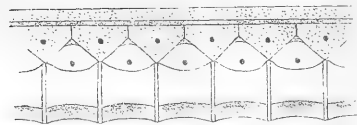
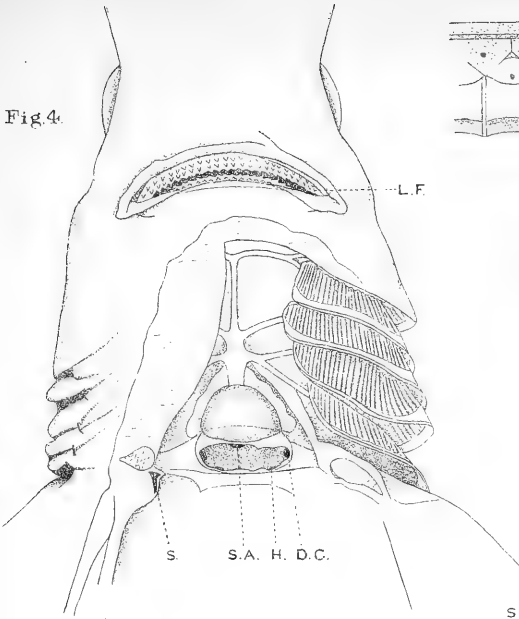


Fig. 7

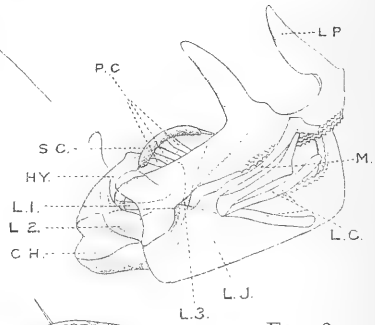


Fig. 6.

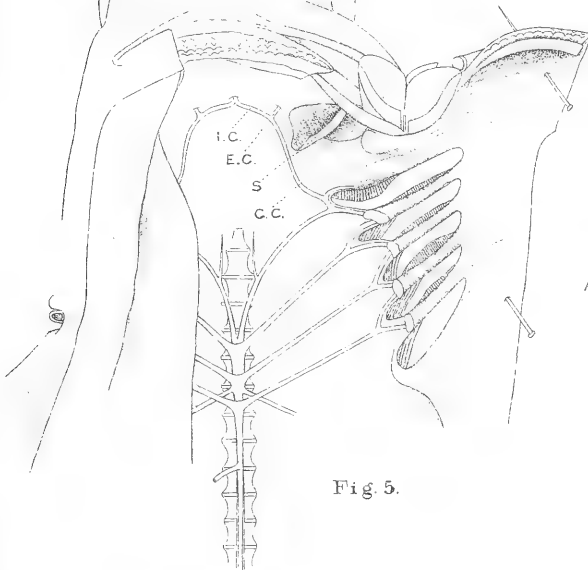


Fig. 5.

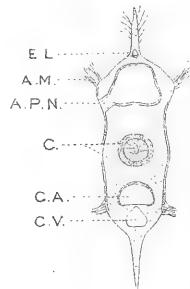
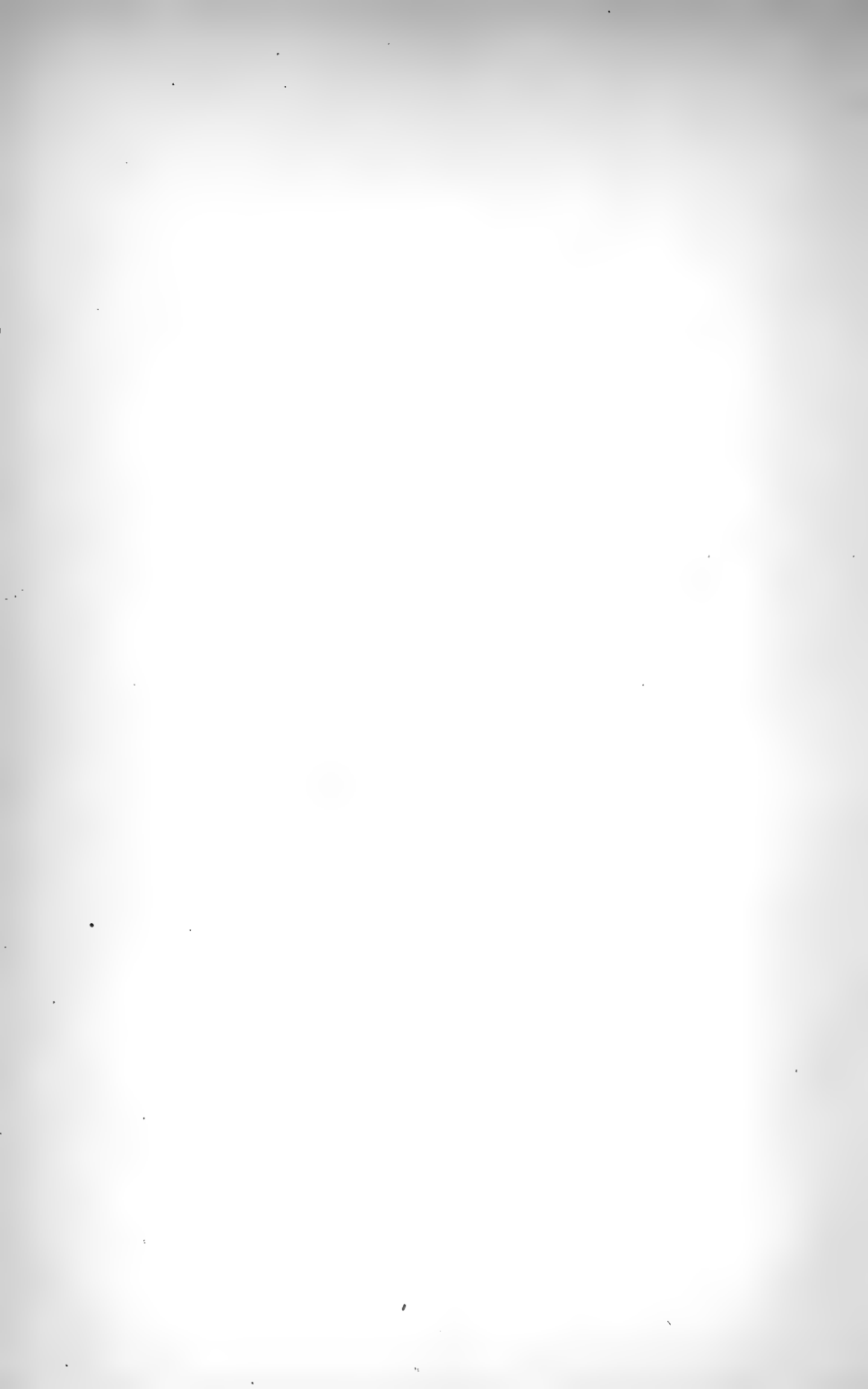


Fig. 8.



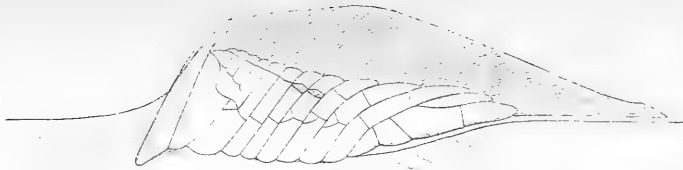


Fig. 9.



Fig 10.

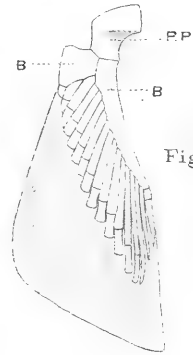


Fig 12.

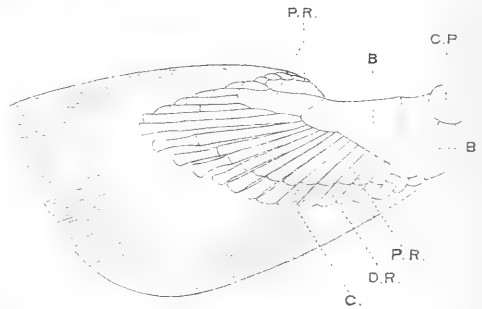
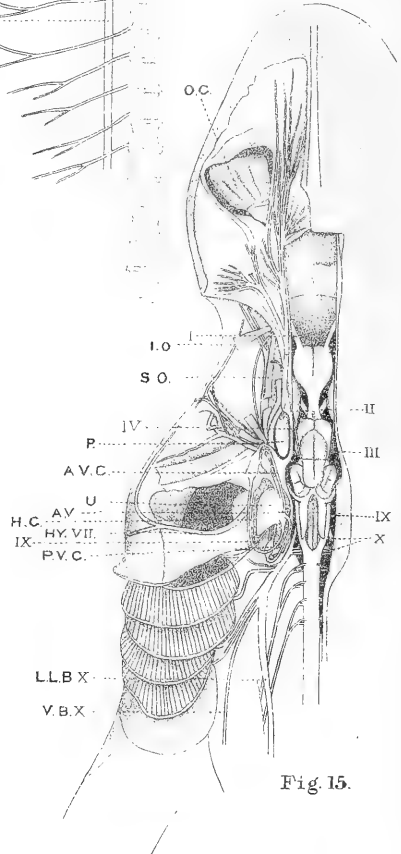
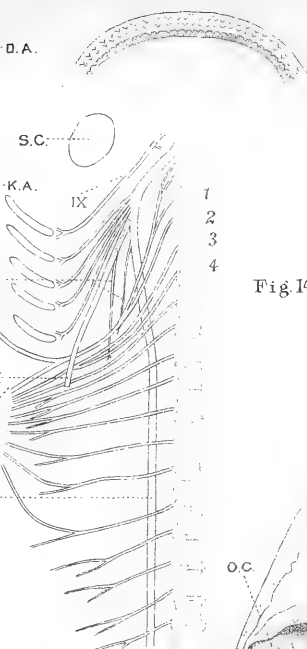
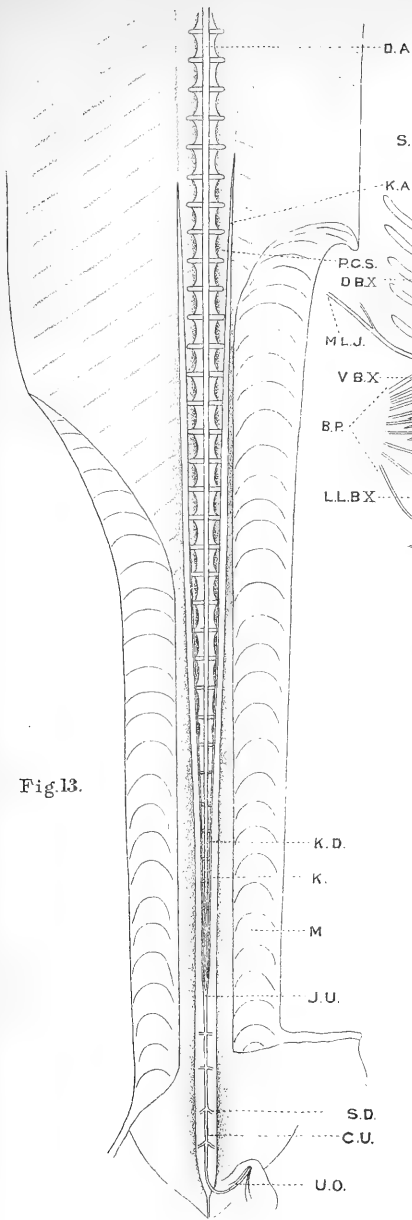


Fig 11



W. W. del.

M. P. Parker lith.
Parker & West imp.

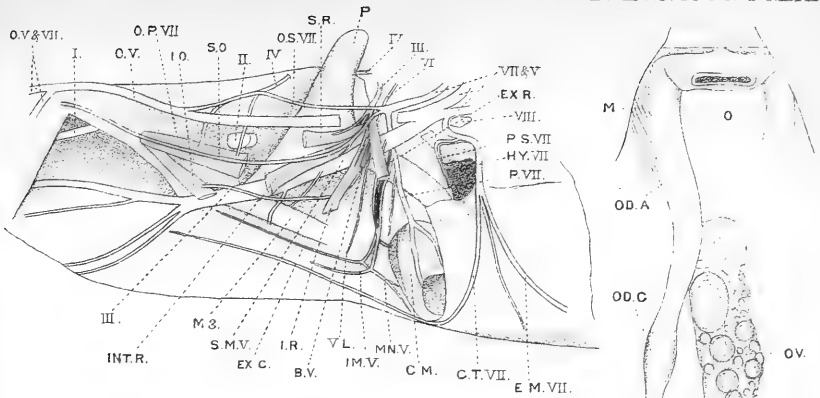


Fig. 16.

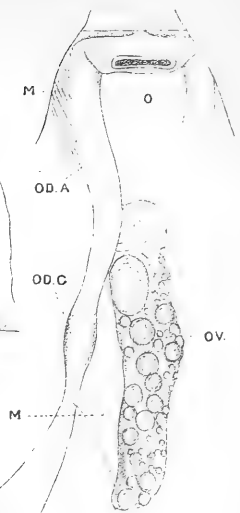


Fig. 18.

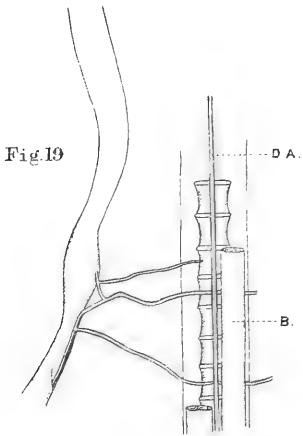


Fig. 19.

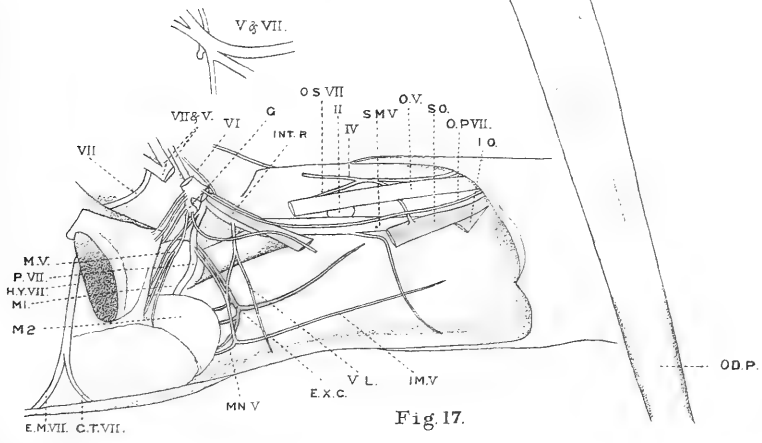


Fig. 17.

W. W. del.

M. P. Parker lith.
Parker & West imp.

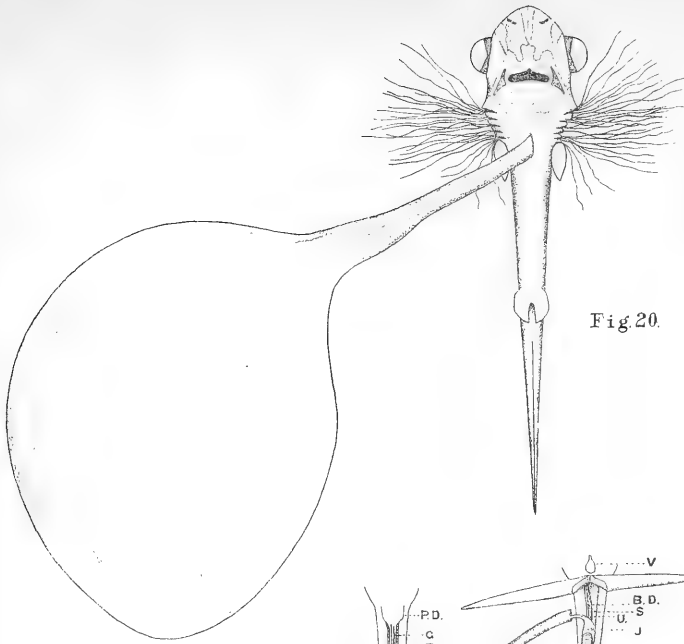


Fig 20.

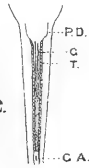


Fig 22.

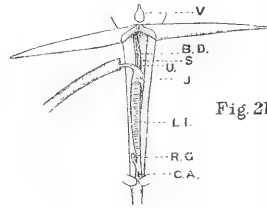


Fig 21.

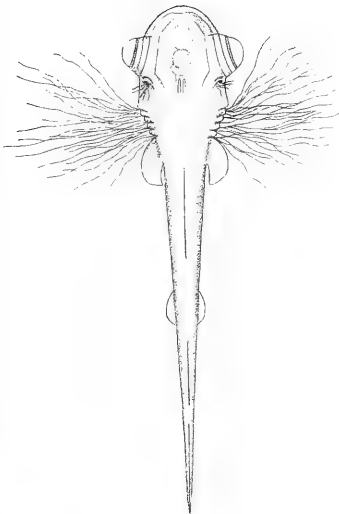


Fig 20.



Schrenk's *Arvicola amurensis**, from the Lower Amur, is probably a true *Evotomys*. It has a molar tooth-row of only 4·7 mm.

It may be remarked that of this fine series not even the oldest specimen shows any trace of the formation of roots to the molars.

9. *LEPUS COREANUS* THOS.†

♂. 720. ♀. 717, 718, 719. Taiku, Southern Korea. 500'.

The type of this Hare was obtained by Mr. C. W. Campbell at Seoul, in 1889.

4. On the Anatomy of *Centrophorus calceus* (*crepidalbus* Bocage & Capello) Günther. By W. WOODLAND, F.Z.S., Demonstrator of Zoology, King's College, London.

[Received October 8, 1906.]

(Plates LVII.—LXII.‡ and Text-figures 127–138.)

Centrophorus calceus is one of the rarest, if not the rarest, species of the not very common genus *Centrophorus*. For this reason alone, a description of the anatomy§ of the species is a desideratum; but in addition to this, there is the fact that up to the present no single member of the genus has yet been fully examined with regard to its internal organisation, and hence, on both grounds, the following fairly complete account of the structure of a female specimen of the above-named species may prove of value. —Further, I may add that certain portions of the anatomy of *Centrophorus calceus* are peculiar, and such I shall of course consider at greater length than those which more or less partake of the normal selachian type. The comparative rarity || of *C. calceus* is most conspicuously proved by the fact that whilst the British Natural History Museum at the present time possesses three adult female specimens and two embryos, the Paris Museum three adult females and five embryos, and the Berlin Museum one poorly-preserved specimen, the museums of Brussels, Vienna, Stockholm, Naples, New York, Cambridge (Massachusetts), St. Petersburg, Tokyo, Cape Town, and Calcutta do not possess a single specimen. The distribution also of *C. calceus* is extremely limited, specimens of the species hitherto, judging from my own enquiries and the statements I have met with, alone having been

* Reis. Amur-lande, i. p. 129 (1859).

† *Lepus sinensis coreanus* Thos. Ann. Mag. N. H. (6) ix. p. 146 (1892).

‡ For explanation of the Plates see p. 884.

§ This piece of work was done, with others, during my tenure of the Derby Scholarship (1903–1905) at University College, London.

|| Bocage and Capello, however, state that *C. calceus* “n'est pas rare dans nos mers [off coasts of Portugal], et nos pêcheurs la connaissent très-bien sous le nom de ‘sapata-branca’”; Lowe, on the other hand, applies to his “*Centrophorus calceus*” the term “rarior,” though not “rarissima.”

found in the Golfe de Gascogne and off the coasts of Portugal and Madeira.

The species *Centrophorus calceus* was first definitely established, under the name of *C. crepidalbus*, by the diagnosis, description, and figure of Bocage and Capello¹ in 1864. *C. crepidalbus* was supposed by these authors to be possibly identical (on what grounds it is hard to understand) with the *Acanthidium calceus*², and later *Centrophorus calceus*³ of Lowe; but in the absence of figures and detailed diagnosis by Lowe, and in view of the fact that Lowe identified *Acanthidium calceus* with the *Centrina salviiani* of Willughby⁴ described in 1686 (which latter, as is indeed obvious from the figure, is certainly not *C. calceus*), this identification is not by any means certain⁵. However, Bocage & Capello allowing the identity on Lowe's authority (at the same time questioning it), the specific name *calceus* was reinstated by Günther⁶ on grounds of priority.

The more important diagnostic characters of *Centrophorus calceus*, as given by Günther⁵, Vaillant⁶, and Moreau⁷, are as follows:—(a) Length of animal, 0·60 m. to 1·06 m.; (b) head flattened dorso-ventrally, with snout excessively elongated, broad and slender, and spatulate in form—a feature specially characteristic of the species, rendering it therefore easy of recognition; (c) trunk elongated and prismoidal in form; (d) colour in the fresh condition an ashy grey, but much paler (nearly white) on the ventral surface; (e) the length of the bases of the two dorsal fins (without spines) is nearly the same and is equal to half the distance between them; (f) the anterior extremity of the ventral fins is situated below the middle of the second dorsal fin; (g) the spine of the second dorsal fin is more developed than the first; (h) the lower angle of the pectoral fin is rounded and not produced; (j) the skin is covered with minute pedunculated tricuspid scutes, giving a velvety appearance to the skin, and (k) the teeth of the upper jaw are pointed, those of the mandible being securiform with a straight edge. Vaillant (his pl. iii. fig. 1) and Bocage & Capello (their fig. 2, from which my text-fig. 127 is copied) give in their papers excellent figures of *C. calceus*, from which it may be seen that the spatulate snout forms the most conspicuous feature of the animal.

The female specimen of *C. calceus*, which came into my possession in the spring of 1904, was caught in the Bay of Biscay, and preserved in ice for two or three days until delivered at the Plymouth Marine Biological Laboratory. The abdominal and brain cavities were immediately opened (five embryos being found in the oviducts), and I had the entire fish placed in strong

¹ Proc. Zool. Soc. Lond. 1864, p. 262, fig. 2. 'Poix. Plagiost.' p. 28, tab. 2. fig. 1.

² Proc. Zool. Soc. Lond. 1839, p. 92. Trans. Zool. Soc. iii. p. 19.

³ Proc. Zool. Soc. Lond. 1843, p. 93.

⁴ 'De Historia Piscium,' Lib. 3, Cap. xii. p. 58.

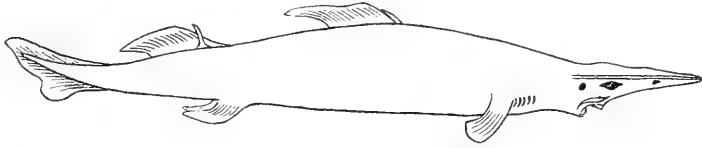
⁵ 'Catalogue of the Fishes in the British Museum,' vol. viii. 1870.

⁶ Vaillant (Poissons: Expéditions Scientifiques du 'Travailleur' et du 'Talisman.' Paris, 1888) also holds this opinion.

⁷ 'Histoire Naturelle des Poissons de la France.' Supplément. Paris, 1891. 'Manuel d'Ichthyologie française.' Paris, 1892.

formalin (about 8 per cent.) in order to ensure the complete preservation of the tissues until I should have an opportunity of properly examining them. I have always found strong formalin

Text-fig. 127.

*Centrophorus calceus* (after Bocage & Capello).

a most excellent fixing and preserving reagent when required to be used in large quantities, and it was so in this case; as is well known, large animals preserved in spirit are of little use for histological purposes.

Principal Measurements of the Fish.

	centim.
1. Length of fish between extremities of snout and tail	87
2. Distance of base of spine of anterior dorsal fin to tip of snout	30
3. Length of base of anterior dorsal fin (including spine).....	11
4. Length of base of posterior dorsal fin (including spine).....	9
5. Distance between anterior and posterior dorsal fins	19
6. Length of base of ventral fin	12.5
7. Distance between posterior end of base of ventral fin and tip of tail	7.5
8. „ from cloacal aperture to tip of tail...	29
9. „ from front row of teeth on upper jaw to tip of snout	11
10. „ from anterior canthus of eye to tip of snout.....	8.5
11. „ of nares from tip of snout	4.5
12. „ from anterior edge of spiracle to tip of snout	12.75
13. „ between spiracle and first gill-cleft.	3
14. Length of side of body occupied by the five gill-clefts.....	3
15. Longitudinal diameter of eye	3
16. Vertical diameter of eye	1.3
17. Distance from base to tip of pectoral fin ...	12
18. „ from base to tip of pelvic fin	8.5
19. Transverse diameter of mouth.....	6
20. Length of spiracular cleft	1.25
21. „ of each gill-cleft	2
22. Vertical height of anterior dorsal fin	3.5

The spiracular cleft is very large and gill-cleft-like, and lies dorsally at the same distance from the extremity of the snout as the ventrally-situated posterior angles of the mouth. When I received the fish, about one inch or more of the right elongated liver-lobe was protruding through the abdominal pore of the same side, which latter was enlarged to at least six times its normal size (Pl. LVII. fig. 1); also on opening the abdominal cavity the entire cardiac portion of the (empty) stomach was found to be thrust up the œsophagus into the buccal cavity, both of which features were due to the sudden release of the animal when brought to the surface from the considerable external pressure under which it normally exists (the pressure due to 500 fathoms of water). The eyes are large, as in many deep-sea fishes. Fig. 2 represents the form of the dermal scutes, which is the same whether the scutes be taken from the dorsal or the ventral surface of the animal. Their form differs somewhat from that represented in the figure of the skin of *C. calceus* supplied by Gegenbaur. It may also be worth mentioning that the peritoneal lining of the body-cavity was silvery-grey in colour—another characteristic feature of deep-sea fishes.

Previous work on the anatomy of this species has been limited, so far as I am able to discover, to the examination of the head-skeleton⁸ and eye-muscles⁹ by Gegenbaur and of the occipito-spinal nerves by Fürbringer¹⁰—these two investigators probably having a single specimen at their disposal.

Before proceeding to the description of the anatomy of *C. calceus*, I wish to express my indebtedness to Dr. E. J. Allen, who very kindly acceded to my desire to purchase the fish for anatomical examination when it was brought to the Plymouth Laboratory; to Mr. Boulenger, who readily permitted me to examine numerous specimens of allied Selachians preserved in the British Museum during the course of my enquiries; to Dr. Ridewood, who very kindly read through the manuscript and advised me on several points; and to Professor Minchin and Professor Hickson for several useful suggestions.

THE ALIMENTARY TRACT AND ASSOCIATED GLANDS.

So far as I can gather from a fairly comprehensive survey of the literature relating to the subject, the alimentary tract of *C. calceus* (Pl. LVII. fig. 3) is striking in several respects. In the first place, the pyloric portion of the stomach is, owing to its thick walls, exceedingly stout, is half as long again as the cardiac portion, and was not reflexed so as to lie parallel with this latter and in apposition with it, as is the case *e. g.* in the ordinary *Scyllium*

⁸ 'Untersuchungen zur vergleichenden Anatomie der Wirbelthiere.' Leipzig, 1872. (Figs. on plates vi., viii., xii., xvi., and xx. of this work.)

⁹ 'Vergleichende Anatomie der Wirbelthiere,' Bd. i. 1898 (fig. 589 on p. 942).

¹⁰ 'Ueber die Spino-occipitalen Nerven der Selachier und Holocephalen und ihre vergleichende Morphologie' in Gegenbaur's 'Festschrift zum siebenzigsten Geburtstage,' vol. iii. Leipzig, 1897.

cavicula, *Galeus canis*, and numerous other Selachians; on the contrary, the two regions normally included an angle of at least 120° . In *C. squamulosus* (and the same was the case in a specimen of *C. granulatus* which I examined at the British Museum), "the anterior [portion of the stomach] is much the larger, of an elongate form, narrowed towards its posterior extremity; it passes by an abrupt bend into the second reverted portion, which is the narrowest part of the intestinal tract,"¹¹ and hence is quite different from its supposed congener.

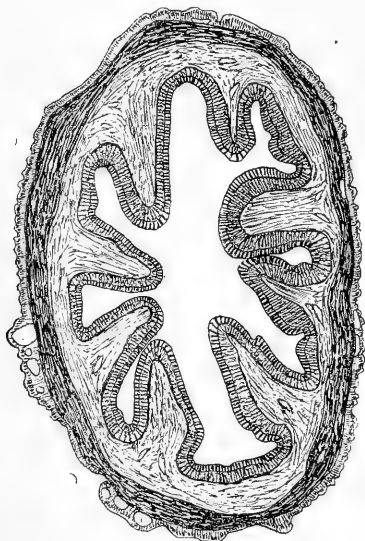
Since it is impossible within the limits of the present paper to give a comparative account of the anatomy of the gut of Selachians or even Squalidæ, I will content myself with merely further remarking that the conditions both of the two portions of the stomach of *C. calceus* described above, and of most of the other features of the gut about to be described, differ from those found in all other Squalidæ—which is not at all remarkable considering the extraordinary variety of form of the alimentary canal found in this family.

The pyloric portion of the stomach of *C. calceus* ends in a very short and small cul-de-sac, or, in other words, the duodenum or homologue of the bursa Entiana arises from the side of the pyloric region just before its termination (fig. 3). This duodenum is remarkable in that (as also to some extent in *Lamargus borealis*, *L. rostratus*, and *Spinax niger*) it is extremely elongated and slender in form, and not abbreviated and globular as in *Centrophorus squamulosus*, *C. granulatus*, *Scyllium cavicula*, and indeed most Selachians. It forms, as shown in fig. 3, a long slender tube, about twice the length of the cardiac portion of the stomach, and at most one-quarter of the diameter of the pyloric, and with a very small lumen, which pursues a slightly curved course until it joins the large intestine containing the spiral valve at a point situated considerably posterior to the stomach. In *C. squamulosus* (and *C. granulatus*), on the other hand, "the spiral valve commences on the level of the posterior extremity of the stomach,"¹¹ as in *Scyllium cavicula*. The large intestine in *C. calceus* is not very long, being about three-quarters the length of the pyloric portion of the stomach and but slightly exceeding it in diameter at its widest portion. The contained spiral valve commences at the level of the posterior extremity of the pancreatic lobe which is in contact with the large intestine (shortly to be described), and consists of about seventeen or eighteen spiral turns. Running parallel with the two portions of the stomach and duodenum is an enormously elongated bile-duct (associated with arteries and veins for its entire length and with the large hepatic-portal vein for the greater part), which originates in connection with the right lobe of the liver and terminates at the junction of the duodenum with the large spiral-valve intestine, which it enters by a conspicuous aperture on the

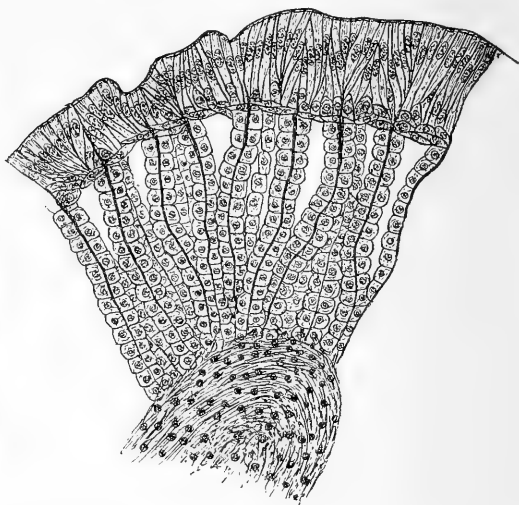
¹¹ Günther, 'Challenger' Report on the Deep-Sea Fishes. 1887.

internal surface of the large intestine just posterior to the junction of this latter with the duodenum. I unfortunately neglected

Text-fig. 128.



Text-fig. 129.

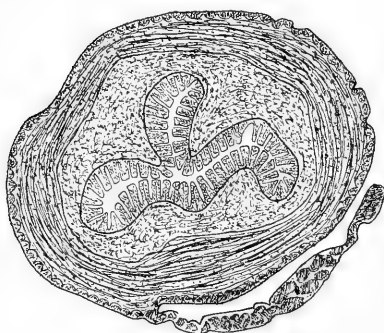


Centrophorus calceus.

Text-fig. 128.—Transverse section through pyloric region of stomach, at about the middle of its length.

Text-fig. 129.—A portion of one of the longitudinal ridges seen in text-fig. 128 more highly magnified.

Text-fig. 130.



Text-fig. 131.



Centrophorus calceus.

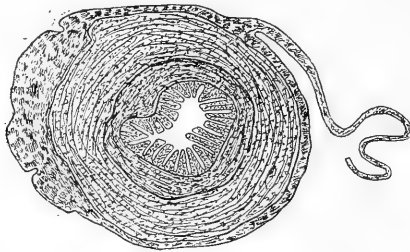
Text-fig. 130.—Transverse section through the duodenum anteriorly.

Text-fig. 131.—One of the villus-like processes shown in text-fig. 130, magnified.

to determine the further course of the bile-duct anteriorly and to ascertain whether a gall-bladder existed or not. I am not aware

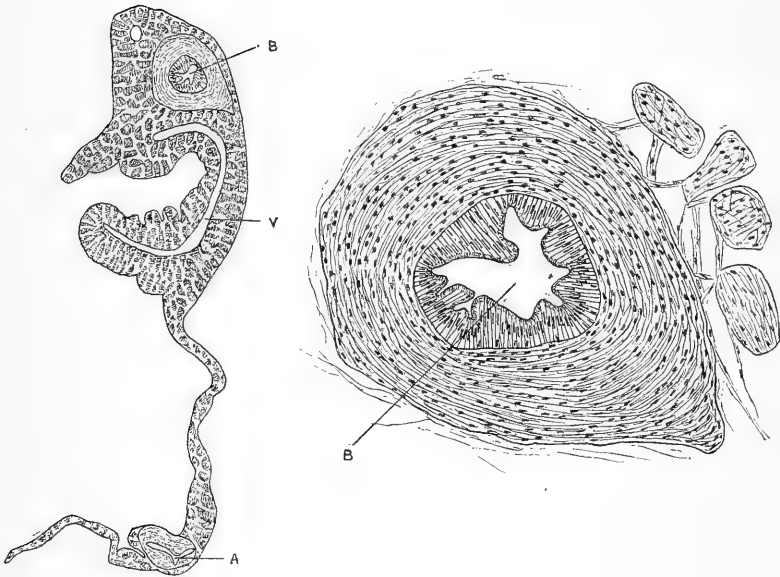
of any other Selachian which possesses these two features, viz. the extremely long and slender duodenum and bile-duct. Other

Text-fig. 132.

*Centrophorus calceus.*

Transverse section through the duodenum posteriorly.

Text-fig. 133.

*Centrophorus calceus.*

Transverse section across the bile-duct (A-B of Pl. LVII. fig. 3).

A, artery; B, lumen of bile-duct; V, portal vein.

Squalidae, as already remarked, possess an elongated duodenum^{12, 13}, and *Læmargus borealis*^{12, 14} (*Somniosus microcephalus*) a fairly slender

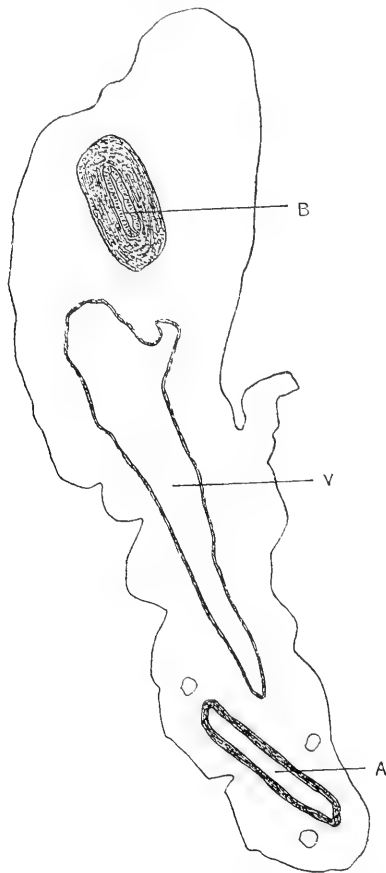
¹² "Die sogenannte Bursa Entiana der Selachier." H. C. Redeke. Anat. Anzeig. xvii. 1900.

¹³ "Ueber den Darm einiger Selachier." H. Helbing. Anat. Anzeig. xxii. 1903.

¹⁴ "A Contribution to the Visceral Anatomy of the Greenland Shark (*Læmargus borealis*)." W. Turner. Jour. Anat. Physiol. vii. 1873.

one; but I have not met with any instance, other than *C. calceus*, in which the ductus choledochus is correspondingly elongated in this striking manner. Normally of course, *i. e.* in *Scyllium*, *Carcharias*, *Squatina*, *Galeus*, &c., the bile-duct enters the large intestine just below the globular bursa Entiana (although here there is considerable variation) at about the level of the anterior

Text-fig. 134.

*Centrophorus calceus.*

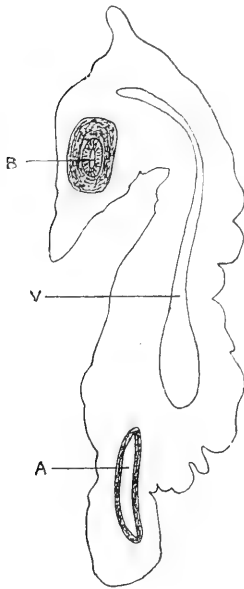
Transverse section across bile-duct (I-J of Pl. LVII. fig. 3).

Letters as in text-fig. 133.

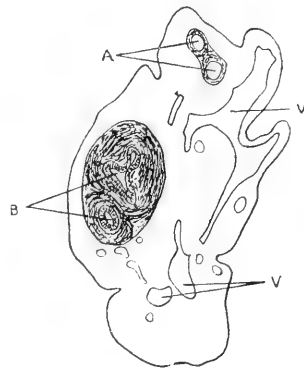
extremity of the cardiac portion of the stomach; and when the globular bursa Entiana is replaced by a small-intestine-like duodenum, as in *Læmargus borealis*, *L. rostratus*, and *Spinax niger*, the bile-duct enters at the loop which this forms anteriorly, *i. e.* as near the liver as possible, and does not extend posteriorly to the cardiac

portion of the stomach, so that the condition found in *Centrophorus calceus* seems to be unique. Owing to this fact that the bile-duct opens into the large intestine and not into the elongated portion of the duodenum, there is obviously no "Zwischendarm" or small intestine* present in *Centrophorus calceus* as in the other three Squalidae referred to. As regards the position of the pyloric thickening in the gut of *C. calceus*, I regret not being able to speak with certainty. Usually it occurs at the commencement of the duodenum, *i. e.*, anterior to the opening of the bile-duct, and there certainly is a thickening in that position in *C. calceus*, but it is not very distinct. There are no pyloric caeca present in *C. calceus* such as occur in *Lemargus*.

Text-fig. 135.



Text-fig. 136.

*Centrophorus calceus.*

Text-fig. 135.—Transverse section across bile-duct (O-P of Pl. LVII. fig. 3).
Letters as before.

Text-fig. 136.—Transverse section across bile-duct (Q-R of Pl. LVII. fig. 3).
Letters as before. The bile-duct has here divided into two.

The internal surface of the cardiac portion of the stomach is quite smooth and devoid of glands; on the other hand, the internal surface of the pyloric portion is folded into longitudinal ridges and highly glandular (text-figs. 128, 129). Transverse sections across the duodenum about half an inch from its commencement (text-figs. 130, 131), and about an inch from its

* I am indebted to Dr. G. J. Jenkins for some information in this connection.

termination in the large intestine (text-fig. 132), show that this is also highly glandular, although its histology differs from that of the pylorus (*cf.* text-figs. 129 & 131), possessing villus-like processes, instead of simple tubular glands. Text-figs. 133-136 represent transverse sections through those portions of the elongated band running parallel with the alimentary tract and containing the bile-duct (B), hepatic-portal vein (V), and arteries (A), which are marked in Pl. LVII. fig. 3, A-B, I-J, O-P, Q-R, the last showing the bile-duct divided into two. Sections across C-D, G-H, M-N simply reveal arteries and veins embedded in the muscular band.

As in *Centrophorus squamulosus*, so in *C. calceus*, "the liver consists of two extremely long [40 cm.] and flat [4 mm. thick and 2.5 cm. broad anteriorly] lobes extending on the right as well as on the left side from the anterior to the posterior extremity of the abdominal cavity." In *C. squamulosus* the liver-lobes anteriorly "are connected by a short transverse strip not broader than the lateral portions and having embedded in its middle line a gall-bladder of moderate size"; and perhaps the same was the case in *C. calceus*, though, as before stated, I did not ascertain it. In *Scymnus lichia*, however, in which the liver is similar to that of *C. calceus* as regards both size and form, a gall-bladder does not exist¹⁵. The shape and size of the liver vary very much among Selachians, but, for the reason already given, I am unable here to enter upon a comparative account of the organ.

In *C. calceus*, as in so many other Squalidæ (e. g. *C. granulatus* and *C. squamosus*¹⁶, *Lepidopus argenteus*¹⁷, *Centrina salviani*^{4, 18}, *Echinorhinus spinosus*^{19, 20}, and others), two spleens are present. The one, slightly the larger (Pl. LVII. fig. 3, S 1), is attached anteriorly near the posterior end of the pyloric stomach and posteriorly to the beginning of the spiral-valve intestine; the other, or supplementary spleen (S 2), is attached anteriorly to the bile-duct band at a point situated at about the middle of its length and posteriorly to the outer lobe of the pancreas near the spiral-valve intestine. Both spleens, as the figure shows, lie in folds of the mesentery (duodeno-splenic omenta), and are attached by this at their extremities. They are extremely elongated slender bodies, and, apart from their position, it would be difficult, owing to their similarity, to say which is "supplementary"²¹. I may here

¹⁵ "Notes on the Anatomy and Embryology of *Scymnus lichia*." T. J. Parker. Proc. & Trans. New Zealand Institute, vol. xv. 1882.

¹⁶ "Remarques anatomiques sur les Squalés observés pendant la dernière campagne du yacht 'Princesse-Alice'." M. H. Neuville. Bull. Mus. Paris, 1897 (2).

¹⁷ "Remarques sur les Squalés de mer profonde observés à Sétubal (Portugal)." Neuville, *loc. cit.* 1897 (3).

¹⁸ "Notes on *Centrina salviani*." W. W. Calderwood. J. Mar. Biol. Assoc. vol. ii. 1892.

¹⁹ "Observations on the Spiny Shark (*Echinorhinus spinosus*)." W. Turner. Jour. Anat. Physiol. vol. ix.

²⁰ "The Brain and Cranial Nerves of *Echinorhinus spinosus*, with Notes on the other Viscera." Jackson & Clarke. Jour. Anat. Physiol. vol. x. 1876.

²¹ "A propos des termes par lesquels on désigne les formes diversés de la rate des Sélaciens." M. H. Neuville. Bull. Mus. Paris, 1898 (4).

point out that the attachments of the slightly larger spleen conclusively prove what I have stated above, namely, that the pyloric portion of the stomach does not normally lie in apposition with the cardiac, but includes a large angle with it.

The pancreas is peculiar in form and is situated, in attachment with both the bile-duct band and the duodenum, just anteriorly to the commencement of the spiral-valve intestine. It consists of three elongated lobes disposed as shown in Pl. LVII. fig. 3. Fig. 3 *a* represents the reverse aspect of the gland. The pancreatic duct opens into the large intestine at the commencement of the latter where the lobe of the pancreas attached to the duodenum is in contact with it. The internal aperture is not very conspicuous and lies close to the first fold of the spiral valve.

The rectal gland (Pl. LVII. fig. 1) is in shape much like that found in the Common Dogfish, and is similarly supplied with the posterior mesenteric artery.

I have yet to mention that on opening the body-cavity of the fish, I found a large yellow mass of (apparently glandular) tissue overlying the extreme anterior end of the cardiac portion of the stomach and abutting against the posterior wall of the pericardium. I am unable to give any opinion as to the nature of this mass, since I have not yet had an opportunity of examining it histologically.

I have examined a specimen of *Centrophorus calceus* in the British Museum, and, so far as I could ascertain, the visceral anatomy was identical with that of my own specimen.

REMARKS ON THE VASCULAR SYSTEM.

The heart of *C. calceus* is of the ordinary selachian type, consisting of a large transversely-elongated sinus venosus, thick-walled ventricle, and capacious atrium or auricle. The internal wall of the ventricle is spongy in nature owing to the presence of muscular fibres, and to a less extent the wall of the atrium is similarly characterised. A pair of atrio-ventricular valves is as usual present at the atrio-ventricular passage. The conus arteriosus is somewhat longer than the ventricle, and possesses only two transverse rows of valves in its cavity: one, consisting of three pocket-shaped valves, at its origin from the ventricle, and the other situated at about one-third of the length of the conus from the commencement of the ventral aorta and also consisting of three valves. It is difficult definitely to compare the number of valves present in the conus of *C. calceus* with the number found in other Selachians owing to the fact that different authors often assign different numbers to the same species (to some extent due to variation in the specimens themselves, perhaps also to a confusion between transverse and longitudinal rows); but despite this, it is certain that the existence of only two transverse tiers of valves in *C. calceus* distinguishes this species from other

species of the same genus and from most if not all other genera of the Squalidæ. According to Günther¹¹, "the valves of the conus arteriosus of the heart" in *C. squamulosus* (and *C. granulatus*) "are arranged in five transverse series, each series consisting of three powerful valves and as many intermediate small ones"^{*}. According to Stohr²², the conus of *Acanthias vulgaris* possesses four rows of valves, but three according to Müller¹⁴; in *Echinorhinus spinosus*, three rows according to Turner¹⁹, four according to Jackson & Clarke²⁰; in *Læmargus borealis*, four according to Turner¹⁴; in *Squalus maximus*, four according to Home²³; in *Squalus catulus*, two according to Stohr.

The afferent arches (Pl. LVIII. fig. 4) are similar in construction to those of the Common Dogfish: the "first" (first and second) dividing into two at some distance from the median line to supply the first two gill-clefts, the third arising from the ventral aorta nearly an inch below the first and supplying the third gill-cleft, and the "fourth" (fourth and fifth) arising just behind the third and emulating the "first" arch by dividing into two shortly after; these respectively supplying the fourth and fifth branchial clefts, and in this respect differing somewhat from *Scyllium canicula*. The afferent arches are the same in *C. granulatus*¹⁰, save that the fifth afferent arches originate from the main ventral aorta, as in the Dogfish.

The efferent arches have the disposition shown in fig. 5. The fourth pair arises about half-an-inch in front of the cœliac artery, and by bifurcating in the usual manner supplies the fourth and fifth gill-clefts. The third and second have the same construction. Between the third and fourth arches the subclavian arteries arise. The first efferent arch forks over the first gill-cleft, and from the inner side of the fork gives off the common carotid which proceeds anteriorly and towards the median line until it meets its fellow of the opposite side and thence proceeds through the cartilaginous floor of the cranium to the brain. About a quarter of an inch from the junction of the two carotids, each gives off an external carotid (the portion of the carotid continuing towards the median line being termed the internal carotid) which runs through the cartilage to the inner wall of the orbit, where it divides into both anterior and posterior branches as shown in Pl. LXI. figs. 16 & 17. The first efferent arches also give off, about half-an-inch from their origin, two small vessels which run forward for a short distance parallel to the vertebral column, and which possibly represent the primitive paired condition of the aorta. There is no hyoidean artery arising from the first efferent arch, such as exists in the Common Dogfish.

* According to both Müller and Owen, the presence of *four* tiers of valves in the conus is characteristic of the genus *Centrophorus*—an obvious misstatement of the facts.

²² "Ueber den Klappenapparat im Conus arteriosus der Selachier und Ganoiden." Morph. Jahrb. Bd. ii. 1876.

²³ "An Anatomical Account of the *Squalus maximus*, &c." Phil. Trans. vol. xcix 1809.

The visceral arteries arising from the dorsal aorta are three in number—the cœliac, the lieno-mesenteric, and the posterior mesenteric. The cœliac, as indicated in Pl. LVII. fig. 3, supplies the liver, stomach, and duodenum. The lieno-mesenteric, about four inches from its origin, divides into the splenic and anterior mesenteric; the former runs to the middle of the larger spleen where, after giving off small branches to this organ, it divides into two vessels, one of which runs to the cul-de-sac of the pylorus and the other to the posterior extremity of the outer lobe of the pancreas; the latter runs directly to the anterior portion of the spiral-valve intestine. The posterior mesenteric supplies the rectal gland as usual. The oviducts are each supplied in the region of the oviducal gland by three arteries arising from the dorsal aorta at about the level of the eleventh or twelfth vertebra, as shown in Pl. LXII. fig. 19.

The posterior cardinal sinuses are large in diameter and lie on each side of the vertebral column; they arise by the bifurcation of the caudal vein about three inches in front of the anterior extremities of the pelvic fins. There is no "renal-portal system"—the slender kidneys lying externally to the sinuses. The posterior cardinals suddenly diverge anteriorly to open as usual into the Cuvierian sinuses, the small lateral veins opening into the posterior cardinals just before. The anterior cardinal sinuses, subclavian arch, brachial veins, and internal jugulars exist as usual. The hepatic-portal vein (which has several conspicuous factors in connection with the spleen, pancreas, and spiral-valve intestine) is large and runs, as before described, in the same muscular band as the bile-duct and goes first to the right lobe of the liver, as shown in fig. 3 (Pl. LVII.). I neglected to ascertain its further course anteriorly, including its relation to the left lobe of the liver. The hepatic veins enter the sinus venosus by two large apertures situated some distance apart (Pl. LVIII. fig. 4). According to Neuville¹⁶ (who has dissected *Centrophorus granulosis* and *C. squamosus*), the genus *Centrophorus* is characterised by the absence of hepatic sinuses: "les veines sus-hépatiques forment des troncs qui, au lieu de confluer pour former un sinus commun, restent complètement indépendants et débouchent directement dans les canaux de Cuvier, après avoir subi un renflement presque insensible." Also, according to Neuville, *Centrophorus*, with Selachians generally²⁴, possesses an intra-intestinal artery and vein which course along the margin of the spiral valve, the latter of course forming a factor of the hepatic-portal vein. The appearance of the hepatic apertures in the sinus venosus of *C. calceus* is confirmatory of Neuville's former statement.

Each of the oviducts has a conspicuous vein running along its outer edge, which I presume enters the posterior cardinal of the corresponding side anteriorly.

A small vessel, apparently a vein (Pl. LXI. fig. 16, B.V.), ran

²⁴ "Sur les Vaisseaux intra-intestinaux des Sélaciens." Bull. Mus. Paris, 1897 (7).

parallel with the inferior rectus muscle in both orbits, and was probably in connection with the lining membrane of the orbit.

As described below, a distinct supra-neural vein was present in the hind caudal vertebrae.

THE NERVOUS SYSTEM.

The brain of *Centrophorus calceus* (Pl. LX. fig. 15) is of the normal selachian type, with however modifications of shape adapted to the elongated snout of the animal. The extremely long slender olfactory lobes are well-marked off from the pro-encephalon, for example, and this latter is also well-defined and distinctly separated into two lobes by a median longitudinal groove. The thalamencephalon is similarly elongated in adaptation to the shape of the head. The large cerebellum has both longitudinal and transverse constrictions dorsally, the optic lobes and restiform bodies are large and the medulla oblongata broad. The tracts of nerve-fibres described by Jackson & Clarke as present in the floor of the cavity of the medulla oblongata of *Echinorhinus spinosus*—the anterior pyramids, terebral tracts, ganglionated tracts (especially well-marked), and “external strands of the medulla oblongata”—are all present and well-marked in the case of *C. calceus*. On the ventral surface the infundibulum and pituitary stalk and body are well-defined, and the saccus vasculosus extends right round the base of the pituitary body.

The cranial nerves of *C. calceus* are, at least judging from a comparison of them with those of *Scyllium canicula*, *Hexanchus*²⁵, *Echinorhinus spinosus*²⁰, *Chimæra*²⁶, *Spinax acanthias*²⁶, *Lemargus*²⁷, *Mustela lævis*²⁸, *Raja*²⁷, and the *Torpedo*²⁹, peculiar, and the interpretations I shall put upon the various branches of the trigeminal and facialis are offered as suggestions only. However, though my interpretations of the facts may turn out to be incorrect, I can absolutely guarantee the correctness of the facts themselves, and this being the case, my figures may be of some use to speculative nerve-morphologists.

There is nothing to remark upon concerning the olfactory, optic, oculo-motor, abducent, auditory, glosso-pharyngeal, and vagus nerves: they are all more or less of the ordinary Dog-fish type. With regard to the patheticus or trochlear nerve, this in the left orbit apparently sends two branches to the superior oblique muscle but only one in the right, and in both orbits the nerve comes into contact for a quarter-of-an-inch or so with the ophthalmicus superficialis of the facial which runs

²⁵ “Ueber die Kopfnerven von *Hexanchus* und ihr Verhältniss zur “Wirbeltheorie des Schadels.” C. Gegenbaur. Jena. Zeitschr. vol. vi. 1871.

²⁶ “Das peripherische Nervensystem der Fische.” H. Stannius. Rostock, 1849.

²⁷ “On the Cranial Nerves of Elasmobranch Fishes. Preliminary Communication.” J. C. Ewart. Proc. Roy. Soc. vol. xlv. 1889.

²⁸ “The Lateral Sensory Canals, the Eye-Muscles, and the Peripheral Distribution of certain of the Cranial Nerves of *Mustela lævis*.” E. P. Allis. Q. J. M. S. n. s. xlv. (2) 1901.

²⁹ “The Cranial Nerves of the *Torpedo* (Preliminary Note).” J. C. Ewart. Proc. Roy. Soc. vol. xlvii. 1890.

immediately under the supra-orbital ridge. Whether there is any interchange of nerve-fibres I cannot say.

The nerves, concerning the identity of the branches of which, as usual, there is doubt, are the trigeminal and facial, and this question of identity is complicated by the fact that the disposition of the nerves is slightly different on the two sides of the head*. The roots of the fifth and seventh nerves, in the first place, are different on the two sides of the head. On the left side (Pl. LXI. fig. 16) † the nerves which I (very possibly incorrectly) term the ophthalmicus superficialis (O. S. VII.), ophthalmicus profundus (O. P. VII.), and palatine (P. VII.) of the seventh originate from a distinct root which is the most anterior of the three giving rise to all the branches of the fifth and seventh nerves; on the right side (fig. 17) † this anterior root, distinct at its origin, is later fused with the other two roots. On the left side again, the ophthalmicus superficialis clearly arises from this anterior root, but on the right it is bound up, for an inch or so, with the large ophthalmic branch of the fifth (O.V.), and hence appears to arise from it. The ophthalmic of the fifth—a very conspicuous nerve—on both sides entirely or mainly arises from the second root of the primary three. This large ophthalmic of the fifth runs along the upper border of the orbit, and sooner or later is joined towards the anterior limit of the orbit by the smaller ophthalmicus superficialis of the seventh, and these (with the ophthalmicus profundus which joins them about half-an-inch in front of the cerebral hemisphere, after piercing the anterior cartilaginous wall of the orbit) ramify over the skin on the dorsal surface of the snout, supplying the mucous canals in the usual manner.

The huge nerve which, like the fifth ophthalmic, appears to arise mainly from the second root of the fifth and seventh nerves, and which runs outwards in the floor of the orbit, I have termed the superior maxillary of the fifth (palato-nasal is perhaps better). Anteriorly it divides into several branches supplying the ventral surface of the snout, and near its origin gives off a smaller nerve which extends downwards at the back of the orbit and forks into anterior and posterior branches which I have respectively named the inferior maxillary (I. M. V.) and mandibular (MN. V.) of the fifth. This nerve is joined, on both sides of the head, by a branch from the palatine (?); in addition to this, it gives off anteriorly on the right side a small nerve (V.L.) which runs almost parallel to it: on the left, the same small nerve originates independently from the large superior maxillary. The large size

* As Prof. Hickson kindly pointed out to me, Collinge has previously described, in 1895, other instances of the asymmetrical distribution of the fifth and seventh cranial nerves in several Teleosts ("On the Unsymmetrical Distribution of the Cranial Nerves of Fishes." Jour. Anat. Physiol. vol. xxix.).

† It is almost needless to say that in the dissections represented by both figs. 16 & 17, large masses of cartilage have been removed both in front of and behind the orbital cavity in order to expose the nerves better, and the same remark applies to a large muscle which lay in the floor of the orbit just anterior to the large vertical process arising from the upper jaw. The auditory organs have of course also been removed.

of the superior maxillary and the small size of the mandibular may perhaps be correlated with the general conformation of the skull—the elongated snout, probably used in “grazing” along the sea-bottom, rendering the movements of the lower jaw of little importance. In the dissection of the right orbit there is clearly observable a large ganglionic mass (G) in connection with the second and third roots of the fifth and seventh, and from this there arise numerous small nerves supplying the muscles in front of the spiracle and elsewhere.

From the most posterior root of the three by which the fifth and seventh nerves originate, there early arises the most characteristic division of the facial nerve, viz. that which bifurcates over the spiracular cleft. The prespiracular branch is small but obvious; the postspiracular is large, and just below the spiracle divides as usual into the internal mandibular branch (chorda tympani), which, as shown in fig. 17 (Pl. LXI.), extends a long distance anteriorly under the orbit, and the external mandibular.

According to the above provisional identification of the various branches of the trigeminal and facialis, fibres of the seventh nerve occur in both the anterior and posterior of the three roots.

The disposition of the occipito-spinal nerves of *C. calceus* is represented in fig. 14 (Pl. LX.). As shown, two nerves originate, ventrally to the vagus, in front of the spinal nerve corresponding to the first vertebra (the first spinal). This statement is contrary to that of Fürbringer¹⁰, who provides figures of a longitudinal section of the hind part of the skull of *C. calceus* in which four such occipital nerves are shown, and of the occipito-spinal nerves of *C. granulatus* in which the presence of four is also implied. My dissection of these nerves was from the ventral surface and was carefully made; I could not, however, observe more than two occipito-spinal nerves, as shown. These join with the first two spinal nerves to form a single trunk which afterwards divides into two branches, one forming a constituent of the brachial plexus, and the other supplying the muscles of the lower jaw. Spinal nerves 3–12 share in the formation of the brachial plexus. The vagus has, in addition to the brachial, visceral and lateral-line branches, two small ones, arising respectively from the main trunk (just in front of and dorsal to the visceral) and from the lateral-line branch near its origin, which run to dorsal muscles more or less parallel with the vertebral column. I did not determine the exact number of spinal nerves forming the pelvic plexus, but I may state that I counted seven.

REMARKS ON THE SKELETON.

Gegenbaur has supplied a full account of the head-skeleton of *C. calceus* in the work before referred to⁸, and I have very little to add to his account. In the lateral view of the skull provided by Gegenbaur (Taf. xii.), the extremely large, slightly-curved process situated anteriorly on the upper edge of the upper jaw is not at

all correctly represented, as my figs. 6 & 16 (Plates LVIII. & LXI.) show when compared with his. The hyomandibular cartilage is, as shown by Gegenbaur, quite separate from the lower jaw, and is only indirectly attached thereto by a broad ligament (fig. 6). Slender ligaments also attach the hyomandibular to the hind extremity of the upper jaw, and the middle of the upper jaw to the hind part of the lower jaw (fig. 6). The upper jaw is apparently held in its place solely by means of its ligamentous attachment to the hyomandibular cartilage and by the large process above mentioned which was loosely inserted into the cartilaginous roof of the orbit. I did not detect any ethmo-palatine ligament. As Gegenbaur states, there are three pre-spiracular cartilages (my fig. 6) situated in the front wall of the large spiracular cleft³⁰. In connection with the upper jaw there are two labial cartilages (enclosed in the folds of skin at the sides of the mouth shown in fig. 4, Pl. LVIII.) and with the lower jaw one, on each side (fig. 6). A prominent vertical ridge of cartilage is situated in the median line on the dorsal surface of the spatulate snout (Pl. LX. fig. 15).

With regard to the vertebral column of *C. calceus*, my figs. 7 & 8 (Pl. LVIII.) supply all the information necessary. The vertebrae are of the ordinary cyclospindylous type; the apertures for the exit of the dorsal and ventral branches of the spinal nerves are respectively situated on the intercalary neural plates and the neural plates proper, and there is in transverse section a small canal situated at the base of the neural spine, as in some other Selachians³¹, which contains a band of elastic fibres running the whole length of the body dorsal to the spinal cord.

In the anterior dorsal fin, the skeleton of which is represented in fig. 9 (Pl. LIX.), the large anterior spine does not reach ventrally to the vertebral column, whereas in the posterior dorsal (Pl. LIX. fig. 10) it is firmly grafted on, with a small cartilage situated immediately in front of it and on top of the vertebral column. The dorsal skeleton of the caudal fin consists, as shown (fig. 10), of a row of small inclined cartilaginous rods, two of these somactids abutting on each intercalary neural plate of the caudal vertebra; ventrally the haemal spines are prolonged. At the anterior extremity of the ventral caudal fin four cartilages are present distinct from the haemal spines, and, since the ceratrichia are in this region attached to these and not directly to the haemal arches, these four cartilages probably represent a vestige of the anal fin.

The skeleton of the paired fins is represented in figs. 11 & 12 (Pl. LIX.). The pectoral fin is dibasal and possesses a few fringing cartilages on its posterior border.

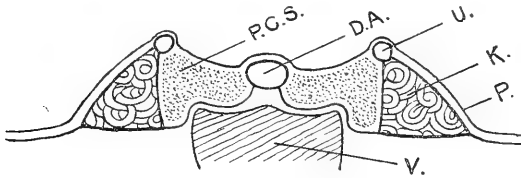
³⁰ See Ridewood for a comparative study of this region of the skull in Selachians: "On the Spiracle and Associated Structures in Elasmobranch Fishes," *Anat. Anzeig.* Bd. xi. (14) 1895.

³¹ "Das Natürliche System der Elasmobranchier auf Grundlage des Baues und der Entwicklung ihrer Wirbelsäule." C. Hasse. Jena, 1872.

THE FEMALE URINOGENITAL SYSTEM.

The kidneys are, as shown in fig. 13 (Pl. LX.), elongated slender bodies commencing at a short distance from the anterior extremity of the body-cavity (about four inches from the base of the pectoral fin) and extending posteriorly to the cloaca. They come into apposition about three inches anterior to the cloaca. Each kidney, for the greater part of its length, possesses its own ureter, which lies on its ventral edge (text-fig. 137); where the kidneys come into apposition, these two ureters fuse to form a single duct which, without forming a urinary bladder, runs to the extremity of the urinary papilla situated in the cloaca, where it opens by a conspicuous aperture. The kidney-substance is functional throughout its entire length, and there is therefore not the slightest indication of a "metanephros," or separated-off posterior portion of the mesonephros, which alone remains functional and possesses a separate duct, as occurs *e. g.* in the Dogfish. Apparently very much the same condition obtains in *Scymnus lichia*¹⁵. As implied above, the kidneys are not sufficiently developed to intrude upon the space occupied by the posterior cardinal sinuses*: there is no "renal-portal system."

Text-fig. 137.

*Centrophorus calceus.*

Diagrammatic transverse section in the region of the kidneys.

D.A., dorsal aorta; K., kidney; P., peritoneum; P.C.S., posterior cardinal sinus; U., ureter; V., vertebral column.

Two ovaries are present, as in *C. squamulosus* and *C. granulatus* and many other Elasmobranchs. The oviducts open anteriorly, just behind the pericardial cavity and anteriorly to the liver, by a single large transversely-elongated aperture (Pl. LXI. fig. 18). Each oviduct, after thus bending in transversely to open in the median line, proceeds posteriorly as a flattened duct (supported by a stout fold of the peritoneum) which, at the level of the ovaries, expands into a small oviducal gland. This gland is apparently functionless, since five embryos (to be briefly described below) were found lying quite free in the cavity of the main uterine portion of the oviduct and without a vestige of an egg-shell in connection with them. Posteriorly to the vestigial oviducal gland, the oviducts each dilate into the thin-walled uterus (smooth internally) which extends to within four or five

* This statement refers to a theory respecting the origin and significance of the "renal-portal system" contained in the succeeding paper.

inches of the cloaca, when the walls become thickened to form an extruding organ.

REMARKS ON THE ANATOMY OF THE EMBRYO.

It was my original intention to include in the present paper a complete anatomical account of the embryo (of the stage of growth mentioned above) of *C. calceus* as well as of the adult, but circumstances at present rendering this impossible to carry out, I must content myself with the following brief remarks.

Five embryos were found in the uterine portions of the oviducts of my specimen of *C. calceus*—four on one side and one on the other, if I remember aright—all about five centimetres in length (Pl. LXII. fig. 20). They possessed a large yolk-sac attached between the pectoral fins; external filamentous gills protruded from the five pairs of gill-clefts, and to a smaller extent from the spiracle (in front of which was a depression in the skin which resembled a cleft); the eyes were large and hemispherical, and the three primary brain-vesicles were as usual distinctly visible from the dorsal surface. One noteworthy peculiarity is that the narial aperture on each side is subdivided into two—a peculiarity not found elsewhere, so far as I know, in Elasmobranchs. The snout is not elongated in the embryo as in the adult and the mouth is but slightly curved; also the caudal fin extends forwards ventrally to the anterior level of the posterior dorsal fin, perhaps so representing a rudimentary anal fin which of course is absent in the adult.

On opening the body-cavity of one of the embryos, I found the liver and alimentary tract to have the conformation depicted in fig. 21 (Pl. LXII.). The liver-lobes are long and tapering, as in the adult. The stomach of the embryo narrows as it approaches the commencement of the spiral-valve intestine, and joins it in the manner indicated. I have not yet studied my sections through this region of the embryonic gut. The bile and umbilical ducts enter the large intestine as shown. The rectal gland and cloacal aperture are well-marked.

Dorsal to the gut, and extending from the cloaca to near the anterior extremity of the body-cavity, lie the two rows of metamericly-arranged kidney-tubules, beautifully distinct in the actual specimen, but which I have not been able to show very well in fig. 22, their position alone being indicated.

The tubules open into the kidney-ducts, which extend more anteriorly, suddenly diverging from the median line as they do so. Situated internally to the rows of kidney-tubes are the two thin genital ridges, extending from the level of the anterior kidney-tubules half-way to the cloaca.

Sections through the posterior caudal region of the embryo and adult distinctly show a blood-vessel of considerable size lying at the base of the neural spine of the vertebra, *i. e.* just above the nerve-cord (text-fig. 138). This vessel, which in the sections contains numerous blood-corpuscles, is apparently a vein. Towards

the base of the tail, *i. e.* towards the cloaca, this supra-neural vein breaks up first into two smaller veins situated to the side of but still above the nerve-cord, and still more anteriorly into a number of very small veins which soon become lost between the constituent masses of the myotomes. In the adult the vein (which is very obvious) lies immediately ventral to the elastic ligament mentioned above; in the embryo examined this ligament was not at that stage developed (fig. 8, Pl. LVIII., represents a section

Text-fig. 138.

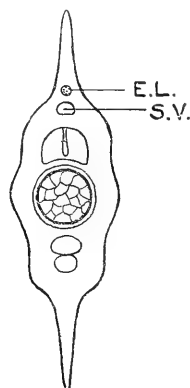
*Centrophorus calceus.*

Diagram of section of posterior caudal vertebra, showing position of the supra-neural vein (S.V.); E.L., elastic ligament.

through an *anterior* caudal vertebra, hence the supra-neural vein is not shown there). The formation of this supra-neural vein by the fusion of numerous lateral veins is a forcible illustration of the production of median vessels by flexion of the body which I have elsewhere³² insisted upon. I have not been able to discover a similar supra-neural vein in the Common Dogfish, and apparently there was not one present in a large specimen of *Echinorhinus spinosus* which was examined for me at Plymouth.

EXPLANATION OF THE PLATES.

PLATE LVII.

Centrophorus calceus.

- Fig. 1. Cloacal region. L.A.P., left abdominal pore; OD., oviduct; R., rectum; R.A., opening of rectum into cloaca; R.A.P., enlarged right abdominal pore; R.G., rectal gland; R.O.A., right oviducal aperture; U.P., urinary papilla.
2. Scales from dorsal and ventral surfaces of body. B.P., basal plate; T.S., trifold spine.

³² "On a New Mode of Persistence of the Posterior Cardinal Vein in the Frog (*Rana temporaria*): with a Suggestion as to the Phylogenetic Origin of the Post-Caval Vein." Zool. Anzeig. Bd. xxviii. (23) 1905.

Fig. 3. The alimentary tract and associated glands. A, B, C, D, E, parts of pancreas; B.D., bile-duct with arteries and veins; C.A., coeliac artery; CAR., cardiac portion of stomach; DUO., duodenum; H.V., hepatic vein; L.M., lieno-mesenteric artery; PY., pyloric portion of stomach; S. 1, large spleen; S. 2, small spleen; S.V.I., spiral-valve intestine; V., ventricle; V.E., vein running from middle lobe of pancreas to bile-duct. (For other letters, see text.)

3 a. Pancreas viewed from other side.

PLATE LVIII.

Centrophorus calceus.

- Fig. 4. The afferent arches. The ventricle has been turned forward somewhat to expose the sinus venosus. D.C., opening of the Cuvierian duct into the sinus venosus; H., opening of hepatic vein into sinus venosus; L.F., labial folds; S., subclavian vein; S.A., sinu-auricular aperture.
5. The efferent arches. C.C., common carotid; E.C., external carotid; I.C., internal carotid; S., spiracular cleft.
6. Suspensorial apparatus of jaws. CH., cerato-hyal; H.Y., hyomandibular; L.C., three labial cartilages of right side; L.J., lower jaw; L.P., large process in connection with upper jaw (well seen in fig. 16, P.); L. 1, ligament connecting hyomandibular to upper jaw; L. 2, large ligament connecting hyomandibular to lower jaw; L. 3, ligament connecting upper and lower jaws; M., muscle in connection with two upper labial cartilages; P.C., three pre-spiracular cartilages in anterior wall of spiracular cleft; S.C., spiracular cleft.
7. Trunk-vertebræ in intra- and inter-vertebral section and in side-view. E.L., elastic ligament.
8. Anterior caudal vertebra in intra-vertebral section. A.M., attached muscle; A.P.N., aperture for spinal nerve; C., calcified region; C.A., caudal artery; C.V., caudal vein; E.L., elastic ligament.

PLATE LIX.

Centrophorus calceus.

- Fig. 9. Skeleton of the anterior dorsal fin.
10. Skeleton of the posterior dorsal and caudal fins.
11. Dorsal aspect of the skeleton of the right pectoral fin. B., basal cartilage; C., ceratotrichia attached to bases of D.R.; C.P., articular process of pectoral girdle; D.R., distal radialis; P.R., proximal radialis.
12. Ventral view of the skeleton of the right pelvic fin. B., basal cartilage; P.P., articular process of pelvic girdle.

PLATE LX.

Centrophorus calceus.

- Fig. 13. The urinary system. C.U., common ureter; D.A., dorsal aorta; J.U., junction of ureters; K., kidney; K.A., anterior extremity of kidney; K.D., kidney-duct; M., myotomes cut across; P.C.S., position of the posterior cardinal sinus (peritoneum removed); S.D., ducts opening into ureter from kidney; U.O., ureter opening on urinary papilla (bisected) in cloacal cavity.
14. Dissection of the 9th and 10th cranial, occipito-spinal, and brachio-spinal nerves. B.P., brachial plexus; D.B.X., small branches from L.L.B.X. supplying dorsal muscles; L.L.B.X., lateral-line branch of vagus; M.L.J., branches of occipito-spinal nerves to muscles of lower jaw; S.C., spiracular cleft; V.B.X., visceral branch of vagus.
15. Dissection of the brain and cranial nerves viewed from the dorsal surface. A.V., aquæductus vestibuli of ear; A.V.C., anterior vertical canal of ear; H.C., horizontal canal of ear; L.L.B.X., lateral-line branch of the vagus; O.C., olfactory capsule; P., large process attached to upper jaw; P.V.C., posterior vertical canal of ear; U., utriculus of ear; V.B.X., visceral branch of vagus; X., vagus nerve.

PLATE LXI.

Centrophorus calceus.

- Fig. 16. Dissection of the cranial nerves in the left orbital region. B.V., blood-vessel running parallel with the inferior rectus muscle; C.M., cavity lodging muscle (M. 2 in fig. 17); C.T.VII., chorda tympani of facialis; E.M.VII., external mandibular of facialis; EX.C., anterior branch of

external carotid; EX.R., external rectus muscle; HY.VII., hyomandibular of facialis; INT.R., internal rectus muscle; I.M.V., inferior maxillary of trigeminus; I.R., interior rectus muscle; MN.V., mandibular of trigeminus; M. 3, muscle in connection with jaw in floor of orbit; O.P.VII., ophthalmicus profundus of facialis; O.S.VII., ophthalmicus superficialis of facialis; O. V. & VII., ophthalmic branches of trigeminus and facialis; P., large process attached to upper jaw; PS.VII., pre-spiracular of facialis; P.VII., palatine (?) of facialis; S.M.V., superior maxillary of trigeminus; S.O., superior oblique muscle; S.R., superior rectus muscle; I., olfactorius; II., opticus; III., oculo-motorius; IV., trochlearis; V.L., small branch from superior maxillary of trigeminus; VI., abducens; VII. & V., three roots of facialis and trigeminus; VIII., auditorius.

- Fig. 17. Dissection of the cranial nerves in the right orbital region. Three rectus muscles removed. Most reference-letters same as in fig. 16. G., ganglion; M. 1, M. 2, large muscles in connection with jaws; MV., small branches of trigeminus to jaw-muscles.
18. Female genitalia. M., mesentery; O., median oviducal aperture; OD.A., anterior part of oviduct; OD.G., oviducal gland; OD.M., middle (uterine) portion of oviduct; OD.P., thick-walled posterior portion of oviduct; OV., ovary.
19. Anterior arteries supplying the oviduct. B., coagulated blood in posterior cardinal sinus; D.A., dorsal aorta.

PLATE LXII.

Centrophorus calceus.

Fig. 20. Ventral, dorsal, and lateral views of an embryo.

21. Alimentary tract of embryo. B.D., bile-duct; C.A., cloacal aperture; J., mass covering junction of large intestine with stomach; L.I., large intestine; R.G., rectal gland; S., stomach; U., umbilical duct; V., ventricle of heart.
22. Urinogenitalia of embryo. C.A., cloacal aperture; G., gonads; P.D., pronephric duct; T., metamERICALLY-ARRANGED TUBULES OF KIDNEY.

5. A Suggestion concerning the Origin and Significance of the "Renal-Portal System," with an Appendix relating to the Production of Sub-abdominal Veins. By W. WOODLAND, F.Z.S., Demonstrator of Zoology, King's College, London.

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(Text-figure 139.)

Literature relating to the "renal-portal system" is of small extent and, so far as I am aware, a recent consideration of the subject does not exist. It is doubtful if any physiologist at the present time holds a definite opinion as to the function of this association of kidney and vein, and, though it is universally termed a "portal" system, few realise the absurdities involved by such a supposition. It is in order to expose these absurdities and to suggest what is to my mind a more rational interpretation of this very general feature of vertebrate anatomy that I have ventured, without bringing forward any new facts, to publish the following lines.

In what follows I have for consistency's sake replaced the terms "renal-portal system" and "renal-portal vein" by "renal cardinal meshwork" and "post-renal vein" (expressions not associated with a theory), and I will proceed to justify this change of nomenclature by first stating as briefly as possible the arguments adverse

to the portal theory of the renal cardinal meshwork—a very necessary preliminary for the suggestions to follow.

Theoretical Objections to the Portal Theory of the Renal Cardinal Meshwork.

Attributing a portal function to the renal cardinal meshwork ordinarily implies that the kidney substance eliminates from the *venous* blood circulating through its sinuses a (nitrogenous) product which is excretory* in nature. It also follows from this supposition that those animals which have a "renal-portal system" possess a considerable advantage over animals which have not, since obviously in the former a far larger proportion of the blood passes through the kidney (the "portal" kidney being "supplied" from both an arterial and a venous source), and hence there exist greater facilities for excretion. Assuming then the hypothesis to be valid, we may reasonably expect to discover that a "renal-portal system" exists in all those animals which manifest the greatest activity, since, activity being coextensive with the amount of excretory matter produced, they need it most. Organs in general are best developed, *i. e.* most efficient in their mode of function, in those animals where they are most required, and an excretory renal-portal system being undeniably an improvement on the non-portal kidney, this should conform to the general rule. The expectation however is not justified by the facts: on the contrary, we find that *in general the more active the animal the less developed is the "renal-portal system"*! In the relatively inactive cold-blooded Pisces, Amphibia and Reptilia, the "renal-portal system" attains its maximum of development, whereas in the active hot-blooded Aves and Mammalia it is either reduced or absent. And this same irrelation between activity of the animal and the presence of the renal cardinal meshwork can also be observed in more special cases: *e. g.*, the caudal vein forms a conspicuous renal meshwork in Pleuronectidæ, but does not form one at all in the Perch and Salmon; indeed the degree to which the renal cardinal meshwork is developed in Teleosts (and other groups) is extremely variable. Thus, apart from other considerations to be adduced, it follows solely from the general rule just mentioned that the renal cardinal meshwork is probably not portal in function.

Evidence of a more special character tends to the same conclusion. The kidney, like all other organs, conforms to another general law, *viz.*, that size is proportional to work done. It is well known for example that excision of one of the kidneys causes the companion organ to enlarge considerably owing to the additional activity thus deputed to it, and it is equally well known that the most active animals possess the largest kidneys relatively to the size of the

* The following arguments equally apply on the supposition that the product is a secretion (like that of the thyroid gland, *e. g.*) which is subsequently added to the blood.

body. From these facts it is evident that if, according to the views now held, the "renal-portal system" possesses an excretory function, then the kidney through the substance of which the post-renal vein "ramifies" ought to be considerably larger than one not so characterised on account of the larger blood-supply; especially will this difference in size be conspicuous when two such differently-constituted kidneys exist in the same animal, since in this case one kidney has the portal functions of two kidneys to perform. But, again, the expectation is not justified by the facts, as is for instance conspicuously shown by renal-portal vein abnormalities found in the Frog and described by Shore (7) and myself (10). These abnormalities in short consisted of the entire absence of a "renal-portal system" on one side of the animal, *i. e.*, the kidney of one side was obviously supplied by the renal arteries alone, and not, as usually appears to be the case, by the post-renal vein as well, and yet, notwithstanding this, the two kidneys in these abnormal frogs were in every case equal in size: a fact easily intelligible on the supposition that the arterial supply of the kidney alone is concerned with excretion, but on no other supposition.

A third line of argument yields evidence equally as conclusive as the two foregoing. The almost universally adopted assumption as to the portal nature of the renal cardinal meshwork is doubtless based upon the belief that the post-renal veins form capillaries in the substance of the kidneys in the same manner as the hepatic-portal in the liver, this belief being supported by the superficial aspect of the adult structure. But recent investigation into the mode of development of the renal cardinal meshwork altogether disproves this supposition. Shore (6, 9) has shown that a radical difference of origin obtains "between the sinus-like system of the mesonephros and that of the liver." Briefly stated, "the former is the result of the penetration of the nephridia into the cardinal vein, whilst in the liver there take place irruptions, as it were, of capillary blood-vessels from the vitelline vein into the solid mass of proliferated hypoblast." "The liver is originally a solid mass of cells which has become fenestrated by blood-vessels, and thus divided into a network of anastomosing cylinders," and "the peculiarities of the liver in different types [of animals, active and inactive] depend upon the extent to which blood-vessels have penetrated and subdivided it." That is to say, in the case of the true portal system of the liver, in which the venous blood discharges certain of its contents into the hepatic substance, *the blood-vessels actively find their way to all parts of the secreting mass*; on the other hand, in the case of the pseudo-portal system of the mesonephros or "metanephros" as the case may be, the blood-vessels take no such active part: on the contrary, *the cavity of the venous sinus itself becomes encroached upon by the growth of the kidney substance*. In the one instance in which we know that certain substances are extracted from the blood, the blood-vessels take an active part in penetration; in the other, in which it is (illogically) assumed that

excretion takes place, the organ through which the blood-vessels pass is the active agent*. Surely such a reversal of activities cannot be ignored! And, confirmatory of this distinction between the hepatic capillaries and most of those so-called of the kidney, Hyrtl (2) † points out in the case of the "renal-portal system" of the Frog that the venous connections between the post-renal veins on the dorsal surface, and the renal veins on the ventral surface of the kidney, are so large that they can scarcely be called capillaries. If we assume, as we logically must, that a given function will, under similar conditions, always be performed in the same manner, then, on this present account alone, the obvious inference is that the "sinus-like system" forming the connection between the posterior cardinal and post-renal veins has nothing whatever to do with the elimination of excretory matter from the blood, and this conclusion harmonises with the arguments already advanced.

Another objection may be urged. In the case of the hepatic-portal system, *e. g.*, it is significant that there does not exist a single instance throughout the vertebrate series of a by-path by which the blood flowing forwards in the portal vein can evade the passage through the liver substance; and it is evident that this persistence in one course is explicable solely on the supposition that it thereby serves an important physiological purpose, namely, the elimination of food-products from the blood; in other words,

* Dr. Arthur Keith has kindly called my attention to a paper on "The Question of Sinusoids," by F. T. Lewis (*Anat. Anzeig.* August, 1904) in which the assertion of this radical difference of origin of the respective vascular supplies of the liver and "portal" kidney is denied. Not having investigated the subject myself I cannot give a definite opinion (though, apart from other reasons, I cannot fail to be biased in favour of Shore, whose paper is as lucid as that of Lewis is obscure), but will content myself with the following suggestions. The "portal" kidney, which alone has a sinusoidal blood-supply, owes this peculiarity, as I have shown in detail below, solely to the facts that it is always well developed and therefore of considerable bulk, and that it originates in the neighbourhood of a vein, on the lumen of which it encroaches as growth proceeds. In the Common Herring *e. g.*, only that portion of the left kidney which, rising dorsally from the posterior limit of the body-cavity, comes into contact with the left posterior cardinal, forms a small renal cardinal meshwork; in other words, there is no "renal-portal system" in the posterior part of the kidney. No renal cardinal meshwork at all exists in connection with the right kidney which does not coincide in position with the more medianly situated right posterior cardinal. This individual instance well illustrates the fact that the sinusoidal circulation of the kidney, when it occurs, is solely due to contact with a vein. Compare now the case of the liver, according to Lewis. Here there is no restriction of the sinusoidal circulation to the region of contact between liver and vein; on the contrary, the venous circulation finds its way to every part of the massive organ—the blood is the active element. I have also on p. 891 indicated another difference, histological in character, between the vascular supplies of the liver and "portal" kidney.

But even assuming that Lewis is right in his statement that the vascular supplies of the liver and "portal" kidney originate in the same way, it does not in the least affect the validity of my theory as to the *raison d'être* of the "renal-portal system," since he also states that the vascular supply of the myocardium is sinusoidal, and this is certainly not developed in connection with an excretory or portal function, and what is true of the myocardium may be true of the kidney.

Dr. Shore writes to me, in reference to Lewis's paper, that "he does not see any reason to alter the opinion he had previously arrived at. The development of the venous sinuses in the liver is certainly that of a penetration of blood-tubes into the hypoblast mass."

† See also footnote on p. 891.

the portal blood contains a substance to be eliminated, and it does not seek to escape a process of depuration so needful for the maintenance of animal life. The same fact is illustrated elsewhere in the vertebrate body, as *e. g.* in the gills of fishes and lungs of Amniota. Now the present argument may best be presented in the form of the following question: how is it, if the renal cardinal meshwork be, as it is usually supposed to be, excretory in nature, that a large proportion of the venous blood returning from the posterior portions of the body, nearly always adopts, in the case of animals possessing a well-marked meshwork, an alternative direction of flow in returning to the heart, thus to a large extent rendering the meshwork useless? If the renal cardinal meshwork exists for the purpose of purifying the venous blood, how is it that in most cases half or more than half of the blood takes the opportunity of evading the process*. To realise this fact (wholly unexplainable on the portal theory) it is only necessary to call to mind the large epigastric veins of Amphibia and Reptilia and the coccygeo-mesenteric of Birds, which evidently carry back to the heart a very considerable portion of the venous blood from the posterior parts of the body, which otherwise would be compelled to traverse the kidney substance. The same phenomenon is observable in most Teleosts, where usually one posterior cardinal alone (the left) is involved in the formation of the renal cardinal meshwork, and where in every such case this cardinal "shows a tendency to become reduced" (Wiedersheim), the greater portion of the blood passing direct to the heart through the swollen and medianly situated posterior cardinal whose lumen is not obstructed. Again, "in a few osseous fishes, as the Shad, some of the caudal branches of the vertebral system of veins *anastomose with the veins of the rectum*, and thus form part of the roots of the portal system" (Owen); these anastomoses "representing a commencement of the anterior abdominal or epigastric vein of higher types" (Balfour).

Finally, it may be urged as an objection of some importance, that the renal cardinal meshwork differs from a capillarisation such that of the true portal system of the liver in the facts that the walls of the larger veins forming the renal meshwork possess no muscular tissue† and are not supplied with vaso-motor nerves, the larger branches of the portal vein, on the other hand, being

* I may here add yet another objection to the supposition that the renal cardinal meshwork is portal in function, and this is that the needlessness of such an additional supply of venous blood to the kidneys in the Ichthyopsida and Sauropsida is sufficiently demonstrated by the fact that only a portion of the blood in the dorsal aorta itself enters the kidney substance and not the whole. The possible reply that the whole of the dorsal aorta could not ramify through the kidney because such a capillarisation would destroy the forcible flow of blood to the hind-limbs and tail, may be met by the fact that the blood propelled from the heart does in all fishes first traverse the capillaries of the gill-filaments before entering the dorsal aorta to supply the locomotor tail, and what is possible in the case of the tail of fishes is possible for the hind-limbs and tails of animals (certainly in Amphibia, Reptilia, and Aves) possessing a renal meshwork.

† Each kidney tubule being alone invested by an "accurately-fitting layer of the flattened epithelial lining of the vein" (Shore, 6).

well supplied with both: the obvious inference being that the blood is not required to traverse the substance of the organ in the former case and so, as we have seen, it adopts an alternative course. Moreover, "the portal vein supplies a rich capillary anastomosis round each liver-cell"—a feature entirely absent in the case of the venæ renales advehentes of the "portal" kidney. If the post-renal "ramifies" into the kidney substance like the portal does into the liver and for the same purpose, surely similar features should be developed in both cases.

Experimental Confirmation.

Since writing these notes and coming to the conclusion on purely theoretical grounds that the renal cardinal meshwork does not exist for the purpose of eliminating excretory substances from the blood, I have met with strong confirmation of this conclusion in the shape of results derived from physiological experiments on the amphibian kidney. It has been definitely proved, by the researches of Nussbaum (5) and Beddard (1), that ligation of the renal arteries in a frog entirely cuts off the circulation through the glomeruli of the kidney, and that this ligation, *without interfering with the renal-portal circulation*, is immediately followed by an absolute cessation in the excretion of substances normally eliminated by the kidney—urine, sugar, and peptone*. Further, the same two investigators also found by numerous experiments that it is impossible to inject the glomeruli either from the post-renal vein or from the post-caval—"it is no more possible to inject a glomerulus backwards from the renal vein in a frog than in a mammal" (Beddard)—which again shows that the blood in the post-renal vein takes no part in glomerular circulation, and, at the same time, renders it probable, especially when we bear in mind Hyrtl's statement before referred to regarding the large diameter of the kidney sinuses, that it also takes no part in the circulation of the small vasa efferentia round the kidney tubules—the only other vascular supply to the kidney elements. In other words, the blood from the vasa efferentia flows into the post-renal sinusoids, but not *vice versa*. If this last very probable supposition turns out to be correct †, it is

* It must be remembered in this connection that the withholding of arterial blood deprives the kidney of oxygen, which is requisite for the due performance of its functions. As Starling ('Elements of Human Physiology,' p. 450) says:—"It seems that a certain supply of arterial blood is necessary to the normal life of the tubular epithelium, since this undergoes fatty degeneration and desquamates in consequence of the occlusion of the glomeruli. It is evident that some means must be devised of repeating these experiments while ensuring an adequate supply of oxygen to the tubular epithelium"; in other words, the venous blood in the post-renal must be artificially oxidised before being allowed to enter the kidney, if we wish to obtain absolutely trustworthy results. However, the results so far obtained tend to confirm the obvious corollary from the above-stated conclusion, viz., that the artificial oxidation of the venous blood in the post-renal would not lead to different results.

† Since writing this sentence I have met with the following passage and statements contained in a paper on the "Caractères lymphatiques de certaines veines chez quelques Squales," by M. L. Vialleton (C. R. Hebdom. des Séances de la Soc. Biol. Paris, tome liv. 1902). The venous sinusoids in the "portal" kidneys of the

evident that the "portal" kidney will resemble in all respects the kidney of Mammalia, and the kidney of the Vertebrata generally will thus be proved to be identical in structure and function throughout*. Finally, Prof. Starling informs me that it has been experimentally proved that ligature of the post-renal and dorso-lumbar veins in a living animal does not interfere appreciably with the normal excretion of the kidneys †—which fact I think by itself sufficiently confirms the conclusion I had previously arrived at on theoretical grounds.

The Nature of the Renal Cardinal Meshwork.

Accepting then as valid, as I think we must do, the conclusion that the renal cardinal meshwork is not excretory in nature, it is evident that the question as to the origin and significance of this structure still remains to be answered. What, then, is a possible cause of the formation of the renal meshwork in the vast majority of the lower vertebrata?

It must first be remarked as a most significant fact that the successively posterior developments of the kidney in the phylogeny and ontogeny of vertebrates (the pronephros, mesonephros, and metanephros) follow the path of the veins of the body posteriorly—the kidney elements select the actual path of the veins as a site for their development. Thus the pronephric tubules form a renal cardinal meshwork in connection with the anterior portions of the posterior cardinal veins, and are in consequence situated some distance from the median line; the mesonephroi, with the posterior cardinals, approach the median line of the animal the more posteriorly they are situated, and the metanephroi (except in mammals) are similarly placed still more in apposition with the vertebral column, since they are still nearer the junction of the posterior cardinals to form the caudal vein. Thus it cannot be doubted but that the kidney develops in most cases in connection with the vein as if for a purpose, but since we cannot assume that the position of an organ in the body is determined by the desirability of that position—a teleological mode of argument too often employed—we must believe that the coelomic epithelium (or the kidney-forming substance above it) has, in the vicinity of

Squalidæ examined by M. Vialleton are, as he says, "fort irrégulières, elles présentent des dilatations considérables alternant avec des rétrécissements marqués, et des bosselures latérales terminées en cul-de-sac. Leurs parois, d'une minceur extrême, ne possèdent pas de fibres musculaires de sorte que, sur les coupes, on dirait de simples lacunes creusées dans le tissu conjonctif, et limitées par un endothélium . . ."

He further states that *there are two sets of "capillaries" in the kidney substance*, one of which consists of very small vessels which soon enter into the second set which, on the other hand, consists of the system of largely developed sinusoids connecting Jacobson's veins with the interrenal—the renal cardinal meshwork. I think this statement by an impartial observer converts my "very probable supposition" into a certainty.

* See footnote on p. 895.

† See Gurwitsch, Pflüger's Archiv, vol. xci. p. 71 *et seq.*, 1902. Prof. Starling says that the diminution in excretion of urine obtained by Gurwitsch is to be regarded as due to the conditions of the operation merely.

Text-fig. 139.

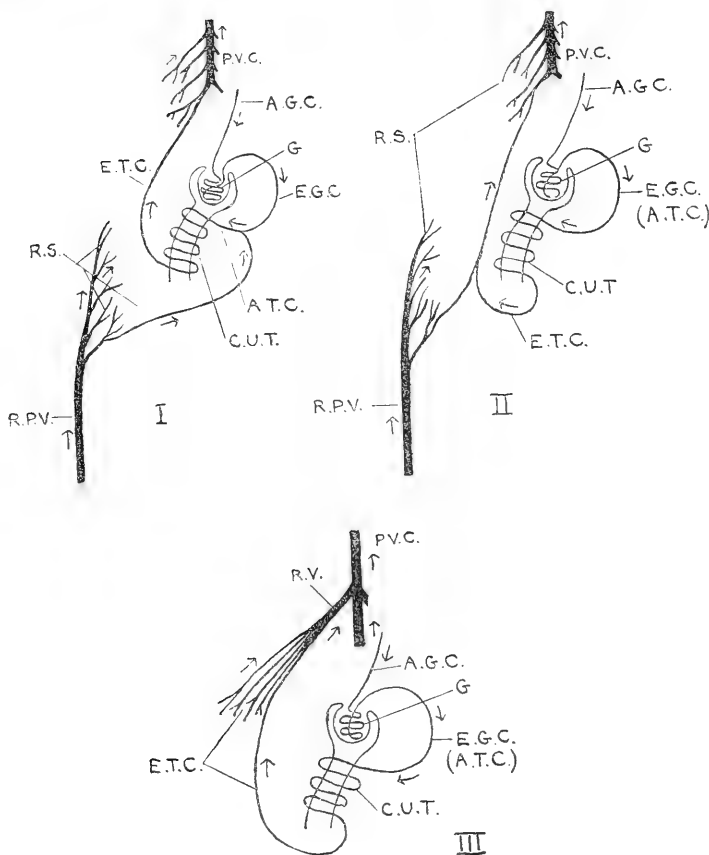


Diagram showing that the vascular supply of the kidney elements is identical throughout the vertebrate series.

I illustrates the portal theory of the amphibian kidney. II illustrates the actual plan of construction of the amphibian kidney. III illustrates the plan of construction of the mammalian kidney.—A.G.C., afferent glomerular capillary; A.T.C., afferent tubular capillary; C.U.T., capillarisation round urinary tubule; E.G.C., efferent glomerular capillary; E.T.C., efferent tubular capillary; G., glomerulus; P.V.C., posterior vena cava; R.P.V., "renal-portal vein" (post-renal); R.S., renal sinusoids; R.V., renal vein.

a vein, a better chance of developing into the kidney than in other places. Why this should be the case may perhaps be explained as follows: the walls of the veins, at the stage of growth of the embryo when the kidneys become developed, are exceedingly thin, consisting in the Frog, *e. g.*, of merely a unilaminar epithelium, and it is on this account that the veins are easily

invaginable by structures adjacent to them; *e. g.*, in the Frog even the ureter sinks into the lumen of the posterior cardinal so as nearly to be completely enclosed (Shore, 6). Now it is evident that the kidneys arise in a position where space is extremely limited, since dorsally and laterally the adjacent space is filled with closely-packed mesenchymatous tissue, which, as the "urinary ridges" show, must offer considerable resistance to displacement, and ventrally the space is bounded by the cœlomic epithelium, the limited distensibility of which must also offer some resistance to the expansion of the kidney substance in this direction. Hence the developing kidney, especially if it attains to at all considerable dimensions*, is subject to pressure; and the obvious inference is that if there exists in the near neighbourhood of the kidney a space which permits of invasion, then the kidney substance, *i. e.* the tubules, will tend to occupy this space, *i. e.* the venous sinus, as that offering the least resistance to expansion. The kidney develops in the position of the veins simply because there here exists more space for the growth of the renal substance than elsewhere. There is nothing new in the facts just stated. It is unquestionable that the walls of the embryonic veins are exceedingly thin and invaginable; it is evident that the kidney during its development must and does exert pressure on surrounding structures, and it is well established that the renal tubules do invaginate the walls of the large venous sinus, transforming the simple lumen into a large meshwork of sinusoids †. All that is new is my contention that the *encroachment of the renal tubules on the space originally occupied by the venous sinus—the "renal-portal system"—is simply due to the expansion of the growing kidney in the direction of least resistance*, and is not in any way concerned, as already proved, with excretion. The renal cardinal meshwork is, on this hypothesis, a purely mechanical and functionless product, and this supposition is congruous with all the known facts of the embryology and physiology of the vertebrate kidney.

It is impossible to here review the various conditions of the renal cardinal meshwork to be found in the vertebrate series; I can merely state that in all cases a renal cardinal meshwork will be found to occur whenever the kidneys are well developed and are able to be situated in the vicinity of the venous channels (impossible in the case of Mammalia, *e. g.*). In a few instances (*Ceratodus*) the meshwork appears to be formed in connection rather with the iliac veins which join the posterior cardinals (renal-portals) than with these latter, but this is of course only an additional illustration of my contention.

* In the Cyclostomes, many Teleosts, and some Elasmobranchs (*Acanthias vulgareis*, *Centrophorus calceus*, and others), the kidney does not attain to considerable dimensions, and this is probably the reason for the absence of the renal cardinal meshwork in these forms.

† As Shore (6) says, the kidney tubules invade the venous lumen adjacent to them, giving this a "sinus-like character, the nephridia having grown into it, invaginating its wall as a reflection over themselves, so subdividing it into a network of irregular channels."

Mammals.

A discussion concerning the renal cardinal meshwork would be incomplete without a reference to the conspicuous non-"portal" condition of the kidney found in mammals. The mesonephros of mammalian embryology forms a renal cardinal meshwork identical with that found in lower vertebrata, but with the development of the mammalian metanephros, with its extreme concentration of the kidney substance and a-median position (being situated externally to the transverse processes of the vertebre), the kidney of the adult mammal loses all connection with the post-caval vein from the "portal" standpoint and is solely supplied with blood by the renal artery*. The two features just noted as characteristic of the mammalian kidney probably account for the absence of the renal cardinal meshwork. Concentration of the kidney substance means a grouping together of the kidney tubules largely in the dorso-ventral direction, and a corresponding shortening in longitudinal extension; in other words, the area of attachment of the kidney becomes more restricted, and hence there must necessarily be less tendency to encroach upon the venous channels. Indeed, in the higher mammals, the kidneys are only prevented from sharing the transposition of the testes (11) by means of a "circumambient development of areolar tissue which usually contains much fat," and is especially developed in connection with this tendency to displacement †. That is to say, besides having no adjacent posterior cardinals upon which to encroach, the kidneys in the higher mammals are, as it were, shaken clear of all surrounding structures. As Owen remarks, the mammalian kidneys "have a more compact and definite form than in birds, and *their vascular system is more exclusively their own*" ‡.

* It is evidently not true, as Johnson (3) alleged, that the kidney of Mammalia, possessing no "portal" system, has a proportionately large artery to supply the supposed deficiency.

† "Maintenance of the position of the kidney is chiefly dependent upon the integrity of the connective-tissue investment. . . . If we take those cases in which the kidney was lowest down, we find chest diseases prominent accompaniments." Dr. C. Addison in Proc. Anat. Soc. Gt. Brit. & Ireland, May, 1904. I should like to add here in connection with my paper on the phylogenetic cause of the transposition of the mammalian testes, published in 1903, that, despite its crudity in several parts, I am not aware that a better idea on the subject has since been suggested. I certainly cannot credit Dr. Keith's hypothesis, *e. g.* ('Human Embryology and Morphology,' 2nd ed. p. 156), because, to supply two obvious reasons only, intratesticular pressure is probably as great as intraabdominal pressure, and the testes in the lower mammals are not shut off from the abdominal cavity and in the active birds do not descend at all.

‡ This and the above statements supply a full answer to the question raised by Minot ("On the Veins of the Wolffian Bodies in the Pig," in Proc. Boston Soc. Nat. Hist. vol. x. 1898), as to the possible phylogenetic significance of the difference obtaining between the sinus-like character of the channels permeating the mesonephros and the true capillarisation of the "metanephros" of the higher vertebrata. As Minot says, "in the [mammalian] metanephros the intertubular vessels are true capillaries and not sinuses," and the arguments I have above adduced show why this should be so. There is no breach of genetic continuity as Minot suggests—the non-portal "metanephros" is not a "new" organ, but simply a posterior development of a mesonephros which has not encroached upon a venous sinus.

It is also exceedingly probable that the completely median position of the primitive posterior cardinals in the region of the kidneys in mammals, is due to the absence of encroachment upon the lumen of the veins by the kidneys.

Recapitulation and Conclusion.

To recapitulate the entire argument: In view of the fact that the supply of arterial blood to the kidneys is only partial and does not involve the whole aorta (the inference from this being that a venous supply is unnecessary), and of the further facts that the renal cardinal meshwork is not found in those animals which most require it, and that in those animals in which it is found at least half the blood avoids its passage; seeing that when the meshwork is absent there is no diminution in volume of the kidney, and that the meshwork is radically different in regard to its mode of origin as compared with the true portal system of the liver; seeing that the venous "portal capillaries" of the kidney are too large to be properly denoted by that term, and that, unlike the hepatic-portal system, the walls of the kidney "capillaries" contain no muscles and are devoid of a nervous supply, there is every reason to believe on *à priori* grounds that the renal cardinal meshwork is not excretory in nature. *A posteriori* evidence in confirmation of this conclusion has also been supplied, as we have seen, by the results of certain physiological experiments, some of which, though not conducted in as satisfactory a manner as could be wished from the present standpoint, yet were probably sufficiently well performed to justify reference to them.

If the renal cardinal meshwork is thus not excretory in nature, then, it being extremely improbable that the meshwork possesses some other function, it follows that the association of the kidney and vein is probably functionless. If functionless, it is on this account certain that the meshwork is accidental in origin—a by-product having no relation to the animal economy—and I have supplied a certain amount of evidence to this effect. In short, I have endeavoured to show that the renal cardinal meshwork is simply an instance of the extension of a growing organ in the direction of least resistance; in other words, a mechanical product bearing no direct relation to the physiological needs of the animal.

In conclusion I wish to express my indebtedness to Dr. Ridewood, who very kindly read through the manuscript and offered several suggestions, and to Professor Starling, who kindly assisted me in connection with the literature of the subject.

APPENDIX.

On the Production of Pelvic Veins; i. e., an additional sub-abdominal communication between the iliac and caudal veins and the heart.

Several reasons have been given in the paper referred to in the text (10) to account for the return to the heart of the venous

blood from the hind-limbs and tail in the mid-*dorsal* channel, but no full explanation has yet been offered to account for the fact that in the majority of the Ichthyopsida and Sauropsida, part of the venous blood derived from the aforementioned regions adopts a mid-*ventral* course in its passage to the heart. What is the explanation of the production of pelvic veins? We cannot suppose that the blood from the limbs is thus in part deviated from the primitive mid-dorsal course merely in order to pass into the portal system of the liver, since the absence of any such feature in most Fishes and in all Mammalia effectually negatives any such idea*. Owen indeed elaborated an ingenuous though somewhat fragile hypothesis which supported this idea, but, as he himself admitted, it was of little value and solely appertained to the coecygeomesenteric of birds and not indeed always to that†.

In my opinion, a possible solution to this problem lies in the fact that the adoption of a mid-ventral way of return by a large proportion of the venous blood is in all cases (save, and for the reason below stated, Chelonia, and perhaps *Apteryx* and other Ratite, in which there exists little or no meshwork) correlated

* Owen remarks in connection with this point that "the anastomosis of the pelvic veins, in being the means of conveying common venous blood into the liver, goes to prove that the blood of the *vena porta* does not require any peculiar preparation by circulation in the spleen or other viscera to fit it for the secretion of bile." If my theory is correct, it would seem that this is no proof.

† Since this ingenuous theory of Owen is, so far as I know, the only one hitherto propounded to account for the presence of epigastric veins in Vertebrata, it seems worth while quoting him fully on the subject. "The venous system of the kidneys is so arranged in birds that the blood can be distributed either to the portal system by the mesenteric vein, or to the pulmonary system by the *vena cava* and right side of the heart, according to the degree of rapidity with which the pulmonary or portal systems of veins are respectively supplied, or in other words, according to the activity with which the circulation in each of these systems may be going on at two different periods. . . . This disposition has been erroneously supposed to indicate that the urine was secreted from the venous blood in birds, as in reptiles and fishes; but the end attained by the venous anastomoses in question bears a much closer relation to the peculiar necessities and habit of life of the bird, and, so far as I know, has not hitherto been explained. There is no class of animals in which there may be, at any two brief and consecutive periods of existence, a greater difference in the degree of energy and rapidity with which the respiratory functions are performed than in birds. When the bird of prey, for example, stimulated by a hungry and an empty stomach, soars aloft and sweeps the air in quest of food, the muscular energies are then strained to the utmost, the heart beats with the most forcible and rapid contractions to propel the current of blood along the systemic arteries, and the pulmonary vessels require the greatest possible supply of blood to serve the heart with the due quantity of arterialised fluid: the digestive system, on the other hand, is in a state of repose and we may conceive the portal circulation to be at its lowest ebb. Suppose the eagle to be gluttoned with his quarry and reduced to a state of torpor; the animal functions are now at rest, but the organic powers concerned in the assimilation of the food are in full play, and the portal or hepatic circulation is as active as was the pulmonary a short time before." But since the same disposition of veins occurs in *Apteryx*, Owen admits that "the modifications of this part of the venous system were less important than I had been led to anticipate in a bird whose comparatively limited powers of locomotion must be attended with less partial and excessive action of the respiratory system than in birds of flight" ("On the Anatomy of the Southern *Apteryx*," *Trans. Zool. Soc.* vol. ii. 1841). Moreover, the theory obviously does not apply to the similar venous arrangement found in *Ceratodus*, Amphibia, and Reptilia. In mammals, on the other hand, which most resemble birds in the alternating activity of the respiratory and portal systems, a communication between the portal and post-renal veins does not exist!

with a highly developed renal cardinal meshwork. The encroachment of the kidney tubules on the venous lumen necessarily causes an obstruction to the flow of blood, notwithstanding that "the whole cardinal vein becomes greatly enlarged *pari passu* with the breaking up of its lumen into sinuses" (Shore, 6) in its endeavour to maintain a sufficient passage*; and it is the failure of the enlarged posterior cardinal, in vertebrates above fishes, to entirely effect this object, owing to the greater bulk and complexity of the kidneys in these animals, which is, I believe, the main cause of the adoption by the venous blood of an alternative course of flow. In fishes which possess no renal cardinal meshwork, as *e. g.* some Selachians, and in those in which it is not developed to a very great extent, as in most Teleosts and Selachians, the whole of the venous blood is still able to return to the heart via the mid-dorsal channel. But in *Ceratodus* (apparently not in *Protopterus*, in which however the hindlimbs are vestigial), which approaches the Amphibia in general structure, in Amphibia, Reptilia, and most Aves, the renal cardinal meshwork becomes very much more developed, owing to the greater size and complexity of the kidney in these higher forms, and hence, the mid-dorsal channel becoming largely obstructed, the venous blood, particularly that returning from the limbs in *Ceratodus*, Amphibia, and Reptilia, has to seek another course for its passage to the heart. That other factors co-operate to produce this mid-ventral channel is possible, and in some cases probable, but the formation of the renal cardinal meshwork is I think the chief.

The principal other factor concerned in the production and persistence of the ventral venous channel is one that has already been referred to in my previous paper. I have mentioned that the probable reason for the mid-dorsal route is the fact that in the majority of cases it is in a more direct line with the large caudal and iliac veins. Now, if the tail be unimportant and the form of the body-cavity such as to render the mid-ventral course as much in line with the posterior veins as the mid-dorsal, then, even in the absence of a renal cardinal meshwork, it is possible for the blood to flow through a pelvic or coccygeo-mesenteric vein as well as, or instead of, through the posterior cardinals. The abnormal distribution of veins in Chelonia and Crocodilia has already been thus interpreted. In the former group, it is probable that the original presence of a fully-developed renal meshwork aided in the production of a sub-abdominal course for the blood, and that subsequently this course, being well adapted to the circumstances, led in turn to the dissolution of the meshwork.

* This is evident from the fact that "the cardinal sinus surrounding the nephridial tubules maintains a large size as far back as the most posterior nephridium, where the vessel almost suddenly narrows and passes into the three veins shown." And again: "At this stage [of the Frog's development] the anterior parts of the posterior cardinal veins are very large and dilated, and almost surround, as a vascular network, the pronephros The posterior parts, however, are more slender" (Shore, 6).

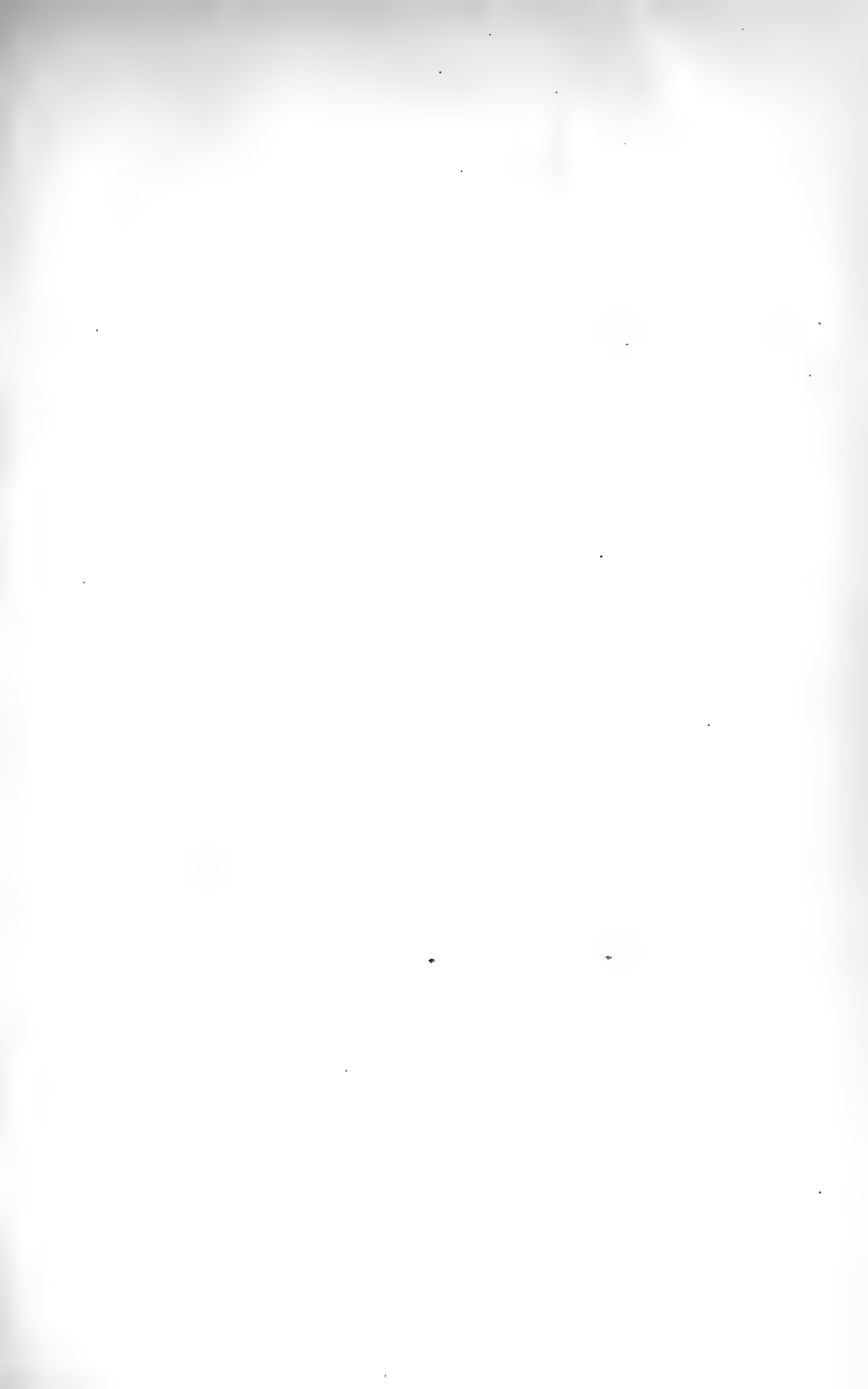
The coccygeo-mesenteric of *Apteryx* also (and perhaps that of other birds) is, in the absence of a renal meshwork, similarly to be interpreted—the blood, owing to the absence of a powerful tail and the shape and position of the trunk relatively to the ground, finding the ventral channel as easy of passage as the dorsal.

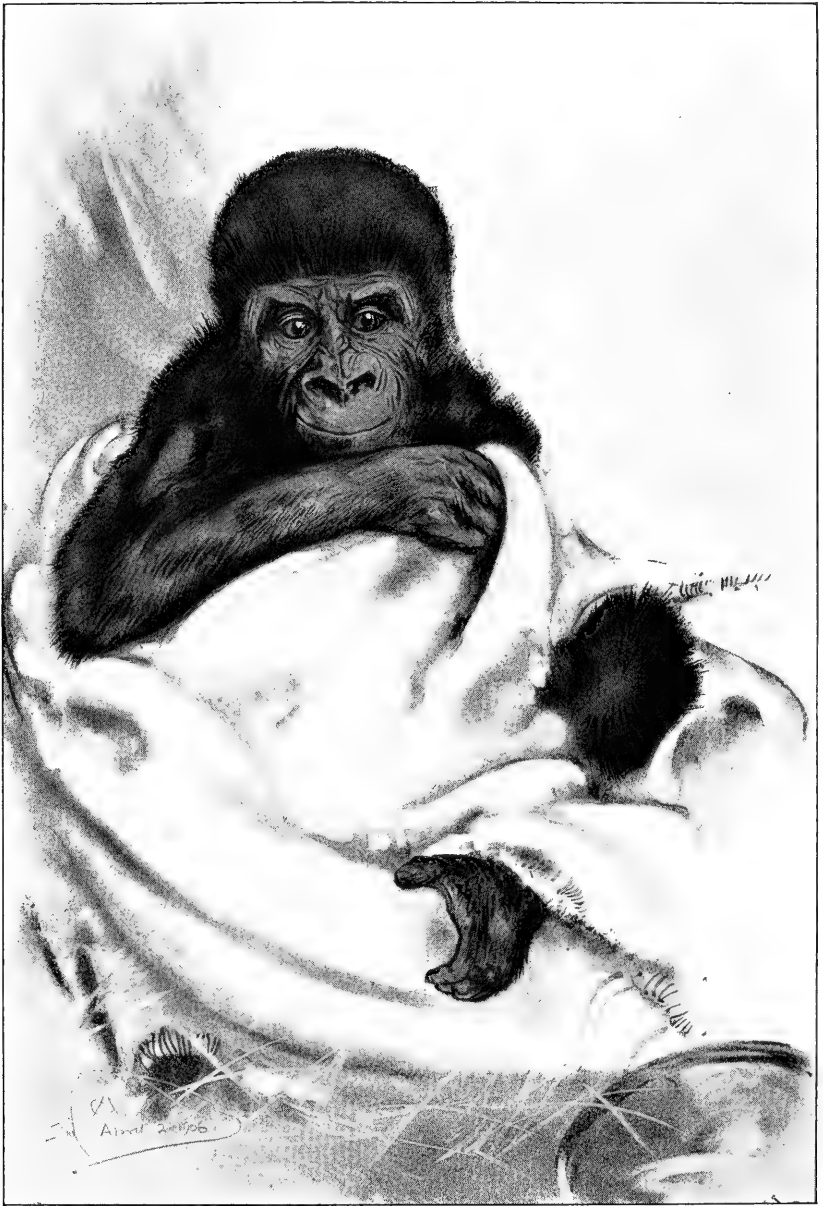
[NOTE.—I am indebted to Mr. F. E. Beddard for kindly drawing my attention to several facts observed by him in certain Lacertilia and Ophidia which at first sight suggest that the blood-flow in the "renal-portal" and certain abdominal veins is directed *posteriorly* and not anteriorly, as is generally assumed. To settle this point at least for the Frog I performed the following experiment—more for my own satisfaction than because I have any reason to believe that it has not been performed before, as doubtless it has been. I pithed a frog, destroying both the brain and spinal cord and then removed as much as possible of the body-wall both ventrally (leaving of course a strip on each side of the anterior abdominal) and dorsally and of the viscera without injuring any large vessel. I then laid the frog, ventral side upwards and somewhat to one side, on a microscope stage powerfully illuminated from below, and with fine forceps gently pulled into the line of reflected light first the anterior abdominal and then the post-renal. The heart still beating vigorously, the blood could easily be observed, even under the low power, rushing *anteriorly* in both the post-renal and the anterior abdominal veins. I repeated the experiment several times on the frog and once on the newt, always with the same result. But the particular modes of disposition of the posterior veins observed by Mr. Beddard differ from the condition found in the frog, newt, and most amphibia and reptiles in that the post-renals, instead of wholly emptying themselves into the kidney-substance, are continued anteriorly for some distance and apparently terminate by small branches (resembling factors) in the parietal muscles (see Beddard, "Contributions to the Anatomy of the Lacertilia," P. Z. S. 1904, vol. ii. p. 15, text-fig. 4; also P. Z. S. 1906, p. 38, text-fig. 10, and P. Z. S. 1906, p. 511, text-fig. 90). In *Pygopus lepidopus*, to take a conspicuous example from the first of the papers just referred to, not only the left post-renal terminates in this manner (the right terminating as in the frog), but also the two lateral abdominals—two veins arising from the femorals and running anteriorly and laterally in the body-wall for a short distance in front of the kidneys and terminating in what appear to be factors. Now I fully admit the *possibility* (though not the probability) of the blood flowing posteriorly in the lateral abdominals and in the anterior prolongation of the left post-renal (this latter in such a case being comparable to a dorso-lumbar, the blood, flowing posteriorly and meeting with the anterior blood-flow in the post-renal proper, being forced into the afferent kidney veins by the resulting pressure—see Shore on an abnormal anterior prolongation of the "renal-portal" in the Frog, Jour. Anat.

Physiol. vol. xxxiv. p. 399); but it seems to me certain that the blood must flow anteriorly in the main portion of the post-renal and in the anterior abdominal. My reasons are these: In the first place, if the blood-flow in the post-renal is posterior, then this vein should open into the femoral in a very different manner from what it does, since, as Mr. Beddard figures it, the streams of blood in the post-renal and femoral would in such a case be in direct opposition with no adjacent sinuses into which the blood could be forced in consequence of the resulting pressure (*cf.* the superior and inferior abdominals of the Crayfish among other instances). Secondly, the inclination of the *venæ renales advehentes* is, the same as in *Rana*, on both sides of the body of *Pygopus*—the inference being that the blood-flow is in the same direction as in *Rana*. Thirdly, if the blood-flow is posterior in the post-renals of *Pygopus*, then the *venæ renales advehentes* must be regarded as factors of the post-renal, and the only source from which these factors could derive their blood is the arterial supply of the kidney, whence the obvious question: where does the post-caval obtain its blood from?—the arterial blood of the kidney being wholly or largely abstracted by the factors of the post-renals. Fourthly, the supposition that the blood-flow is posterior in the post-renals is negatived by the small size of the anterior abdominal vein, into which the blood would, in such a case, have to be poured. But extraneous considerations prove that little weight is to be attached to the supposition that because the post-renals and lateral abdominals terminate anteriorly by venules in the muscle-substance, therefore the blood-flow is from the venules to the main trunk. Lewis in the paper before referred to (footnote on p. 889) shows that the contrary is the case in the sinusoidal system of the myocardium—the lumen of the vein being broken up by intrusion of the muscle-tissue in the same manner as the delta system of a river is formed by terrestrial impediments and the stream of fluid being in the same direction in both cases. Further, in the preceding paper on the anatomy of *Centrophorus*, I have myself described, in the caudal supra-neural, an undoubted case of this splitting-up of a vein in the parietal muscle-tissue to form a sinusoidal system which is apparently purely mechanical in origin.]

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YOUNG FEMALE GORILLA.

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December 11, 1906.

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

The Secretary exhibited a black-and-white sketch of a young female Gorilla (Pl. LXIII.), made by Mr. Carton Moore-Park, R.B.A., F.Z.S., from an animal that had lived for a few weeks in the Society's Gardens in 1906. He stated that most of the published figures of Gorillas appeared to represent more adult animals. Young Gorillas were much more human, and more gentle and intelligent than was generally supposed.

Mr. H. B. Fantham, B.Sc., F.Z.S., exhibited original drawings of “*Trypanosoma*” *balbianii* (Certes), showing apparent cilia, which might, however, be only threads of the sheath or undulating membrane which had become ruptured. These were first seen in this organism by M. Fred Vlès and himself at Roscoff this summer. This parasite, which occurs in the crystalline style of the Oyster, was compared with various Spirilla and Spirochetes, and its systematic position among the Protista was discussed.

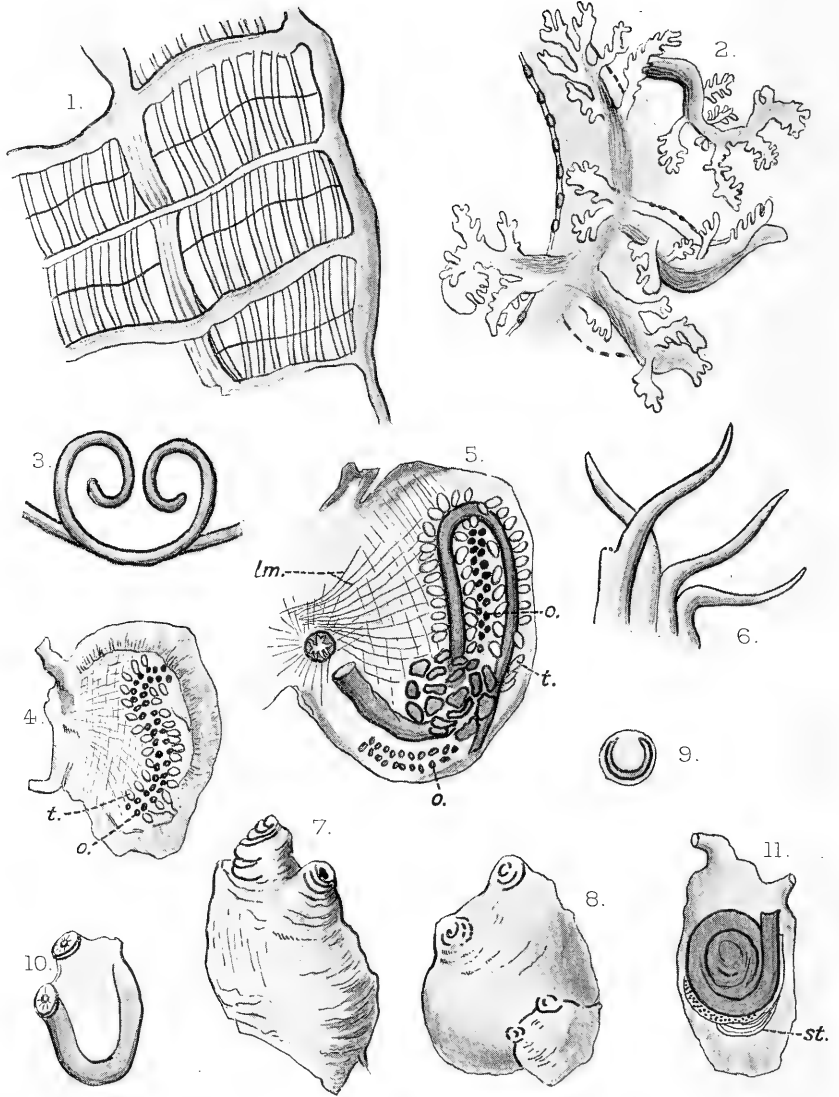
Mr. F. E. Beddard, F.R.S., F.Z.S., exhibited and made remarks upon some examples of the Earthworm (*Benhamia johnstoni*) from Mt. Ruwenzori, which had been entrusted to him for study by Mr. W. R. Ogilvie-Grant.

Mr. J. L. Bonhote, F.Z.S., exhibited one of the innermost secondaries of the Knot (*Tringa canutus*) taken from a bird in his aviaries. The specimen was remarkable from the fact that the summer feather, instead of being cast at the autumn moult, was

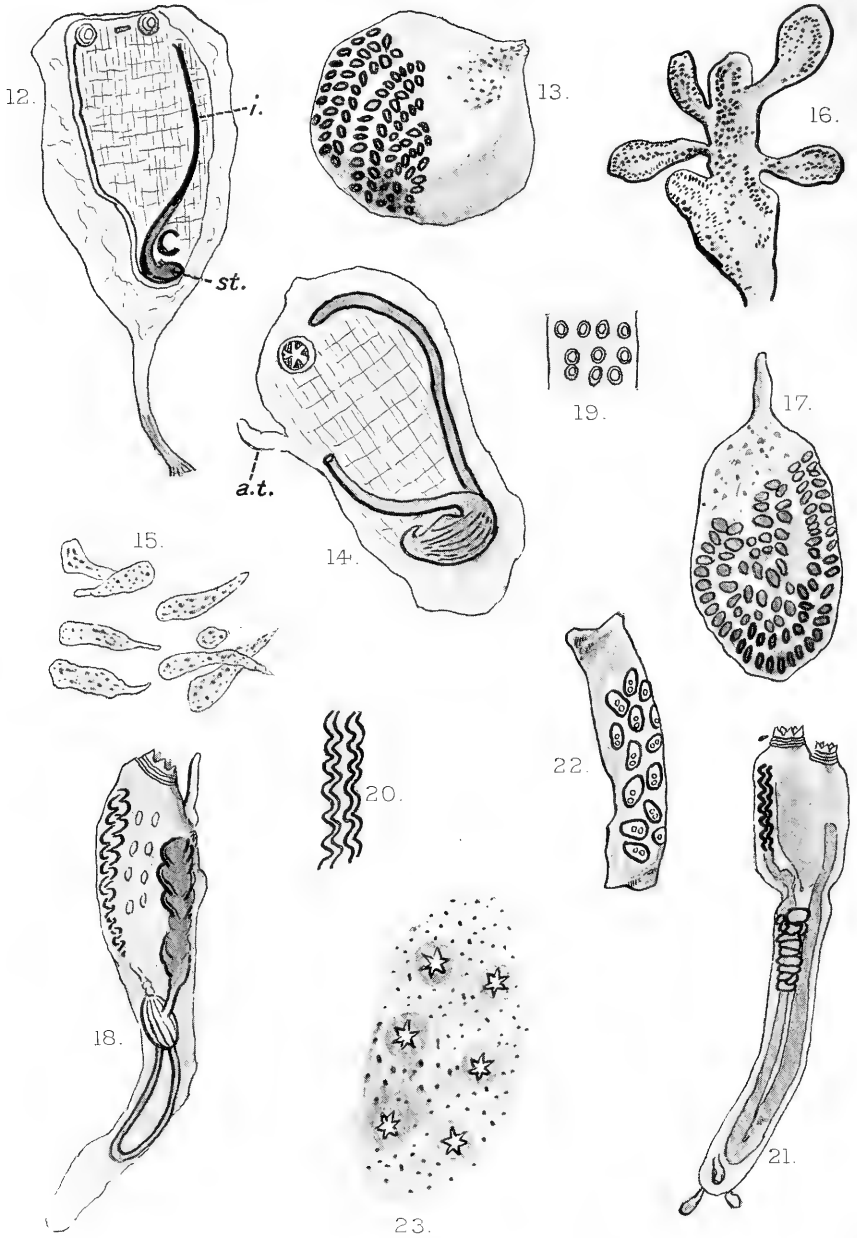
continuous with the new autumn feather; it did not merely adhere to the tip of this latter, but the shaft was continuous and the barbs were forming at the proximal extremity; the white tip of the winter feather formed also the light base of the summer feather. The summer feather was rather shorter than in the normal condition, and possibly was not fully grown when the autumn moult intervened.

Mr. R. I. Pocock, F.Z.S., Superintendent of the Gardens, exhibited the rattle formed of modified quills in the tail of a Porcupine, *Hystrix cristata*, and pointed out that the organ must be classed functionally in the same category as the rattle of the Rattlesnake and the stridulating organs of some Scorpions and large Spiders, that is to say, its use was aposematic. He continued as follows:—The behaviour of Porcupines at night when prowling abroad is quite different from that of most nocturnal animals. Instead of being silent in their movements like the latter, they seem to make as much noise as possible, rattling their quills and uttering hoarse guttural grunts, both of which sounds can be heard at a considerable distance. Their proximity is also advertised in another way, namely, by the whiteness of their quills, which when erected in the characteristic fan-like manner are quite conspicuous in the dark and enable the observer to locate the animal accurately, which the crepitation of the quills alone is incapable of doing. Warning or aposematic attributes are characteristic of poisonous or nauseous animals which nevertheless may be readily killed or damaged by the attack of more powerful animals ignorant of the protective attributes of their prey, and of the risk of injury they themselves run in attempting to seize it. Porcupines, in spite of their spiny armature, are easy to kill on account of the extreme thinness of the skin which can be torn to shreds with the greatest facility. A dog trained to the work will shake one to pieces in a few seconds when he has once taken hold below or in front of the spiny area, as Mr. Pocock has been informed by Mr. Simons, one of the collectors employed in S. Africa by Col. Sloggett, D.S.O., F.Z.S. This correlation between the defensive spine armature and the facile destructibility of Porcupines accounts, on the theory of aposemasy, for the advertising characteristics of the animals.

The same explanation must be extended to the Brush-tailed Porcupines (*Atherura*), of Africa and India, which also possess rattles formed of modified quills on their tails and display a conspicuous white blaze by elevating the spines on the lumbar area of the back. On the other hand, the North-American Porcupine (*Erethizon*), and the prehensile-tailed South and Central-American species (*Coendu*), which are without the rattle but have the spines thickly interspersed with hairs, are known to be procryptically coloured amongst the branches and foliage of trees. When, however, the animals are disturbed they raise their spines and become visible at once by the display of the white or red colour at their



ASCIDIANS FROM CAPE VERDE.



ASCIDIANS FROM CAPE VERDE.

bases near the skin. A similar combination of procryptic coloration when at rest and of aposematic coloration when disturbed, is shown by the large Indian Mygaloid Spider *Pecillotheria* and by many of the Lycosidæ*.

The above-mentioned facts and theories are based upon observations of the Porcupines that have lived during the past three years in the Society's Gardens.

Dr. C. G. Seligmann, F.Z.S., exhibited two skulls of male Domestic Sheep, and made the following remarks:—The two heads shown contrast the form of skull of the normal ram of the Herdwick breed (in which only the males have horns) and a ram of the same age and breed castrated in infancy. The skull of the castrated sheep or wether is less rugged and the bones thinner, but besides such general differences and the obvious absence of horns the plane of the os frontis is continued backwards behind the orbits at a very obtuse angle. In the skull of the normal ram the plane of the frontal behind the orbit lies almost at right angles with the interorbital portion of the bone, the horn-cores arising from the upper or horizontal area. Although the skull generally is thicker in the normal ram than in the wether, this alone does not account for the difference in external form, seeing that the cranial cavity presents a corresponding extension in the frontal region. It is worth noting that the conformation of the skull of the castrated animal resembles that of the hornless ewe of the breed.

The following papers were read:—

1. On Collections of the Cape Verde Island Marine Fauna, made by Cyril Crossland, M.A. (Cantab.), B.Sc. (Lond.), F.Z.S., of St. Andrews University, July to September 1904.—THE ASCIDIANS. BY JOHN RENNIE, D.Sc., and HARRY WISEMAN, M.A., B.Sc., University of Aberdeen.†

[Received October 12, 1906.]

(Plates LXIV. & LXV.‡)

This memoir deals with the Ascidians collected by Mr. Crossland at Cape Verde in the year 1904. Although a fairly abundant supply of material was secured, it has not proved particularly rich in species. In all, examples of only ten forms were collected, two of which appear to be new to science. Notes regarding localities are meagre; most of the specimens appear to have been obtained at Mattiota, St. Vincent Harbour.

* See Pocock, Ann. Mag. Nat. Hist. (7) iii. p. 84, 1899.

† The expenses of Mr. Crossland's collecting trip were borne by the Carnegie Trustees.

‡ For explanation of the Plates see p. 910.

Description of Species.

TUNICATA Lamarck, 1816.

Order I. ASCIDIACEA Blv. 1827.

Sub-Order 1. Ascidiæ Simplices.

Family HALOCYNTHIDÆ Verrill, 1879.

(Cynthiidae Savigny, 1816.)

HALOCYNTHIA RUBRILABIA Verrill. (Plate LXIV. figs. 1-6 & 8.)

This species was represented by a fair number of specimens, the external characters of which agree well with previous descriptions. The four-lobed branchial and atrial apertures are conspicuous. The average height is 34 mm., width 22 mm. The reddish test is conspicuous only in a few specimens, most appearing of a dull dirty white colour. The inner surface of the test is smooth and glistening. The mantle is very thin except where the muscular strands are present. These are very numerous and exhibit a regular arrangement, the longitudinal bands radiating excentrically from near the atrial opening (fig. 5) and forming a network over the branchial sac (fig. 1). Of some interest is the fact that the tentacles are compound, presenting some degree of complexity (fig. 2). Van Name's specimens from Bermuda were "simply pinnate . . . and of various sizes." We observed none in this species which could be so described. The dorsal tubercle shows a pair of well-curved horns (fig. 3). The ovary is yellowish in colour; the testes are pale and club-shaped. These glands form a double row on both sides of the animal, and in most cases the serial arrangement is very noticeable (figs. 4 and 5).

Locality. Attached to bottom of lighter, St. Vincent Harbour. Formerly recorded from Bermuda, adherent to stones, shells, corals, &c., common in shallow water.

STYELA PARTITA Stimpson. (Plate LXIV. figs. 7 & 9.)

Several examples of this species were found. From earlier accounts (Verrill, Van Name) it is evidently very variable in all parts of its range. The Cape Verde examples agree well with Van Name's description of Wood's Hole specimens. Mr. Crossland supplies a note that externally they were "yellow on a dark brown ground." At Bermuda they are, according to Van Name, "more or less reddish or brownish yellow, or greyish yellow, becoming brown or red on the upper surface, especially about the siphons." Verrill's "alternate striping of red and white in the apertures" has not been observed in the present examples. They measure about 43 mm. long and 26 mm. wide. The test is coriaceous, varying from 2 to 4 mm. in thickness. It is roughest around the apertures. The number of tentacles is about sixteen, and they appear uniform in size. These, however, according to Van Name, are variable characters depending upon size and age.

He has observed from about 30 to 50 and of different sizes. The dorsal tubercle (fig. 9) is elevated and horseshoe-shaped. The horns are simple and only slightly inturned. The gonad of the left side of the body is larger than that of the right. The ovary is a sinuous coil of pale colour; the testes are numerous and club-shaped.

Family ASCIDIIDÆ Herdm. 1880.

ASCIDIA OBLIQUA Alder. (Plate LXIV. figs. 10 & 11.)

External appearance.—The shape is oval, the anterior end being rather narrower than the posterior rounded surface. The body is somewhat compressed laterally and is attached by the posterior half of the left side. A terminal branchial aperture with 8 lobes and an atrial opening with 6 lobes are both present on the dorsal edge. The general colour is light grey.

Dimensions of specimens measured:—

	1.	2.	3.
Length	3.2 cm.	2.9 cm.	2.5 cm.
Breadth.....	1.4 cm.	1.6 cm.	1.4 cm.

The test is gelatinous and translucent. A marked U-shaped fold is very characteristic of the right side (fig. 10).

The branchial sac has no longitudinal folds, is very tough and not easily torn. Narrow transverse vessels are present.

The stigmata are straight and number from 4 to 6 in a mesh. Meshes are numerous. There are finger-shaped lobes at the branchial and atrial openings.

The dorsal tubercle is curved, with inturned horns.

The tentacles are very numerous, long and filamentous.

In this species the outline of the mantle shows conspicuously through the test. The stomach is longitudinally ribbed (fig. 11). The genitalia lie in regular rows round the outer curve of the intestine (fig. 11.)

Family CLAVELINIDÆ Forbes, 1853.

ECTEINASCIDIA TURBINATA Herdm. (Plate LXV. fig. 12.)

The description in the 'Challenger' account applies to the specimens of this species.

Measurements of specimens:—

	1.	2.	3.
Length	1.2 cm.	2.2 cm.	2.8 cm.
Breadth of anterior end ...	0.5 cm.	0.9 cm.	1.0 cm.

The branchial sac occupies most of the space within the test, is not folded, and possesses distinct longitudinal bars. Papillæ are not present on the longitudinal bars, but there are numerous lappets projecting inside the sac.

The tentacles are very numerous, simple and filiform, with very minute tubercles present on them. They are of two dimensions.

The stomach is small, and the intestine after leaving it runs for a short distance anteriorly, then slopes across the left side of the posterior part of the branchial sac from the ventral to the dorsal edge and is continued anteriorly as a dark-coloured rectum.

Sub-Order 2. *Ascidia Composita* Savigny, 1816.

Family BOTRYLLIDÆ Giard, 1872.

SARCOBOTRYLLOIDES WYVILLII Herdm. (Plate LXV. figs. 13–15.)

Colony.—Six colonies came under observation. Each colony is onion- or balloon-shaped, slightly incrusting with, in some cases, a short tapering peduncle. The colonies had been attached to soft slimy-looking débris, which still adheres in places.

Sizes of colonies:—

	1.	2.	3.	4.	5.
Length ...	1.15 cm.	0.7 cm.	0.65 cm.	0.7 cm.	0.65 cm.
Breadth...	1.0 cm.	0.8 cm.	0.75 cm.	0.85 cm.	0.8 cm.

The ascidiozooids are aggregated on the upper hemisphere and appear black or very dark purple in the preserved specimens. In their natural state the colonies show “yellow lines on a dark brown ground.” There is a fairly definite distribution of the zooids of each colony. Two or three rows of alternating paired zooids are diagonally inclined across the inner surface of the common test, while shorter rows of paired zooids fill up the intermediate space and complete the occupation of that part of the hemisphere.

Ascidiozooids (fig. 14).—The ascidiozooids are not much elongated antero-posteriorly and are slightly inclined to the surface of the test. An anal tentacle is present. Of two individuals measured the following dimensions were found:—

	1.	2.
Length	2.0020 mm.	1.8326 mm.
Breadth (abdominal).....	0.6468 mm.	0.8624 mm.
Breadth (thoracic)	0.8932 mm.	1.0318 mm.

There are also present numerous smaller individuals about half the dimensions of the larger ones.

The test is gelatinous, and swollen at that part where the colony is congregated. It is transparent or translucent in places, especially at the peduncular region and round the margin of the colony. Club-shaped vascular appendages with swollen end-bulbs (fig. 15) and filled with blood-corpuscles penetrate the matrix of the test and are very numerous.

The mantle is stout. Muscle-bands form an irregular network.

The branchial sac is well developed. Longitudinal bars are present internally and divide the inner surface into meshes. The stigmata are straight and there are six in a mesh; they are

quite regularly arranged, of elongated elliptical shape, and about as wide as the longitudinal vessels between them.

The tentacles are 16 in number, 8 large and 8 small.

The dorsal lamina is a plain narrow membrane.

The dorsal tubercle is a small circular aperture.

The alimentary canal is somewhat posterior to the branchial sac, thus making two imperfectly defined regions to the animal. The stomach is dilated and has from 4 to 5 longitudinal striations on each side.

Reproductive organs lie alongside the alimentary canal.

Three small colonies were found at 3 fathoms depth.

Herdman's specimens differ from the foregoing in minor particulars only; the colony examined by him is larger and also irregular in form, while the present examples are quite definite in shape. The ascidiozooids of the Cape Verde specimens appear to be in most cases larger than those of the type of the species. Lastly it is of interest to note that Herdman's examples from the North Atlantic occurred at 363 fathoms; the Cape Verde specimens were found in comparatively shallow water, viz. 3 fathoms.

SARCOBOTRYLLOIDES PARVUM, sp. n. (Plate LXV. figs. 16 & 17.)

The colony consists of a number of lobed fleshy masses united to a common trunk by short stalks (fig. 16). Ascidiozooids are present throughout the whole investing test. The size of a single lobe of the colony (fig. 17) is—length 12·5 mm., breadth 6 mm., and thickness 3 mm. The colour of the whole (spirit specimen) is pale purple, translucent between the ascidiozooids and around the margins. The ascidiozooids are brick-red in colour, are very minute and lie in elongated double rows; no common cloacal aperture was seen.

Dimensions of ascidiozooids:—

	1.	2.	3.
Length	1·078 mm.	1·232 mm.	0·770 mm.
Breadth.....	0·539 mm.	0·462 mm.	0·385 mm.

The test is firm; it is penetrated by many bulbous vessels which are of a reddish-purple colour like the zooids themselves. The vascular bulbs are readily seen, relatively large, ovate, rounded and spindle-shaped. Numerous corpuscles are present in the bulbs. The branchial sac is large; there are seven stigmata in a dorso-ventral row. The dorsal lamina is a plain membrane. The tentacles are about eight in number.

The branchial and atrial apertures are near each other and are almost terminal.

The alimentary canal lies alongside and at the posterior end of the branchial sac. The stomach has ten longitudinal folds. The gonads lie on each side of the branchial sac.

The material is badly preserved, and some points could not be made out with certainty, *e.g.*, the number of tentacles or the characters of the dorsal tubercle.

Family DISTOMIDÆ Giard, 1872.

DISTOMA CAPSULATUM Van Name. (Plate LXV. fig. 21.)

The colony is incrusting, more or less lobed, light brown or greyish in colour, permeated with amorphous calcareous particles. Size 25 mm. by 14 mm. and about 5 mm. in thickness.

The test is semi-cartilaginous, no systems are apparent, and the zooids are relatively few in number.

The ascidozooids (fig. 21) are elongated antero-posteriorly and divided into a short branchial and a long abdominal region. The branchial region measures 1.25 mm. and the abdominal is more than twice as long.

The mantle is highly muscular. The muscles are arranged in well-defined longitudinal and transverse bands on the surface of the pharynx.

The branchial sac is short, and the branchial aperture is 6-lobed. This aperture is apparently capable of being everted. The endostyle is large and undulating. In the young forms the separation between branchial and abdominal regions is not clearly marked.

The atrial aperture, placed a short distance behind the branchial, is also 6-lobed.

The tentacles are simple and fairly numerous.

Vascular processes arise from the posterior end of the abdomen. The hepatic glands surrounding the intestine consist of numerous tubules on the anterior portion of the intestine.

Only a small colony was found, and it is doubtfully placed in this species. The characters made out agree well with Van Name's description of the type, although some points remain unverified for lack of satisfactory material.

Previously recorded from Bermuda below extreme low-water mark.

Family POLYSTYELIDÆ Herdman, 1886.

SYNSTYELA INCRUSTANS Herdm. (Plate LXV. fig. 22.)

Two colonies referred to this species came under observation. One of these spreads over *Styela corrugata*, covering about 6 sq. cms. of surface and varying in thickness from 1 to 2 mm. The other colony was attached to the tube of a Sabellid worm in an investing mass of about 3 sq. cms. Slight differences in external appearance occur in both these colonies. The mass which covered the simple ascidian was tough in texture and dirty white in colour. The zooids did not project above the common surface of the colony; they are oval, and in length measure 2.5 mm., in breadth 1.5 mm. A distinct bluish tinge is noticeable in those zooids which cover the tube of the Sabellid worm. Each zooid is slightly elevated, and there is a more distinct separation between each animal than in the first mentioned colony. The size of each individual is about 6-7 mm. in length and 2-3 mm. broad.

The test contains vascular bulbs, and rosette-shaped spicules are sparsely present.

The branchial and atrial openings are not closely apposed and are slit-like without lobes, both being present on the exposed surface of the zooid.

A well-developed branchial sac shows distinct longitudinal bars, straight stigmata, and a dorsal lamina with a plain membrane.

The alimentary canal lies alongside the branchial sac. The stomach is longitudinally ridged and has a cæcum.

The dorsal tubercle is oval.

The tentacles are simple.

In branchial stigmata, lamina, tentacles, tubercle, bars, &c., these two specimens agree with Herdman's description.

The apertures are distinctly slit-like and there is no suggestion of lobes.

Family POLYCLINIDÆ Giard, 1872.

AMAROUCIUM CROSSLANDII, sp. n. (Plate LXV. figs. 18-20.)

The colony is fleshy and incrusting, and from its base of attachment it grows up in an irregular convex manner towards the top. The colour is a dirty yellow. The surface is smooth and glistening. The length is about 6.5 cm. and breadth 4.6 cm. and thickness .5 cm.

The ascidiozooids are about 1.5 mm. long, are slender and club-like, terminating posteriorly in a bluntly rounded end (fig. 18). They lie at right angles to the surface of the test. Each is divided into three regions—branchial, abdominal, and postabdominal. The branchial aperture is terminal and 6-lobed; the atrial, which is situated dorsally, has a long languet. The zooids occupy cavities in the test, which have each a separate opening to the exterior. These openings occur in no definite arrangement. The zooids in some instances were found extruded through these apertures. The upper part of the test is soft and fleshy and surrounds the branchial and abdominal regions of the animal. The lower part is tough, and in it is embedded the postabdominal portion of the animal. The postabdomen is comparatively short.

The test as already noted is firm and cartilaginous in the lower part of the colony and soft and gelatinous in the upper part. It is semitransparent and contains very few vessels. Terminal bulbs are present.

The mantle musculature, which forms an irregular network, is well developed, particularly the longitudinal bands.

The branchial-sac stigmata, in young specimens, are small, oval, and fairly numerous (fig. 19), but longer slit-like stigmata are present in older individuals. Numerous papillæ project from the sac into the branchial chamber. Longitudinal bars are absent.

The endostyle is large and conspicuous and has a regularly undulating course (fig. 20).

The dorsal lamina is formed of a large number of closely

placed languets. Both languets and branchial papillæ resemble each other in size.

The tentacles are simple and few in number, probably 8.

The dorsal tubercle is an oval slit.

The alimentary canal is of an opaque, greyish-yellow colour. The stomach has 10-12 longitudinal folds. The rectum is long and wide.

Three small pieces were found. The most distinctive characters of this species appear to be the presence of distinct branchial papillæ, the number of stomach-folds, and the short post-abdomen.

Family DIDEMNIDÆ Giard, 1872.

LEPTOCLINUM sp.

One small colony of *Leptoclinum* (Pl. LXV. fig. 23), growing on calcareous algae, came under observation. The zooids were quite disintegrated, and no diagnosis beyond that of the colony was possible.

The colony in general appearance is white. An outer layer of a thin crust and a lower layer fairly thick, gelatinous and brownish, seemed to have at one time contained the zooids.

The systems are not well defined.

Common cloacal apertures are not apparent.

The branchial apertures are 6-lobed.

Stellate calcareous spicules are very numerous.

Literature referred to.

HERDMAN, W. A.—Report on the Tunicata collected during the Voyage of H.M.S. 'Challenger.'

Part I. Ascidiæ Simplicis. 1882.

Part II. Ascidiæ Compositæ. 1886.

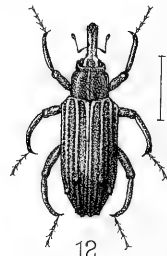
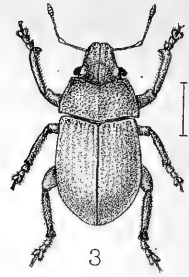
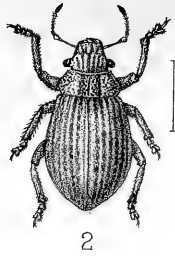
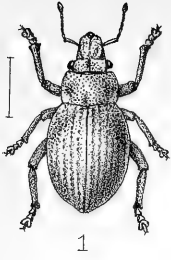
HERDMAN, W. A.—"A Revised Classification of the Tunicata." Journal of the Linnean Society, Zoology, 1891, vol. xxiii. p. 558.

VAN NAME, WILLARD G.—"The Ascidians of the Bermuda Islands." Trans. Connecticut Academy of Arts and Sciences, vol. xi. 1902.

EXPLANATION OF THE PLATES.

PLATE LXIV.

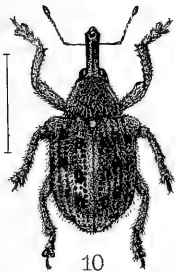
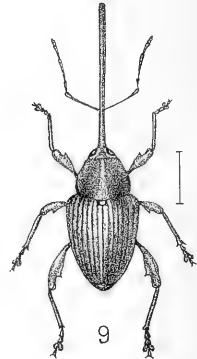
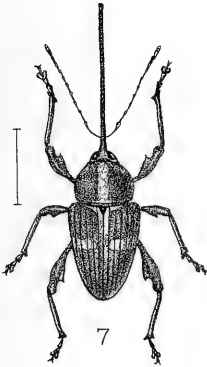
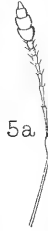
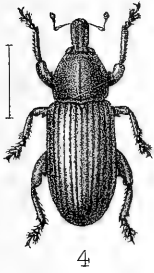
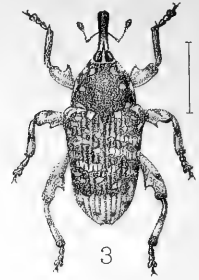
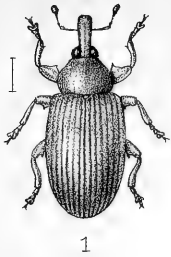
- Fig. 1. Part of branchial sac of *Halocynthia rubrilabia*. × 250. (p. 904.)
 2. Tentacles of *H. rubrilabia*. × 250. (p. 904.)
 3. Dorsal tubercle of *H. rubrilabia*. × 250. (p. 904.)
 4. Right side; 5. Left side of *H. rubrilabia*, showing ovaries (*o*), testes (*t*), intestine (*î*), and renal organs (*r*). × 40. (p. 904.)
 6. Dorsal lamina showing languets of *H. rubrilabia*. × 250. (p. 904.)
 7. *Styela partita* Stimpson. × 2. (p. 904.)
 8. *Halocynthia rubrilabia* Verrill. × 2. (p. 904.)
 9. Dorsal tubercle of *Styela partita*. × 220. (p. 905.)
 10. *Ascidia obliqua* Alder. × 1. (p. 905.)
 11. Dissection of *Ascidia obliqua* showing coils of intestine, stomach, and gonads. × 1. *st*, stomach. (p. 905.)



Horace Knight del. et lith.

West, Newman imp.

NEW AFRICAN CURCULIONIDÆ.



Horace Knight del. et lith.

West, Newman imp.

NEW AFRICAN CURCULIONIDÆ.

PLATE LXV.

- Fig. 12. *Ecteinascidia turbinata*, showing stomach (*st*) and intestine (*i*). (p. 905.)
 13. Colony of *Sarcobotrylloides wyvillii* Herdm. × 5. (p. 906.)
 14. Zooid of do. × 48. *a.t.*, anal tentacle. (p. 906.)
 15. Vascular bulbs from test of do. × 220. (p. 906.)
 16. Colony of *Sarcobotrylloides parvum*, sp. n. × 5. (p. 907.)
 17. Lobe of colony of *S. parvum*. × 10. (p. 907.)
 18. Zooid of *Amaroucium crosslandii*, sp. n. × 20. (p. 909.)
 19. Stigmata of *Amaroucium crosslandii*. × 48. (p. 909.)
 20. Endostyle of *Amaroucium crosslandii*. × 48. (p. 909.)
 21. Zooid of *Distoma capsulatum* Van Name. × 48. (p. 908.)
 22. Colony of *Synstyela incrustans* Herdm. × 1. (p. 908.)
 23. Portion of surface of a *Leptoclimum* colony. × 48. (p. 910.)

2. On New Species of African Coleoptera of the Family
 Curculionidæ. By GUY A. K. MARSHALL, F.Z.S.

[Received October 5, 1906.]

(Plates LXVI. & LXVII.*)

The following is a list of the species dealt with in this paper:—

Ectatops sheppardi.	Hypsomus parvus.
Strophosomus salisburyensis.	Bagous punctipennis.
" binotatus.	" beiranus.
" sulcatifrons.	" humeralis.
" acuticollis.	" senegalensis.
Platycoptes alfredensis.	" promontorii.
" tuberculatus.	Phacemastix trinotata.
Piazomias varicolor.	" pardalis.
" deceptor.	" poultoni.
" pratensis.	Aplemonus zizyphi.
Rhinosophus mutabilis.	Euops cyaneus.
Catamonus tristis.	Balaninus nubifer.
Systates dentipes.	" ficorum.
Ellimenistes callosicollis.	" aurivillii.
Zeugorygma (g. n.) hirta.	" barkeri.
" orangæ.	" diversicornis.
Hipporrhinus mendicus.	Euderus natalis.
" impressicollis.	Euderoides (g. n.) mossambica.
" monilis.	Neiphagus mashunus.
" dispar.	Pachyonyx niveus.
" foveolatus.	" triangularis.
" montanus.	Endeus floralis.
" purrelli.	" bauhiniae.
Cyclomus algoensis.	" hispidus.
" simplex.	Acanthorrhinus carinatus.
Myorrhinus longstaffi.	" zambesianus.
Rhyparosomus mashunus.	" And
Diabathrarius setulosus.	Cyrtorrhinus castaneipennis Boh.
" velutinus.	

ECTATOPS SHEPPARDI, sp. nov. (Plate LXVI. fig. 1.)

Long. $5\frac{1}{5}$ –9, lat. $2\frac{2}{5}$ – $4\frac{2}{5}$ mm. †

Colour black, densely and uniformly covered with pale grey scaling which usually has a decided pinkish reflection; scales on the tarsi often with a pale green reflection.

* For explanation of the Plates, see p. 958.

† All length measurements are exclusive of the rostrum.

Head strongly transverse; forehead with a deep central furrow, but without any supra-ocular tubercle; eyes very prominent and subconical in shape. *Rostrum* separated from head by a deep transverse furrow, as long as broad, the sides straight and slightly narrowed from base to apex; upper surface plane, with five short and rather shallow longitudinal impressions in the basal half which are more or less hidden by the dense scaling. *Antennæ* densely squamose, the scape reaching the posterior margin of eye, the two basal joints of the funicle subequal. *Prothorax* much broader than long, basal margin faintly bisinuate, apical margin narrower and truncate, sides moderately rounded and broadest about middle; upper surface convex, rugosely punctured throughout and with a very short longitudinal impressed line in the middle of the base. *Elytra* subovate, with a shallow basal constriction, the basal margin jointly emarginate, subacuminate at apex; sides rounded, broadest not far from base owing to the presence of a low rounded prominence on the inflexed margin below the shoulders; upper surface convex, steeply declivous behind, with deep punctures forming three regular rows near the suture, but irregular laterally especially in the basal half, the intervals smooth and impunctate. *Legs* stout, densely squamose; tibiæ sparsely pilose, not crenulate internally, but with from three to six stout spine-like setæ on the apical half; tarsal claws connate at base.

PORT. E. AFRICA: Beira (*P. A. Sheppard*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

Much smaller than *E. cinerosus* Fähr., which differs in having a prominent supra-ocular tubercle and a much more elongate prothorax with a deep central furrow; the eyes are not conical, the punctuation of the elytra is in regular rows throughout, and the tibiæ are distinctly crenulate and densely pilose.

Through the kindness of Mr. Sheppard I have been able to examine a good series of this species, which varies considerably in size.

STROPHOSOMUS SALISBURIENSIS, sp. nov.

Long. $5-6\frac{1}{5}$, lat. $2\frac{2}{5}-4$ mm.

Colouring extremely variable, being either uniform grey, or grey mottled or striped with brown, or light brown mottled with dark brown and grey; thorax always with two paler stripes, and two pale spots adjoining them at the base of the elytra.

Head almost plane, closely punctured and with a broad and deep central furrow; eyes rather prominent, rounded, the posterior margin of the orbit produced into a short sharp point. *Rostrum* separated from head by a deep subarcuate furrow which does not reach the margin, gradually narrowed from base to apex, the sides straight; upper surface plane, with two broad deep oblique sulci which join the basal furrow at a little distance from each other. *Antennæ* rufescent with the club fuscous; second joint of the funicle distinctly longer than the first. *Prothorax* moderately transverse, base and apex of equal width and both truncate, sides

slightly rounded, broadest at middle; upper surface convex, with a shallow transverse impression before middle, somewhat closely set with small low granules and with a faint narrow central carina. *Elytra* subglobose, truncate at base, basal angle not prominent, sides strongly rounded, broadest rather before middle; upper surface very convex, with shallow striae containing rows of deep separated punctures, the intervals broad, almost plane, smooth and devoid of true setæ. *Legs* moderate, similar in the two sexes, the anterior tibiæ shallowly sinuate internally.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

This species is the local representative of *S. lineatus* Fähr., which occurs commonly in Matabeleland and which may be distinguished from it by the following characters:—Its more prominent eyes; the entire absence of the orbital projection behind the eye; the prothorax is distinctly narrowed towards the base, being broadest close to the apex; and finally the oblique rostral furrows unite at the base.

STROPHOSOMUS BINOTATUS (Est. *in litt.*), sp. nov.

Long. 8–8½, lat. 4¼–4½ mm.

Colour black, with opalescent grey scaling which is paler and denser laterally; the elytra sometimes with a more conspicuous paler spot behind middle.

Head closely punctured and with a deep central furrow; eyes prominent, rounded, but not directed backwards, the posterior margin of the orbit produced into a sharp point. *Rostrum* separated from head by a transverse furrow which does not reach the margin, and strongly narrowed from base to apex, its sides straight; upper surface plane, closely punctured, with a smoother central line and a shallow oblique basal sulcus on each side of it. *Antennæ* black, with pale pubescence; the second joint of funicle distinctly longer than the first. *Prothorax* strongly transverse, subcylindrical, base and apex of equal width, sides scarcely rounded, basal margin arcuate, apical margin broadly sinuate; upper surface convex, with a transverse impressed line close to apex and without any central carina, closely punctured and with scattered small granules showing through the scaling, which is usually denuded in the middle. *Elytra* ovate, subtruncate at base, shoulders very oblique, sides rounded, broadest about middle, apex broadly rounded; upper surface convex, with distinct deeply punctured striae, the intervals convex, smooth and devoid of setæ. *Legs* black, with dense grey scaling and short pale setæ.

MASHONALAND: Salisbury (*G. A. K. M.*). PORTUGUESE E. AFRICA: Amatonga's (*P. A. Sheppard*). GERMAN E. AFRICA.

TYPE in the British Museum.

The narrowness of the shoulders gives this insect a somewhat characteristic pear-shaped facies. It is allied to *S. lineatus* Fähr. and *S. salisburyensis* Mshl., both of which differ from it in having

the rostrum less narrowed in front, in their less transverse prothorax, which is truncate at base and apex, and in their more rotund elytra.

STROPHOSOMUS SULCATIFRONS, sp. nov. (Plate LXVI. fig. 2.)

Long. $7\frac{2}{5}$ –9, lat. $4\frac{1}{5}$ – $5\frac{1}{5}$ mm.

Colour black, with dense grey or brownish scaling, prothorax with a darker subdenuded central stripe, each elytron usually with two very faint paler spots placed obliquely about middle.

Head broad, plane, with seven broad and deep sulci, separated by narrow carinae and becoming shorter outwardly; eyes very prominent, projecting backwards and subacuminate posteriorly. *Rostrum* separated from head by a narrow curved stria which is obsolete laterally, strongly narrowed anteriorly, its sides sinuate near apex; upper surface with four deep sulci which are much broader than those on head. *Antennae* fuscous, joints 1 and 2 of funicle subequal. *Prothorax* more than twice as broad as long, apex sinuate, a little narrower than the base which is broadly curved, sides dilated into a sharp angular projection slightly behind middle; upper surface convex, coarsely and longitudinally rugose, with a complete smooth narrow central carina. *Elytra* broadly ovate, jointly sinuate at the base, with the basal angles projecting a little beyond the base of the prothorax and subacute; sides rounded, broadest rather behind middle; upper surface convex, with broad sulci containing rows of deep punctures; the intervals convex, smooth, finely aciculate and each with two irregular rows of very short subrecumbent setae. *Legs* moderately stout; anterior tibiae straight, but with the internal apical angle sharply produced.

ORANGE RIVER COLONY: Bothaville (*Dr. H. Brauns*). NATAL: Charlestown (*A. E. Haviland*). TRANSVAAL: Johannesburg (*H. Fry*).

TYPE in the British Museum.

In the twelve examples before me I cannot detect with certainty any external sexual differences.

Of the described S. African *Strophosomi* only *S. strigifrons* Fähr. and *S. plumbeus* Fähr. (which are doubtfully separable) exhibit a series of sulci on the forehead. But in these insects the sulci are more numerous and much shallower; in them also the prothorax is not angulated laterally, the elytra are much more elongate, and the striae are finer and less coarsely punctured.

STROPHOSOMUS ACUTICOLLIS, sp. nov. (Plate LXVI. fig. 3.)

Long. $4\frac{3}{5}$ – $6\frac{2}{5}$, lat. $2\frac{2}{5}$ – $3\frac{1}{5}$ mm.

Colour black, covered with dense uniform grey scaling and devoid of true setae.

Head plane, closely punctured and with a deep narrow central furrow; eyes very prominent, directed backwards and acuminate posteriorly. *Rostrum* separated from the head by a narrow

angulated furrow which is continued to the margin, comparatively elongate, strongly narrowed from base to apex, with its sides almost straight; upper surface plane, depressed in the centre and with three faint carinæ which are often more or less obsolete. *Antennæ* dark rufescent, with the club fuscous; the two basal joints of the funicle subequal. *Prothorax* strongly transverse, twice as broad as long, sides almost straight, broadest at base; apex deeply emarginate, much narrower than the base which is rounded in the middle and deeply sinuate on each side close to the exterior angles, these angles are very sharp and project well beyond the base of the elytra; upper surface gently convex, with fine confluent punctuation throughout which is hidden by the dense scaling, and with no trace of any central carina. *Elytra* oblongo-ovate, jointly and deeply emarginate at base, the basal angles sharp, prominent and subrectangular, the sides straight from the basal angle to about middle, thence roundly narrowed to apex; upper surface moderately convex in ♀, subdepressed and less steeply declivous posteriorly in ♂, in which sex also the lateral margins are more sharply inflexed, striæ with rows of shallow punctures; the intervals smooth and impunctate, almost plane in ♂, slightly convex in ♀. *Legs* thick, similar in the two sexes; anterior tibiæ straight, denticulate internally and with the apical angle very strongly produced inwardly.

ORANGE COLONY: Bothaville (*Dr. Hans Brauns*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

Nearly allied to the aberrant *S. brevicollis* Fähr., with which it quite agrees in general facies. That species however is covered with distinct erect setæ, the prothorax has a short central carina, and the legs are a good deal more slender.

PLATYCOPES ALFREDENSIS, sp. nov.

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

Dark piceous brown, with uniformly dense grey or ochreous-grey scaling, the elytra sometimes variegated with brown markings.

Head convex on vertex, flattened on forehead, finely and longitudinally aciculate, without any superciliary prominence. *Rostrum* separated from head by an angulate impression, the lateral carinæ less evident towards the base. *Antennæ* with the scape strongly dilated, its posterior margin sharply angulate not far from apex, funicle with joint 2 much longer than 1, and 7 longer than 6. *Prothorax* twice as broad as long, its base fitting closely to the elytra in both sexes; sides rounded, broadest near base, strongly constricted near apex, and with a transverse impressed line; upper surface convex, closely granulate except along the anterior margin. *Elytra* suborbicular, jointly sinuate at base in both sexes, moderately convex, the antero-posterior curvature comparatively low, slightly greater in the ♀, basal angle sharp, the sides obliquely amplified from there to the

subhumeral tubercle and rounded posteriorly; upper surface with shallow striæ containing large punctures which are partially hidden by the scaling, the intervals plane, smooth and impunctate. *Legs* normal, rather stout; anterior tibiæ a little thicker and more curved internally in the ♂ than in the ♀.

CAPE COLONY: Port Alfred (*Father O'Neil*).

TYPES, ♂ ♀ in the British Museum.

The sexual differences are slight, being confined to the anterior tibiæ and the slightly greater convexity of the elytra in the ♀; there appears to be no difference in the development of the humeral tubercle.

PLATYCOPEs TUBERCULATUS, sp. nov.

Long. $5\frac{1}{5}$, lat. $3\frac{3}{5}$ mm.

Colour black, with earth-brown scaling.

Head very short, nearly three times as broad as long, flattened and longitudinally rugose. *Rostrum* separated from head by a straight transverse impression, subquadrate, but rather narrower apically, the lateral carinæ obtuse but continued to base. *Antennæ* with the scape strongly dilated, its anterior margin only slightly curved, its posterior margin simply rounded; the funicle with joints 1 and 2, and also 6 and 7, subequal. *Prothorax* transverse, its length greater than half its breadth, broadest close to base, much narrower (but scarcely constricted) at apex, sides slightly rounded; upper surface convex, uneven, rugose and with a few indistinct tubercles. *Elytra* as broad as the prothorax and jointly sinuate at base, sub-orbicular, the sides obliquely amplified from base to the sub-humeral tubercle, which is prominent; upper surface convex, with a single regular juxta-sutural row of punctures, the remainder of the surface with large irregular punctures; each elytron with three rows of large rounded tubercles, the rows containing 5 (or 6), 4 and 4 tubercles respectively from the suture outwards, and in addition a small common tubercle on the suture not far from the base. *Legs* comparatively slender, the tibiæ sub-linear but all produced inwardly at the apex.

TRANSVAAL (*T. Ayres*).

TYPE in the British Museum.

In the British Museum (Fry Collection) there is a series of eight specimens of this very distinct species, and I have received a single example from my friend Dr. W. Horn.

Schönherr was clearly unacquainted with the marked sexual differences which occur in the genus *Platycopes*, for most of the distinctive characters which Boheman specially emphasises have merely a sexual significance.

The following synopsis of the known species may therefore facilitate identification:—

- | | | |
|----------|---|----------------------------------|
| 1. (20.) | Elytra not tuberculate, but with regular punctured striæ. | |
| 2. (15.) | Body with grey or brown scaling. | |
| 3. (4.) | Head with a prominent supra-ocular tubercle. | <i>P. gravidus</i> Pasc. |
| 4. (3.) | Head without any supra-ocular tubercle. | |
| 5. (6.) | Prothorax more raised dorsally in front | <i>P. spathulatus</i> Gyl. |

- | | | |
|-----------|---|-----------------------------------|
| 6. (5.) | Prothorax not elevated anteriorly. | |
| 7. (10.) | Posterior margin of scape sharply angulate. | |
| 8. (9.) | Prothorax not constricted or impressed near apex; first joint of funicle equal to, or slightly longer than, second. | <i>P. squalidus</i> Boh. |
| 9. (8.) | Prothorax evidently constricted and with a transverse impressed line near apex; second joint of funicle longer than first | <i>P. atfredensis</i> , sp. nov. |
| 10. (7.) | Posterior margin of scape simply rounded. | |
| 11. (12.) | Second joint of funicle evidently longer than first. | <i>P. gonopterus</i> Boh. |
| 12. (11.) | First joint of funicle as long as, or longer than, second. | |
| 13. (14.) | Rostrum not elevated dorsally; first joint of funicle equal to the second | <i>P. turgidus</i> Boh. |
| 14. (13.) | Rostrum subelevated dorsally; first joint of funicle longer than second | <i>P. pygmaeus</i> Boh. |
| 15. (2.) | Body with green scaling. | |
| 16. (17.) | Rostrum separated from head by an angulated stria. | <i>P. argyrellus</i> Sparrm. |
| 17. (16.) | Rostrum separated from head by a straight transverse stria. | |
| 18. (19.) | Elytra with an infra-humeral tubercle | <i>P. virens</i> Boh. |
| 19. (18.) | Elytra with no infra-humeral tubercle | <i>P. prasinatus</i> Boh. |
| 20. (1.) | Elytra each with three rows of large tubercles, the interspaces with large irregular punctures | <i>P. tuberculatus</i> , sp. nov. |

I have received from Father O'Neil a pair of *P. gonopterus* Boh., taken *in coitu* on *Euphorbia*. Boheman has described the ♂ only. The ♀ differs in having the basal margin of the elytra truncate and narrower than the prothorax, whereas in the ♂ the base is jointly sinuate and as broad as the prothorax, which it embraces. Owing to this the sides of the prothorax appear to be much more strongly rounded in the ♀. The latter sex also has the infra-humeral tubercle of the elytra very much more prominent; the elytra are more convex, and the legs are thinner, the posterior pairs of tibiæ not being dilated as in the ♂.

From the same indefatigable collector I have received also a pair taken *in coitu* of a species which I attribute to *P. pygmaeus* Boh., the type of which is lost. In this case the only structural differences consist in the much more convex or globose elytra and the slightly more prominent humeral tubercle of the ♀; the leg structure is practically identical, those of the ♂ being, if anything, the thinner. But whereas the ♂ is of a uniform grey colour, the ♀ is brown with the alternate intervals whitish, the stripes being more or less broken up.

The type of *P. prasinatus* Boh. is missing, but from the description this species seems to differ from *P. virens* Boh. only in the absence of the humeral tubercle. It is therefore highly probable that the former will prove to be merely the ♂ of the latter.

I examined the type of *P. alternans* Boh. at Stockholm, and certainly cannot separate it from *P. gonopterus* Boh., of which it is no more than a slight variation.

The genus *Piotypus* was founded by Pascoe (Cist. Ent. ii. 1881, p. 596) for the reception of his *P. gravidus*; but there is no character by which this species can be separated from *Platycopes*, with which it is here included.

PIAZOMIAS VARICOLOR, sp. nov.

Long. 6-7, lat. $2\frac{3}{5}$ -3 mm.

Head slightly convex, rugosely plicate and with a narrow central stria, the sculpturing more or less hidden by dense scaling; eyes lateral, almost circular. *Rostrum* about as long as head, subquadrate and not narrowed apically; upper surface plane, subrugose, plicate in the basal half, usually with a shallow depression in the middle and with a central stria continuous with that on the head, with dense scaling and short erect pale setæ. *Antennæ* piceous, with grey pubescence; scape abruptly clavate, reaching middle of eyes; funicle with first joint much longer and thicker than the rest, second as broad as third and only a little longer. *Prothorax* as long as broad, truncate at base, apical margin scarcely narrowed and slightly rounded dorsally, sides moderately rounded, broadest at middle; upper surface convex, but subdepressed in the middle, closely set with round flattened tubercles except along the median part of the anterior margin, and with a distinct narrow central furrow which reaches neither base nor apex; colour black, with dense scaling which is fuscous dorsally with two paler bands of either grey, light brown or dull gold; the underparts entirely of the same colour as the discal bands. *Elytra* ovate, the basal margin a little broader than the prothorax, truncate and narrowly elevated; sides slightly rounded, broadest about middle; upper surface somewhat convex and gradually declivous behind, with distinct deeply punctured striæ; the intervals narrow, convex, finely aciculate and with regular rows of long erect distant pale setæ; colour black, covered with dense scaling of very variable colouring, being either uniform pale sandy grey, dark grey or dull golden, or grey with darker mottling, or dark brown with a broad lateral stripe of brownish pink. *Legs* with dense grey scaling and pale setæ; tibiæ strongly crenulate internally, especially the anterior pair.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

The long erect setæ on the elytra will render this species easily recognisable.

PIAZOMIAS DECEPTOR, sp. nov.

Long. $5\frac{1}{5}$ -6, lat. $2\frac{2}{5}$ - $2\frac{1}{2}$ mm.

Head broad, slightly convex, coriaceous, not plicate, and with a narrow central stria. *Rostrum* as long as head, subquadrate, scarcely narrowed apically; upper surface plane, coriaceous, with a very short central furrow in the basal half and close to it on each side a much longer furrow which curves strongly backwards towards the inner margin of the eye; the sculpturing normally hidden by dense scaling. *Antennæ* quite similar to those of *P. varicolor*. *Prothorax* as long as broad, basal margin faintly sinuate, apical margin a little narrower and slightly lobate; sides moderately rounded, broadest at middle; upper surface somewhat convex, rugosely coriaceous, but smoother near apical margin and

with a fine abbreviated central stria; colour black, covered with dense grey or pinkish scaling and with very short subdepressed white setæ. *Elytra* ovate, jointly sinuate at base and slightly broader than the prothorax, but the margin not raised, sides slightly rounded, broadest about middle; upper surface convex, gradually declivous behind, with regular and distinctly punctured striæ; the intervals slightly convex, smooth, finely aciculate and with regular rows of short depressed white setæ; colour black, with dense even scaling, which is either pale grey mottled with pinkish brown, or greenish grey above turning to pink laterally. *Legs* with dense grey scaling and pale setæ; the two anterior pairs of tibiæ crenulate internally, posterior pair smooth.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE ♀ in the British Museum.

Very similar in general facies to the preceding species, but differing in important details, such as, the absence of the long erect setæ, the presence of the curved sulci on the rostrum, the non-plicate forehead, and the less deeply punctured and non-marginate elytra. *P. palliatus* Fähr. is a more slender insect, with the anterior legs, and especially the tarsi, much longer; the elytra are truncate at the base and the rostrum has a short carina on each side of the central furrow.

PIAZOMIAS PRATENSIS, sp. nov.

Long. $2\frac{4}{5}$ – $3\frac{3}{5}$, lat. $1\frac{1}{5}$ – $1\frac{3}{5}$ mm.

Head broad, convex, coriaceous, and with a fine central stria, with dense scaling, which is dark brown above scattered with pale squamiform setæ, and grey beneath and round the eyes. *Rostrum* as long as head and gradually narrowed from base to apex; upper surface with a central depression containing a distinct fovea which is usually connected with the cephalic stria; scaling as on head. *Antennæ* piceous, similar to those of *P. varicolor*. *Prothorax* as long as broad, base truncate, apex scarcely narrower and slightly lobate, sides rounded, broadest at middle; upper surface convex, with a distinct transverse impressed line just behind apex and a very fine central stria, which is often absent; colour black, with dense dark brown scaling and a sub-lateral and infra-lateral paler stripe on each side, also some scattered pale squamiform setæ. *Elytra* subovate, the basal margin scarcely broader than the prothorax, truncate and not elevated, sides moderately rounded, broadest rather behind middle; upper surface convex, steeply declivous behind, with distinctly punctured striæ, the intervals slightly convex, smooth, aciculate, and with rows of very short suberect pale setæ; colour black, with dense dark brown scaling which is somewhat paler laterally. *Legs* with dense scaling and pale setæ; tibiæ crenulate internally, except the posterior pair.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

Apart from its much smaller size, this insect differs from both

varicolor and *deceptor* in the shape of its elytra, which are more bluntly rounded apically and much steeper on the declivity. It is more nearly allied to the latter, but lacks the curved furrows on the rostrum.

RHINOSOMPHIUS MUTABILIS, sp. nov. (Plate LXVI. fig. 4.)

Long. $8\frac{1}{2}$ –11, lat. $3\frac{1}{2}$ – $4\frac{3}{4}$ mm.

Head almost plane above, with a deep central furrow, densely clothed with pale brownish or whitish scales and with a few scattered erect setæ; strongly constricted behind the eyes, which are subpedunculate, prominent and very convex. *Rostrum* separated from head by an angulated impressed line, about twice as long as head, but shorter than the prothorax, narrower than the forehead between the eyes, its sides slightly dilated apically; upper surface almost plane, with a very shallow central impression, the scaling dense and similar to that on head. *Antennæ* densely squamose and with scattered suberect setæ. *Prothorax* transverse, apex narrower than base, sides subparallel from base to middle, thence rapidly converging towards apex; basal margin strongly bisinuate, apical margin gently lobate dorsally; upper surface convex, with five deep longitudinal furrows, the central one straight and the costa on each side of it broad and rounded, the two lateral furrows rather sinuate and the costa between them narrower and subcarinate; the costæ with very dense pale scaling and with scattered dark setigerous punctures, the furrows dark brown. *Elytra* much broader than prothorax at base, shoulders very prominent and subrectangular; sides subparallel to middle, then rapidly narrowing to apex, the posterior declivity very steep and subcompressed; scutellum distinct, with dense pale scaling; upper surface convex, with distinct striæ containing rows of large deep punctures which are more or less hidden by the scaling, the intervals slightly convex, coriaceous, and with rows of closely-set erect dark setæ; scaling dense; colour variable: in the type form the ground-colour is light brown with an irregular angulated common dark marking before the middle and another behind the middle, the two enclosing a broad V-shaped patch of the ground-colour; these two markings are liable to become more or less obsolete; the ground-colour too varies to hoary white, and in some cases the intervals are alternately hoary white and dark brown, the dark discal markings being rather indistinct; the elytra are occasionally entirely abraded, appearing then of a shiny black colour. *Legs* with dense uniform pale brownish or white scaling and scattered setæ.

MASHONALAND: Salisbury, Umfuli R. and Rusapi (*G. A. K. M.*), Umtali (*A. Bodong*); MATABELELAND: Sebakwe (*D. Dodds*).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

The genus *Rhinosomphus* Fairm. (*Ann. Soc. Ent. Belg.* 1896, p. 463) contains only one other species (*Stigmatotrachelus guttiferus* Waterh. from Madagascar, which is a very different

looking insect, being of a rich crimson-brown colour with large patches of pure white.

CATAMONUS TRISTIS, sp. nov.

Long., ♂ $7\frac{1}{2}$ – $8\frac{1}{2}$, ♀ $10\frac{1}{2}$; lat., ♂ 3 – $3\frac{1}{2}$, ♀ $4\frac{1}{2}$ mm.

Head almost plane above, transversely wrinkled on vertex; forehead rugosely punctured and with three distinct furrows, normally hidden by dense brown scaling. *Rostrum* longer than head but scarcely as long as prothorax, stout, slightly curved and broadly dilated at apex; upper surface almost plane, closely punctured and scaled, with three fine carinæ of equal height; scrobes very deep anteriorly, broad and shallow behind, extending to anterior margin of eye. *Antennæ* piceous, with fine pale scaling and short depressed setæ; scape just exceeding posterior margin of eye; second joint of funicle longer than first. *Prothorax* transverse, apex much narrower than base, sides subparallel from base to about middle, then rapidly converging anteriorly; basal margin deeply bisinuate, anterior margin truncate; upper surface rather convex, closely and rugosely punctured, with a faint central furrow near base only; colour black or dark ferruginous, with greyish scaling more or less denuded. *Elytra* broadest at shoulders and gradually narrowed to apex, shoulders prominent, the base strongly trisinuate; upper surface with regular striæ containing rows of large deep punctures, which are normally hidden by the scaling, the intervals narrow, convex, and coriaceous, appearing much broader when the scaling is not denuded; colour dark ferruginous to black, with coarse brownish or greyish scaling (much denuded in the four examples examined) and very short subdepressed setæ. *Legs* black or piceous, rugosely punctured, and with pale scaling and setæ, which conceal the sulcus on the inner edge of the posterior pairs of tibiæ.

MASHONALAND: Mtoko's (*E. Head*), Mazoë (*J. ff. Darling*).
MATABELELAND: Sebakwe (*D. Dodds*).

TYPE in the British Museum.

A near ally of the only other South African species, *C. melancholicus* Boh. (Natal and Transvaal), from which it differs in its much more transverse thorax, which has also a much fainter central furrow; the elytra are noticeably more slender in both sexes and the shoulders more prominent; the anal abdominal segment in the ♀ is much less acute.

SYSTATES DENTIPES, sp. nov. (Plate LXVI. fig. 5.)

♂ long. $5\frac{2}{5}$ – $7\frac{1}{5}$, lat. $1\frac{4}{5}$ – $2\frac{3}{5}$; ♀ long. $5\frac{3}{5}$ – $6\frac{2}{5}$, lat. $2\frac{3}{5}$ – 3 .

Colour bronze-black, with an ill-defined lateral stripe of thin pale scales on thorax and elytra; upper surface normally bare and shiny, but in a few females it is thinly covered with pale scales; no trace of setæ.

Head convex, shining, with scattered shallow punctures, which are closer and more confluent on the forehead where there is a

small elongate fovea. *Rostrum* longer than head, slightly longer than broad, its sides quite straight and parallel to apex, the pterygia not dilated; upper surface almost plane, rugosely punctured, with a narrow central carina and the margins sharply carinate. *Antennæ* very slender, ferruginous, with the club and apices of all the joints infusate; scape very slender, cylindrical and abruptly clavate. *Prothorax* transverse (more so in ♀), broadest behind middle; sides strongly rounded in ♂, only slightly so in ♀, apex narrower than base; upper surface convex, bare, shining and without punctures or granules, sometimes with faint transverse aciculation or with traces of a central stria, lateral margin aciculate and with a stripe of pale scales. *Elytra* broadly ovate in ♀, much narrower and more elongate in ♂, truncate at base; shoulders extremely oblique; upper surface convex, with closely punctured striae, the intervals broad, convex, smooth and very finely aciculate; entirely devoid of setæ. *Legs* piceous black, with sparse pale scaling and setæ; simple in ♀, except for a shallow excavation near apex of anterior tibiae; in ♂ the anterior tibiae are thickened laterally and with a stout perpendicular tooth about middle of the inner margin, while on the underside there is a large curved tooth, the outer apical half of the tibia being deeply excavated; the intermediate tibiae have a long, slender, curved tooth before middle, while the posterior tibiae are strongly but simply curved, with their inner surface flattened.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

An isolated species, somewhat resembling *S. amplicollis* Gerst. in general facies, but the structure of the legs is very different and the elytra are not constricted at the base as in that species; further, *dentipes* differs from this and all other described *Systates* known to me in the complete absence of granules on the prothorax.

It is a common insect about Salisbury throughout the summer, feeding on various grasses.

ELLIMENISTES CALLOSCOLLIS, sp. nov.

Long. $8\frac{4}{5}$, lat. $3\frac{1}{5}$ mm.

Colour black, with the entire body and limbs densely covered with brownish-grey scaling.

Head broadly but shallowly depressed on forehead; eyes short ovate, scarcely prominent. *Rostrum* scarcely longer than head, almost as broad as long, elevated and compressed between the antennæ and with a distinct central furrow which is broader and shallower towards base. *Antennæ* rather slender and elongate, squamose, and with scattered short white setæ; funicular joints of normal length. *Prothorax* transverse, broadest at base and regularly narrowed to apex, the sides being slightly rounded; basal margin strongly bisinuate and with the basal angles acute, anterior margin slightly concave; the upper surface is abruptly

elevated in the basal two-thirds, which is separated from the anterior part by a deeply bisinuate impressed line, the elevation is much highest in the centre, where it forms a very prominent callosity bearing a short deep central furrow; among the scaling are some scattered short squamiform setæ, which also form a sparse fringe along the basal margin. *Elytra* broad, subquadrate, deeply and jointly bisinuate at base; sides obliquely dilated to some distance from base, forming a prominent humeral angle, and from there gradually narrowed to the apex; upper surface convex, with fine striæ containing rows of large punctures (only visible when the scaling is removed); the intervals broad, slightly convex, shiny and finely aciculate; intervals 3 and 5* are elevated at the base, and the latter bears also a tubercular prominence which projects horizontally from the declivity and is much larger in the ♂ than in the ♀; each interval has an irregular row of very short depressed squamiform setæ. *Legs* normal, set with short, pale, suberect setæ.

CAPE COLONY: East London (*Dr. G. B. Longstaff*, Sept. 1905).

TYPE in the Oxford Museum.

This species is somewhat intermediate between *E. pulvinaticollis* Boh. and *E. bidentatus* Boh. In the former the structure of the thorax is very similar, but the insect is much larger, the elytra are more elongate and show no traces of the basal or posterior callosities. In size and facies *callosicollis* much resembles *bidentatus*, but in the latter species the thorax is simple and the elytra have no basal callosities.

ZEUGORYGMA, gen. nov. (Tanytrhynchides.)

Head hemispherical; the eyes widely separated, convex. *Rostrum* rather longer than the head and prothorax, strongly curved; under surface as densely squamose as the upper; scrobes foveiform, placed very close together on the upper surface* in front of the middle and with a very fine stria connecting them with the apex. *Antennæ* with the scape reaching nearly to the middle of the prothorax; the two basal joints of the funicle very elongate, the second slightly longer than the first. *Prothorax* transverse, broadest at base and rapidly narrowed to apex; basal margin arcuate; apical margin subtruncate dorsally, slightly lobate laterally and without vibrissæ; the anterior coxæ placed about in the middle of the prosternum. *Elytra* ovate, with oblique shoulders and with 10 finely-punctured striæ; the intervals smooth, almost plane, and with rows of very long erect hairs. *Legs* stout; femora unarmed, posterior pair not reaching the apex of the elytra; tibiæ straight, anterior pair not denticulate, corbels of posterior pair enclosed; tarsi short and broad, the second joint shorter and narrower than the first and third, fourth joint short, the claws small and connate. *Abdomen* with the

* The space between the suture and the first stria is reckoned as the first interval.

intercoxal process broad and truncate, segment 2 as long as 3 and 4 together and separated from 1 by a perfectly straight incision.

TYPE, *Z. hirta*, sp. nov.

This genus is evidently very closely allied to *Goniorhinus* Fst. (Deut. ent. Zeit. 1889, p. 143), from the Transvaal, with which I am not acquainted. Dr. K. M. Heller has, however, very kindly compared my specimens with Faust's type and considers them to be generically distinct, on the grounds that in *Goniorhinus* the eyes are approximated and the apical margin of the prothorax is vertically truncate. A further difference is to be found in the corbels of the posterior tibiae, which are stated by Faust to be open and truncate. The species of this genus exhibit a close affinity to *Sympiezorrhynchus*, with which at first I provisionally associated them; they may, however, be discriminated superficially by their long erect setae and the longer and more slender rostrum.

ZEUGORYGMA HIRTA, sp. nov.

Long. $3\frac{1}{5}$ – $3\frac{3}{5}$, lat. $1\frac{1}{5}$ –2 mm.

Colour black, with dull green scaling, the suture dull pink; the lateral margins and underparts pale with a metallic pink or golden reflection; body set with very long erect setae.

Head subglobose, with dense scaling and a tuft of erect setae above the eye, forehead with a central fovea. *Rostrum* elongate, a little longer than the head and prothorax, subcylindrical and distinctly curved; scrobes in the form of two deep oval fossae on the upper surface, separated by a narrow carina, evanescent posteriorly, but continued to apex in the form of an extremely fine line; scaling rather sparse laterally but dense above, with short erect setae on the basal half, which give the base an elevated appearance. *Antennae* piceous, with pale scaling; funicle with joints 3 and 4 subequal in length. *Prothorax* transverse, broadest at base, which is gently curved, apex much narrower and constricted, the margin slightly lobate dorsally, sides moderately rounded; upper surface convex, densely squamose, with a faint central furrow and a row of erect setae on each side of it. *Elytra* ovate, sides gently rounded, broadest about middle; upper surface convex, with fine punctured striae; the intervals almost plane, with dense scaling and with single rows of remote, very long pale setae on each interval except 4 and 6, which occasionally bear a few short setae. *Legs* piceous, with dense pale opalescent scaling.

NATAL: Estcourt (*A. E. Haviland*); Frere (*G. A. K. M.*).

TYPE in the British Museum.

ZEUGORYGMA ORANGLE, sp. nov.

Long. 3 – $4\frac{1}{4}$, lat. $1\frac{1}{2}$ – $2\frac{1}{2}$ mm.

The description of *Z. hirta* applies entirely to this species, except in the following particulars:—The rostral scrobes are continued backwards from the fossa, and even when hidden by the scaling their upper edge may be seen in the form of a narrow

bare carina running from the antennæ more than halfway to the eye, there being no trace of this in *hirta*; the elytra also have their bases distinctly marginate and at the external angle there is a slight projection which just overlaps the base of the prothorax, both these characters being absent in *hirta*; finally, the antennæ are slightly more elongate, and the third joint of the funicle is distinctly longer than the fourth.

ORANGE COLONY: Bothaville (*Dr. H. Brauns*). CAPE COLONY: Port Elizabeth (*Dr. H. Brauns*).

TYPE in the British Museum.

Dr. Brauns has kindly sent me a series of eleven specimens, in which the above-mentioned characters are quite constant.

HIPPORRHINUS MENDICUS, sp. nov.

Long. 15, lat. $6\frac{1}{5}$ – $7\frac{1}{2}$ mm.

Head coarsely rugose and with scattered scaling; forehead almost plane, with a low central carina; antecular furrows present. *Rostrum* separated from head by a transverse incision, moderately stout, curved and slightly dilated at apex; upper surface with a broad and distinct central furrow, the adjoining coste coarsely punctured; upper lateral sulci broad and deep, uniting at base, the lower pair of equal length, but narrower, shallower, and not uniting; scrobes lateral, deep and straight; inferior basal furrow broad and deep. *Antennæ* with the scape scarcely reaching eye, the two basal joints of the funicle subequal. *Prothorax* as long as broad, apex narrower than base, sides moderately rounded, broadest about middle, apical margin distinctly rounded dorsally; ocular lobes well developed; upper surface convex, closely and evenly set with large conical granules, leaving a narrow but distinct central furrow containing no carina; granules bare, each with a short depressed dark seta, the interstices with dense brownish-grey scaling. *Elytra* oblongo-ovate, much broader in the ♀, broader than the prothorax at base (especially in ♀), the shoulders obtusely prominent; sides moderately rounded, broadest about middle, apical processes small and conical in both sexes; upper surface convex, with broad very shallow sulci containing rows of very small granules, the intervals with rows of more closely-set granules, those on intervals 3, 5, and 7 being much larger and more elevated, especially towards apex; the apices of the granules bare, the rest of the surface being densely covered with round greyish-brown scales. *Legs* notably short in ♀, much longer and thicker in the ♂; all the tibiæ curved (more strongly so in ♂) and coarsely dentate; posterior tarsi with the three basal joints subequal in length and breadth.

CAPE COLONY: Touw's River (*R. M. Lightfoot*).

TYPES, ♂ in the South African Museum, ♀ in the British Museum.

Allied to *H. gravidus* Mshl., but in that species the upper lateral sulci of the rostrum do not unite at the base, and the basal inferior furrow is much shallower; the shoulders of the elytra

are also much more oblique, and the scaling is different, being much thinner, with the scales large, round, and white.

HIPPORRHINUS IMPRESSICOLLIS, sp. nov.

Long. $12\frac{1}{2}$, lat. $3\frac{1}{5}$ mm.

Colour black, moderately shining, and entirely devoid of scaling, except for a small white spot at the extreme apex of the elytra.

Head convex, with scattered shallow punctuation; forehead with two faint longitudinal impressions; anteocular furrows deep. *Rostrum* about as long as head and prothorax, cut off from head by a dorsal incision; sides parallel to middle, thence gradually dilated to apex; upper surface convex, with five distinct narrow carinae, the outer one on each side abbreviated apically, the basal margin impressed in the middle and obtusely elevated laterally; lateral sulci broad and deep, subequal in length, the upper pair only uniting at base; scrobes very deep, lateral, almost straight; inferior basal furrow very deep. *Antennae* with scape scarcely reaching eye, the two basal joints of funicle equal. *Prothorax* a little broader than long, of equal width at base and apex; sides moderately rounded, broadest about middle, dorsal anterior margin truncate; ocular lobes feebly developed; upper surface almost plane, gradually elevated posteriorly and steeply declivous along the basal margin, closely set with low rounded tubercles, leaving a narrow central furrow which, owing to the posterior elevation, appears much deeper towards the base and contains a fine abbreviated carina; tubercles each with a very short depressed dark seta. *Elytra* elongato-ovate in ♂, shoulders rounded; sides very slightly amplified, broadest before middle; apical processes absent; upper surface convex, with shallow sulci containing regular rows of distinct granules; all the intervals evenly raised, convex, with regular rows of depressed and often elongate granules, each bearing a very short depressed dark seta, except on the declivity, where the setae are long and erect. *Legs* comparatively long and slender, with scattered dark setae; posterior tarsi with the 1st joint longest and as broad as 3rd, 2nd rather narrower but as long as 3rd.

CAPE COLONY: Stellenbosch (*L. Péringuey*), Malmesbury (*R. M. Lightfoot*).

TYPE in the South African Museum.

In general facies this species most resembles *H. capensis* L., but its rostrum is much more slender and distinctly dilated at the apex; moreover, the gradual posterior elevation of the prothorax and its unusually deep central furrow will distinguish *impressicollis* from all its nearest allies.

HIPPORRHINUS MONILIS, sp. nov.

♂ long. 10-17, lat. 4-7; ♀ long. 11, lat. 5 mm.

Head convex, bare, with scattered large deep punctures; forehead plane and somewhat plicate; anteocular furrows, as seen from above, very deep. *Rostrum* a little shorter than prothorax,

deeply incised at base, gently curved, the sides parallel to beyond middle and slightly dilated at apex; upper surface convex, with five narrow undulating carinæ, the central one sometimes a little higher than the others; the two lateral sulci on each side narrow, deep, and of equal length; scrobes deep and lateral; inferior basal furrow very deep. *Antennæ* with the scape reaching eye, the first joint of funicle longer than the second. *Prothorax* as long as broad, sides subparallel from base to beyond middle, thence rapidly narrowed to apex, anterior margin truncate dorsally; ocular lobes well developed; upper surface slightly convex, densely and evenly set with large rounded granules and without any trace of a central furrow, entirely devoid of scaling. *Elytra* oblongo-ovate, much narrower in ♂, truncate at base, shoulders prominent and subrectangular, sides slightly rounded, broadest about middle; apical processes absent in ♂, very small in ♀. Upper surface convex, without any distinct sulci, the whole surface being densely covered with even and regular rows of large rounded granules; these granules bare, and each with a short depressed dark seta; the interstices entirely devoid of scales, except for a few along the extreme lateral margin. *Legs* rugose, with black setæ on the tibiæ and a few white ones on the femora; the inner edges of tibiæ strongly dentate; posterior tarsi with the three basal joints subequal in length and breadth.

NAMAQUALAND: O'okiep (*G. Warden*).

TYPES, ♂ in the South African Museum, ♀ in the British Museum.

Very nearly allied to *corpulentus* Gyl., which, however, has the rostrum shorter, thicker, and more strongly curved; the prothorax is also much larger in proportion to the elytra in *corpulentus*, the elytra are less elongate and jointly sinuate at the base with the humeral angles projecting forwards, whereas in *monilis* the base is truncate with the shoulders subrectangular.

HIPPORRHINUS DISPAR, sp. nov.

Long. $11\frac{1}{5}$ – $11\frac{3}{5}$, lat. $4\frac{1}{5}$ – $5\frac{2}{5}$ mm.

Head convex, with scattered fine punctuation; forehead with a deep central impression; antecular furrows deep. *Rostrum* separated from head by a deep incision, as long as prothorax, strongly curved and moderately dilated at apex; upper surface almost plane, rugosely punctured in the central portion and with a broad smooth central carina; the lateral sulci broad and deep, the upper pair only uniting at base, the lower pair much shorter; scrobes deep and lateral; inferior basal furrow very broad and deep. *Prothorax* broader than long, apex scarcely narrower than base, sides strongly rounded, broadest at middle; apical margin faintly concave dorsally; ocular lobes moderate. Upper surface slightly convex, evenly set with small rounded tubercles, leaving a narrow central furrow containing no carina; tubercles bare, the interstices with a few scattered pale scales. *Elytra* oblongo-ovate, truncate at base, shoulders prominent and sub-

rectangular; sides scarcely rounded, subparallel to beyond middle; apical processes absent in both sexes; upper surface with broad sulci containing rows of large shallow punctures separated by small granules, the intervals all evenly raised and with regular rows of larger granules; granules bare, with short depressed black setæ, which, however, are much longer and erect on the declivity; the interstices with thin, very scattered, white scaling. *Legs* moderately slender, the posterior pairs of tibiæ not dentate internally; posterior tarsi with joints 1 and 3 of equal width, 2 a little narrower, 2 and 3 subequal in length, 1 distinctly longer.

CAPE COLONY: Sir Lowry's Pass and Ashton (*F. Purcell*).

TYPES, ♂ in the British Museum, ♀ in the South African Museum.

The two examples here associated present a very different appearance superficially, owing to the fact that in the ♀ the granules on the elytra are much larger and distinctly elevated; whereas in the ♂ they are small and much depressed, giving the insect an appearance very much like that of *H. caffër*.

A similar form of variation may, however, be observed in other species of the genus, such as *wahlbergi* Boh. &c., and in all other respects these examples are clearly referable to a single species.

HIPPORRHINUS FOVEOLATUS, sp. nov.

Long. $8\frac{2}{5}$ – $13\frac{1}{2}$, lat. $3\frac{1}{5}$ –6 mm.

Head convex and closely punctured on vertex; forehead flattened, more sparsely punctured, and with a distinct central fovea; ante-ocular furrows absent. *Rostrum* not incised at base, moderately stout, scarcely curved, slightly dilated at apex; upper surface with a shallow central furrow, rather deeper anteriorly, the adjoining costæ with a few setigerous punctures; upper lateral sulci complete, deep anteriorly but uniting very shallowly at base, the lower sulci much abbreviated; scrobes directed beneath base of rostrum; the inferior basal furrow shallow. *Antennæ* with the scape scarcely reaching eye, the first joint of funicle rather longer than the second. *Prothorax* a little broader than long, its length equal to the width at base, the apex slightly narrower; sides moderately rounded, broadest about middle, apical margin truncate dorsally; ocular lobes feeble; upper surface convex, closely set with small rounded tubercles, leaving an ill-defined central furrow containing a strong carina; tubercles bare, each with a very short depressed seta; the interstices with scattered large round white scales. *Elytra* oblongo-ovate, shoulders roundly prominent, sides subparallel from shoulders to beyond middle; apical processes very small and conical in both sexes; upper surface convex, with regular rows of large subreticulate foveæ, the intervals narrow, smooth and devoid of granules dorsally, but with traces of depressed granules laterally and on the declivity; black, shiny, with small scattered patches of large white scales and with a few minute depressed setæ. *Legs* moderately stout, with sparse white

scaling; the anterior tibiæ more curved interiorly in the ♂; posterior tarsi with the three joints subequal in length, the second a little narrower than the others.

CAPE COLONY: Bredasdorp (*H. Fry*).

TYPES, ♂ in the British Museum, ♀ in the South African Museum.

A somewhat distinct species, owing to its regularly and deeply foveate elytra. It comes, perhaps, nearest to *partitus* Gyl., but in that species there is no inferior basal furrow on the rostrum, the forehead is deeply excavate, and the elytra are more elongate and less distinctly foveate.

HIPPORRHINUS MONTANUS, sp. nov.

Long. $17\frac{1}{5}$ –18, lat. $7\frac{2}{5}$ mm.

Head convex, with close deep punctuation on vertex; forehead more sparsely punctured, with two shallow impressions in ♂, which are obsolescent in ♀; antecular furrows deep, converging dorsally. *Rostrum* not cut off from head at base, but much elevated dorsally, as long as prothorax only, thick, curved and strongly dilated apically; upper surface shallowly impressed towards apex, slightly convex in the basal half and with a deep central stria which vanishes anteriorly; lateral sulci deep, the upper pair much longer and uniting deeply at the base, lower pair not uniting, each forming a large triangular fovea; scrobes very deep, directed beneath base of rostrum, but not uniting; the inferior basal furrow being absent. *Antennæ* short and stout; scape scarcely reaching eye and coarsely punctured; funicle with first joint much longer than second. *Prothorax* a little broader than long, apex narrower than base, sides rounded, broadest rather before middle, anterior margin truncate dorsally; ocular lobes very prominent; upper surface slightly convex, somewhat closely set with rounded tubercles, leaving a central furrow containing a broad abbreviated carina; tubercles bare, each with a depressed dark seta, the interstices with grey scaling. *Elytra* subovate, similarly shaped in both sexes, shoulders prominent and subrectangular, sides slightly rounded, broadest about middle; apical processes obsolescent; upper surface convex, with regular rows of large reticulate foveæ, the intervals narrow, 1, 3, 5, and 7 being distinctly costate, smooth and devoid of granules, the remaining intervals depressed and transversely plicate, but irregular and sometimes indistinct; colour black, with sparse minute pale scaling. *Legs* stout, with very scattered pale scaling; the posterior tibiæ strongly deatate internally; the tarsi broad, the basal joints of equal width, but the second shorter than the first and third.

CAPE COLONY: Matroosberg (*Dr. Marloth*).

TYPES, ♂ in the British Museum, ♀ in the South African Museum.

This species will stand next to *delectans* Hbst., with which it agrees very closely in its rostral structure (except that the lower

lateral sulci do *not* unite at the base); it may, however, be easily distinguished by its convex forehead, the much greater development of the ocular lobe of the prothorax, and especially by the large subreticulate foveæ on the elytra.

HIPPORRHINUS PURCELLI, sp. nov.

Long. $12\frac{2}{5}$, lat. $5\frac{1}{2}$ mm.

Head deeply and rugosely punctured; forehead subpiculate, broadly impressed, and with a short elevated central carina; antero-ocular furrows absent. *Rostrum* not incised at base, as long as the prothorax, scarcely curved, but sharply declivous at apex, broadly and regularly dilated from base to apex; upper surface rugosely punctured, with a broad smooth central carina which is continued right up to the base, the adjoining carinæ shorter, narrower, and lower; lateral sulci not uniting at base, the lower ones rather narrower than the upper, but of equal length; scrobes entirely lateral, straight and oblique; the inferior basal furrow absent. *Antennæ* with the scape just reaching eye, the two basal joints of funicle subequal. *Prothorax* transverse, apex and base of about equal width, sides strongly rounded, broadest at middle, anterior margin slightly sinuate dorsally; ocular lobes well developed; upper surface slightly convex, fairly closely set with low rounded tubercles, leaving a narrow central furrow containing a distinct but abbreviated carina; tubercles bare, with short depressed setæ, the interstices with grey scaling. *Elytra* oblongo-ovate, shoulders subrectangular, sides scarcely rounded, broadest about middle, apical processes obsolescent; upper surface without striation, but with rows of small granules in lieu of punctures; interval 1 with distant, small, depressed tubercles vanishing on the declivity, intervals 2 and 4 with only one or two larger rounded tubercles before middle, 3, 5, and 7 with closely-set rows of large elevated tubercles which are sharply conical except on the basal portion of the disk, interval 6 quite smooth; tubercles bare, with short depressed dark setæ, the interstices with a very few scattered pale scales. *Legs* rugose, except the central part of the femora which is smooth; the interior edges of all the tibiæ strongly dentate; the posterior tarsi with the three basal joints of equal width, the first a little longer than second or third which are equal.

CAPE COLONY: Sir Lowry's Pass (*F. Purcell*).

TYPE ♂ in the South African Museum.

CYCLOMUS ALGOENSIS, sp. nov. (Plate LXVI, fig. 6.)

Long. $6\frac{2}{5}$ – $8\frac{2}{5}$, lat. $2\frac{3}{5}$ – $3\frac{2}{5}$ mm.

Black, with fine grey setiform scaling.

Head closely and rugosely punctured throughout, and with sparse setiform scaling; eyes very prominent, lateral. *Rostrum* rather shorter than the head and similarly sculptured, scrobes

continued beneath the eyes in the form of a distinct narrow furrow. *Antennæ* long and slender, piceous, with very fine grey pubescence; first joint of funicle as long as the club. *Prothorax* slightly longer than broad, obliquely truncate at apex, steeply retuse at base which is not broader than the apex, sides rounded, broadest at middle, shallowly constricted and transversely impressed anteriorly; upper surface very convex, with even rugose punctuation and a high narrow central carina. *Elytra* ovate, narrower in ♂, shoulders sloping, sides rounded, broadest about middle; upper surface convex, not striate, but with regular rows of minute granules in lieu of striae dorsally and with rows of punctures laterally; the intervals 1, 3, and 5 with rows of small tubercles, each of which bears a very short depressed seta, intervals 2 and 4 plane, often with abbreviated or interrupted rows of small granules, 6 and 7 more convex and usually granulate, the outer intervals plane and smooth. *Legs* long and slender, piceous, with pale pubescence; tarsi elongate, the third joint deeply bilobed; femora strongly clavate, the posterior pair almost reaching the apex of elytra in ♂, much shorter in ♀.

CAPE COLONY: Algoa Bay (*Dr. H. Brauns*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

CYCLOMUS SIMPLEX, sp. nov. (Plate LXVI. fig. 7.)

Long. $5\frac{3}{5}$ – $9\frac{3}{5}$, lat. $2\frac{2}{5}$ –4 mm.

Colour black, with fairly dense, grey or light brown, long, recumbent pubescence.

Head very convex, coarsely and closely punctured, thinly pubescent; eyes short ovate, very prominent. *Rostrum* shorter than the head, coarsely punctured, the scrobes evanescent posteriorly, passing obliquely much below the eyes. *Antennæ* moderately slender, piceous, with fine long grey pubescence; the club longer than first joint of funicle. *Prothorax* broader than long, obliquely truncate at apex, strongly retuse at base, sides strongly rounded, broadest at middle, slightly constricted near apex; upper surface subdepressed, longitudinally rugose, without any central carina and with recumbent pale pubescence. *Elytra* ovate, subacuminate apically, shoulders rounded, broadest before middle; upper surface convex, with deep striae containing rows of granules, the intervals broad and plane in ♀, narrower and more convex in ♂, but all evenly raised, finely coriaceous, devoid of tubercles and with long depressed pale pubescence. *Legs* comparatively stout, piceous, with long grey pubescence; third tarsal joint strongly bilobed.

CAPE COLONY: Grahamstown.

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

This insect may be readily distinguished from all its congeners by its smooth even elytra.

I have received five specimens through Dr. Horn labelled "Natal," but the locality seems doubtful.

Six species of *Cyclomus* have been described previously, and the following synoptic table may help to distinguish them :

- | | | | |
|-----|-------|---|--------------------------------|
| 1. | (2.) | Third tarsal joint not bilobate; scrobes broad and deep, reaching right up to the eyes, their edges continued so as to form the ocular orbits | <i>C. simus</i> Wied. |
| 2. | (1.) | Third tarsal joint strongly bilobate; scrobes foveiform apically, very shallow or even obsolete behind, being continued as faint oblique lines well below the eyes. | |
| 3. | (4.) | Prothorax broad, quite plane, with a deep excision on each side about middle | <i>C. planicollis</i> Pér. |
| 4. | (3.) | Prothorax convex, sides not excised. | |
| 5. | (14.) | Elytra with the alternate intervals elevated or tuberculate. | |
| 6. | (9.) | Eyes situated on the superior margin of forehead; prothorax not, or only obtusely, carinate. | |
| 7. | (8.) | Rostrum with a narrow central furrow | <i>C. boops</i> Boh. |
| 8. | (7.) | Rostrum without a central furrow | <i>C. languidus</i> Boh. |
| 9. | (6.) | Eyes lateral; rostrum without a furrow. | |
| 10. | (11.) | Prothorax without a central carina; eyes subpedunculate. | |
| | | | <i>C. eminus</i> Boh. |
| 11. | (10.) | Prothorax with a very distinct narrow central carina; eyes prominent but never subpedunculate. | |
| 12. | (13.) | Tubercles on elytra bearing long erect setæ; legs covered with very long fine hairs | <i>C. dasyptus</i> Germ. |
| 13. | (12.) | Tubercles on elytra with very short depressed setæ; legs with short recumbent pubescence | <i>C. algoensis</i> , sp. nov. |
| 14. | (5.) | Elytral intervals all perfectly smooth and of equal height. | |
| | | | <i>C. simplex</i> , sp. nov. |

C. simus Wied. has been redescribed by Pascoe (Ann. N. H. (5) xx. p. 354, 1887) under the name of *Exaetoderes scabripennis*.

MYORRHINUS LONGSTAFFI, sp. nov.

Long. $3\frac{1}{5}$ – $3\frac{2}{5}$, lat. 2 – $2\frac{1}{5}$ mm.

Colour entirely black, uniformly and fairly densely covered with light green scaling and closely set with short suberect pale setæ.

Head shortly conical, densely squamose; eyes depressed and closely approximated. *Rostrum* elongate, as long as head and prothorax, strongly and regularly curved, compressed dorsally towards base (there being a broad lateral furrow from the antenna to the eye), but flattened and slightly spatulate at the apex; upper surface not gibbous at the insertion of the antennæ, but with a short shallow central furrow at that part, basal portion punctate and squamose, apex and under surface bare shiny and impunctate; colour black. *Antennæ* inserted about middle of rostrum, black, with the base of scape dark ferruginous; scape moderate, slightly curved, gradually clavate and as long as funicle without the club. *Prothorax* transverse, truncate at base and apex, the latter shallowly constricted and much narrower than the base, sides strongly rounded, broadest about middle; upper surface evenly convex, with fine shallow punctuation concealed by the scaling. *Elytra* short, subglobose, their sides strongly rounded, broadest before middle; upper surface convex with fine distinctly punctured striæ, the intervals smooth and impunctate. *Legs* ferruginous brown, the femora darker; the latter with green scaling, tibiæ with depressed whitish setæ.

CAPE COLONY: East London (*Dr. G. B. Longstaff*).

TYPE in the Oxford Museum.

Nearly allied to *M. setarius* Fähr., but in that species the setæ are inconspicuous, being much fewer and very minute; the rostrum and legs are also of a different colour, being testaceous yellow.

I have much pleasure in dedicating this species to Dr. Longstaff, who has kindly entrusted to me the Curculionidæ which he took during the recent visit of the British Association to South Africa.

RHYPAROSOMUS MASHUNUS, sp. nov. (Plate LXVI. fig. 8.)

Long. $4\frac{2}{5}$ –6, lat. $1\frac{3}{5}$ – $2\frac{2}{5}$ mm.

Colour black, with dark brown scaling and thinly covered throughout with stiff erect setæ; elytra with a common V-shaped pale marking behind middle (often abraded), and sometimes with a broad pale lateral stripe.

Head rugosely punctured; forehead plane, with a short deep central furrow and a shallower one on each side of it, all three being continuous with the rostral furrows. *Rostrum* shorter than the prothorax, broad, scarcely curved, its sides subparallel; upper surface with three deep continuous furrows of equal length, the central one being rather broader than the others, beyond these a short lateral basal stria. *Antennæ* piceous, the scape slender, abruptly clavate, sparsely setose; funicle with the two basal joints elongate, the first much longer than the second. *Prothorax* as long as broad in ♂, slightly broader than long in ♀, apical margin slightly rounded, ocular lobes distinct, basal margin strongly rounded, sides gradually dilated from base to beyond middle, abruptly narrowed at apex; upper surface almost plane, the lateral margins retuse, rugosely and confluent punctured throughout. *Elytra* elongato-ovate, much narrower in ♂, deeply emarginate at base, the basal angles projecting sharply forwards; shoulders oblique, with a very faint humeral tubercle, sides parallel from there to beyond middle; upper surface convex with shallowly punctured striae, with the suture and alternate intervals more raised than the others but without any tubercles; the intervals rugosely punctured and each with a row of stiff erect setæ, which are more numerous on the elevated intervals. *Legs* with dark brown scaling, rarely with paler markings, and set with stiff erect setæ; anterior pairs of tibiae very strongly curved near apex in both sexes, but especially in the ♂.

MASHONALAND: Salisbury and Marandella's (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

A common species, occurring round the roots of various low-growing plants. It is evidently allied to *R. inæqualis* Boh. (type missing), but, according to the description, that species differs in having a transverse row of three foveolæ on the thorax, the elytra are truncate at the base, and the raised intervals have rows of remote obtuse tubercles.

DIABATHRARIUS SETULOSUS, sp. nov. (Plate LXVI. fig. 10.)

Long. $5\frac{1}{2}$ -6, lat. $2-2\frac{1}{2}$ mm.

Head strongly deflected, retracted and invisible from above when at rest; forehead convex, covered with dense brown or grey scaling and without any central stria; eyes broadly ovate, not acuminate inferiorly. *Rostrum* shorter than head, somewhat amplified at apex, its upper surface almost plane, squamose uniformly with the head at base, bare and rugosely punctured at apex; antennæ ferruginous. *Prothorax* longer than broad, its sides scarcely rounded, broadest at base and gradually narrowed from there to apex, base deeply bisinuate, apex strongly and roundly produced above head, ocular lobes obsolete, gular situation very deep; upper surface convex, closely set with large subreticulate punctures and with a distinct complete central furrow; the sculpturing is, however, very largely concealed by a thick brown or grey indumentum; the larger punctures bear short thick erect setæ, which are more numerous and paler along the apical margin. *Elytra* jointly trisinuate at base, somewhat broader than the prothorax at the shoulders, which are sloping, sides subparallel to beyond middle; scutellum distinct, densely squamose but not prominent; upper surface convex, with rows of large separated foveolæ which are partly concealed by a thick greyish indumentum; the intervals narrow, plane, coriaceous, and with rows of short thick distant erect setæ, which are more numerous posteriorly and a number of which unite to form a prominent fascicle on the declivity of the third interval. *Legs* covered with thick grey or brown indumentum; tibiæ with two short stout teeth internally at apex; tarsi short and broad, fourth joint entirely absent.

MASHONALAND: Salisbury and Umtali (*G. A. K. M.*). TRANSVAAL: Shilouvane (*Rev. H. Junod*).

TYPE in the British Museum.

DIABATHRARIUS VELUTINUS, sp. nov. (Plate LXVI. fig. 9.)

Long. $8-8\frac{1}{2}$, lat. $3\frac{3}{4}-4$ mm.

Head deflected, only a small portion visible from above when at rest; forehead convex, with a shallow central stria, densely clothed with golden-brown scales and with scattered yellow setæ; eyes narrowly ovate, but broadly rounded inferiorly. *Rostrum* about as long as head, straight, parallel-sided at base, very broadly and triangularly dilated on each side at apex; upper surface plane, rugosely punctured and with a narrow central carina; antennæ ferruginous, the club fuscous. *Prothorax* as long as broad, sides parallel from base for two-thirds of the length, then rapidly narrowed to apex, base bisinuate, apex roundly produced above the head, ocular lobes slight, gular situation very deep; upper surface convex, densely and evenly clothed throughout with large golden-brown scales which strongly overlap one another and with scattered depressed yellow setæ. *Elytra* jointly trisinuate at base, much broader than prothorax at shoulders, which are rounded

and very prominent; sides not rounded, broadest at base and very gradually narrowed towards apex; scutellum distinct, prominent, densely squamose; upper surface convex, with regular striæ containing rows of deep punctures more or less hidden by the scaling; the intervals plane, closely set with large rounded scales, which stand almost vertically and thus give the insect a velvety appearance; each interval has a row of pale depressed setæ; the colour of the scales is dark brown with a common V-shaped lighter mark behind middle, immediately followed by a broader similar mark of the ground-colour, the apex again being lighter; but in the cotype the whole ground-colour is much lighter, and thus only the darker posterior band is noticeable. *Legs* densely covered with golden-brown scales and with depressed yellow setæ; tibiæ dilated at apex, with a stout spine at the inner angle and a shorter one just above it; tarsi very broad and short, fourth joint entirely absent.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE in the British Museum.

HYSOMUS PARVUS, sp. nov. (Plate LXVI. fig. 11.)

Long. $2\frac{1}{2}$ -3, lat. $\frac{1}{5}$ -1 mm.

Head globose, with dense brown scaling and closely punctured, without impressions or carinæ. *Rostrum* elongate, as long as the prothorax, cylindrical, gently curved, slightly elevated at base and separated from the head by a faint impressed line, with close punctuation and dense brown scaling throughout, and without carinæ or sulci; scrobes disappearing rapidly beneath the rostrum and continued to base, but not uniting there. *Antennæ* piceous, scape not reaching the eye; first joint of funicle thicker and rather longer than second, the remainder very short, subequal, but gradually widening apically. *Prothorax* longer than broad, subcylindrical, sides almost straight but slightly narrowed anteriorly, basal margin arcuate, apex slightly lobate, ocular lobes feebly developed; upper surface convex, very closely and evenly punctured throughout, with dense brown scaling and a narrow longitudinal white line on each side. *Elytra* elongate, basal margin jointly sinuate and not broader than the prothorax, the sides rapidly dilated to form a rounded humeral angle, thence subparallel to beyond middle and rapidly narrowed to apex, where each elytron is shortly and separately acuminate; upper surface subdepressed and very gradually declivous posteriorly, with regular and distinctly punctured striæ; the intervals rather narrow, scarcely convex and finely coriaceous; colour piceous, with dense even brown scaling, except along the extreme lateral margin, which is greyish white like the whole of the under parts. *Legs* densely squamose; first tarsal joint as broad as, but a little longer than, second, third rather broader, deeply bilobate; claws free.

ORANGE COLONY: Bothaville (*Dr. H. Brauns*).

TYPE in the British Museum.

A small narrow species, which, except for its smaller size, quite resembles in general facies its congeners *scapha* Boh. and *lembunculus* Boh. The former, however, which is the larger ($5\frac{1}{2}$ mm.), differs from both the other species in having two shallow furrows on each side of the rostrum above the scrobes; the scrobes also unite beneath at some distance from the base; further, the basal margin of the elytra is wider than the prothorax, the outer angles bearing a small blunt tubercle, and owing to a constriction just behind the base the margin is somewhat raised; finally, the thorax is more transverse and has the sides rounded. The present species is much more nearly allied to *lembunculus* ($3\frac{3}{4}$ mm.), but in that insect the rostrum is not elevated at the base, but is continuous with the head; the ocular lobes of the prothorax are well developed and there are three white stripes dorsally, the outer ones being much broader; the basal margin is not wider than the prothorax nor is it elevated, but there is no humeral prominence as in *parvus* and the shoulders are oblique.

H. scapha I have taken in Natal at Estcourt, and it was also found at Howick by Dr. F. Dimock Brown. *H. lembunculus* I have received only from Uitenhage, where it has been taken by Father O'Neil.

BAGOUS PUNCTIPENNIS, sp. nov. (Plate LXVI. fig. 12.)

Long. $6\frac{1}{2}$, lat. $2\frac{2}{5}$ mm.

Black, uniformly covered throughout with dirty grey scaling having the appearance of putty.

Head retracted, forehead with a very deep and broad central impression and with a rounded prominence above each eye. *Rostrum* rather long and slender, as long as prothorax, subdepressed, sharply deflected at one-third from base, sides parallel throughout; upper surface slightly convex and with a faint central carina; when the scaling is removed the surface is found to be piceous, very shiny and minutely punctured. *Antennae* inserted well behind middle of rostrum, piceous, with the club grey, the scape very short. *Prothorax* longer than broad, basal margin arcuate, apical margin slightly lobate and somewhat elevated; sides subparallel from base to near apex and there sharply constricted; ocular lobes prominent; upper surface almost plane, with close faint punctuation and irregular wrinkling, with a mere trace of a broad very shallow central furrow and with a distinct lateral impression about middle. *Elytra* oblong, jointly sinuate at base, the margin being somewhat elevated and crenulated; shoulders sloping and with a sharp humeral prominence; sides almost straight and gradually narrowed posteriorly, apex slightly and separately produced and with a sharper prominence from the end of the third interval; upper surface almost plane on disk, with broad striae containing rows of large round punctures, which are visible through the scaling to the naked eye, the intervals plane on disk and slightly convex laterally, 3 and 5 each with a sharp conical tubercle on the declivity, the latter being nearer the apex; interval 3 is also dentately carinate on the apical

half of the declivity, the carina forming a sharp prominence at the apex. *Legs* densely squamose, the tibiæ with sparse very long setæ; tarsi extremely slender, the three basal joints no broader than the fourth, the second joint slightly longer than the first.

PORTUGUESE E. AFRICA: Beira (*P. A. Sheppard*).

TYPE in the British Museum.

This very distinct species was caught by Mr. Sheppard at light. The very slender tarsi, the apical prominences, and the short scape and scrobe are all characters which will at once distinguish it from any of the other African forms.

BAGOUS BEIRANUS, sp. nov.

Long. $2\frac{3}{4}$, lat. 1 mm.

Colour black, with uniform dark brown scaling.

Head convex, forehead without any impression. *Rostrum* shorter than prothorax, curved and with its sides parallel; upper surface convex, smooth and with a short basal sulcus on each side above the scrobe. *Antennæ* inserted close to apex of rostrum, piceous. *Prothorax* as long as broad, arcuate at base, apical margin truncate dorsally, broadest before middle, the sides being gradually dilated from base to near apex and there sharply constricted; upper surface slightly convex, with subrugose confluent punctuation throughout. *Elytra* shortly oblongo-ovate, jointly sinuate at base, shoulders roundly prominent, sides almost parallel from base to behind middle, apex abruptly subacuminate; upper surface gently convex, subretuse posteriorly, with a small prominence on the fifth interval at the summit of the declivity, the striæ broad and deep and containing rows of large subreticulate punctures, which become smaller laterally and quite disappear on the declivity, the intervals very narrow and undulating on the disk. *Legs* black, with dense scaling, the tibiæ with a few long setæ on the inner edge; tarsi with joints 1-3 subequal in length and breadth, longer than broad, joint 4 much longer and scarcely narrower, joint 3 not lobate.

PORTUGUESE E. AFRICA: Beira (*A. Bodong*).

TYPE in the British Museum.

The facies is that of a small *B. cænosus* Gyl., from which it may be distinguished by the anterior dilatation of the prothorax, the coarsely punctured striæ on the elytra, and the narrow undulating intervals.

BAGOUS HUMERALIS, sp. nov.

Long. $4\frac{3}{5}$, lat. $1\frac{2}{5}$ mm.

Head slightly convex, finely punctured; forehead with a shallow central impression. *Rostrum* shorter than prothorax and comparatively stout, strongly deflected close to the base; upper surface convex, smooth, and with a short basal furrow above the scrobe. *Antennæ* inserted at the middle of rostrum. *Prothorax* as long as broad, arcuate at base, apical margin subtruncate dorsally and slightly elevated, the sides gradually dilated from

base to beyond middle and sharply constricted at apex; upper surface slightly convex, rugosely punctured, and with a deep complete central furrow. *Elytra* only slightly sinuate at base, broadest at the humeral angles, which are rather sharply prominent, the sides subparallel from there to behind middle; upper surface slightly convex, with broad striae containing rows of deep closely set punctures which are shallowly visible through the scaling; the intervals narrow, costate, the alternate ones distinctly more elevated, the fifth with a small prominence on the declivity. *Legs* piceous brown, the tibiae with a row of long erect setae on the interior edge; tarsi with the three basal joints subequal in length and breadth.

CAPE COLONY: Uitenhage (*Father O'Neil*).

TYPE in the British Museum.

This species has the appearance of a large *B. cœnosus* Gyl., from which it differs in its much shorter, thicker, and more sharply deflected rostrum; the scape and scrobe are also much shorter; the apical constriction of the thorax is stronger and the central furrow deeper; finally, in *cœnosus* the punctuation of the striae on the elytra is much finer and invisible through the scaling, the alternate intervals are not raised, and the tibiae have no long setae.

BAGOUS SENEGALENSIS (Faust, i. l.), sp. nov.

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

Black, with uniform dense brown scaling.

Head convex; forehead with a large central fovea and without supraocular prominences. *Rostrum* about as long as prothorax, regularly curved, and slightly dilated at apex; upper surface convex, smooth, the punctuation hidden by the scaling, the lateral sulcus above the scrobe shallow and rather indistinct. *Antennae* inserted nearer the apex of the rostrum. *Prothorax* as long as broad, bisinuate at base, apical margin subarcuate dorsally, sides subparallel from base to near apex and there sharply constricted; upper surface slightly convex, closely and distinctly punctured, without any central furrow, but with a number of irregular shallow impressions. *Elytra* subquadrate, faintly trisinate at base, the humeral angles bluntly prominent; upper surface almost plane, with a broad shallow V-shaped impression near base and with fine striae containing shallow punctures which are quite hidden by the scaling, the intervals being broad, plane, and closely punctured (beneath the scaling); intervals 3 and 5 each with a large rounded tubercle at the summit of the declivity. *Legs* with dense brown scaling; tibiae denticulate internally, each denticle with a short erect seta; tarsi with joint 3 not bilobate, joint 1 longer than 2 or 3.

SENEGAL (*Pipitz—coll. Faust*).

TYPE in the Dresden Museum.

Allied to *B. fastosus* Hartm., but a distinctly larger and heavier

insect. It differs also in the following characters: the evenly raised intervals of the elytra, the larger tubercles, the more prominent humeral angles, the non-bilobate third tarsal joint, and the denticulate tibiæ. The last character does not occur in any other African *Bagous* with which I am acquainted.

BAGOUS PROMONTORII, sp. nov.

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

Head convex, with dense grey scaling; forehead with a small central fovea. *Rostrum* about as long as prothorax, distinctly curved and slightly dilated from base to apex; upper surface convex, smooth, minutely punctured, and without any basal lateral sulcus. *Antennæ* inserted close to apex of rostrum. *Prothorax* about as long as broad, basal margin slightly arcuate, apical margin truncate, sides subparallel from base to beyond middle and evidently constricted near apex; upper surface slightly convex and quite smooth except for a small fovea in the centre of the base and a shallow transverse impression near the apex. *Elytra* short, subquadrate, subtruncate at base, shoulders roundly prominent, sides subparallel to beyond middle; upper surface almost plane, with fine striæ containing shallow punctures which are not visible through the scaling, the intervals plane dorsally, the fifth bearing a slight elevation on the apical declivity. *Legs* ferruginous, with thin grey scaling; tarsi with joint 3 not lobate, quite similar to 2, scarcely as long as broad, as broad as and a little shorter than 1, broader and much shorter than 4.

CAPE COLONY: Cape Town*.

TYPE in the South African Museum.

Resembles a small *B. cænosus* Gyl. in appearance, but that species has a distinct central furrow on the prothorax, as well as a basal furrow on each side of the rostrum above the scrobe.

In addition to the five species of *Bagous* described above there are four others known from Africa. Of these the only one which I have not yet seen is *B. crispus* Faust, from the Congo (Ann. Soc. Ent. Belg. 1899, p. 408). *B. fastosus* Hartm. was described from Dar-es-Salaam (Deut. ent. Zeit. 1904, p. 391), and I have seen two specimens taken by Mr. P. A. Sheppard at Beira. *B. longulus* Gyl. is apparently widely distributed throughout S.E. Africa, occurring in Cape Colony, Natal, Mashonaland, and Beira; it is found commonly on the water-lily (*Nymphaea stellata*). Father O'Neil has taken a number of *B. cænosus* Gyl. under a stone in a damp spot near Uitenhage, Cape Colony; the only other localities from which I have seen it are the Victoria Falls, where a single specimen was recently found by Dr. G. B. Longstaff, and Bothaville, O.R.C., whence I have received one example from Dr. Brauns.

* Since this description was written, Dr. K. M. Heller has kindly submitted to me two small beetles of the genus *Bagous*, from Lagos and Ashanti respectively, which I can attribute only to this species. They differ in being of slightly larger size and in having the prominence on interval 5 much more strongly developed and the alternate intervals slightly more raised posteriorly.

The nine species may be discriminated by the following characters:—

1. (2.) Upperside set with erect curled setae..... *B. crispus* Fst.
2. (1.) Upperside entirely devoid of erect setae.
3. (4.) Antennae inserted behind middle of rostrum; elytra with a sharp prominence at apex of interval 3 and with the striae deeply punctured; joints 2 and 3 of tarsi longer than 1..... *B. punctipennis*, sp. nov.
4. (3.) Antennae inserted at or beyond middle of rostrum; elytra with no prominence at apex of interval 3; joints 2 and 3 of tarsi not longer than 1.
5. (8.) Striae on elytra deeply and closely punctured, the punctures being distinctly visible through the scaling; tibiae with a row of long setae on their inner edge.
6. (7.) Prothorax without a central furrow; antennae inserted near apex of rostrum; size small (under 3 mm.). *B. beiranus*, sp. nov.
7. (6.) Prothorax with a deep and continuous central furrow; antennae inserted at middle of rostrum; size larger (over $4\frac{1}{2}$ mm.)..... *B. humeralis*, sp. nov.
8. (5.) Striae impunctate or with fine or shallow punctation, which is quite invisible through the scaling; tibiae, at most, with very short depressed setae.
9. (10.) Third joint of tarsi evidently bilobate..... *B. fastosus* Hartm.
10. (9.) Third joint of tarsi not bilobate.
11. (16.) Forehead with no supraocular prominence; elytra subquadrate; third joint of anterior tarsi not broader than second.
12. (13.) Tibiae denticulate internally; third interval of elytra with a large rounded tubercle at the summit of the declivity; size larger (5-6 mm.)..... *B. senegalensis*, sp. nov.
13. (12.) Tibiae not denticulate; third interval of elytra without any tubercle; size smaller (2-3 mm.).
14. (15.) Prothorax with a continuous central furrow; rostrum with a basal lateral sulcus above the scrobe..... *B. caenosus* Gyl.
15. (14.) Prothorax with no central furrow; rostrum without a basal lateral sulcus..... *B. promontorii*, sp. nov.
16. (11.) Forehead with a small prominence above the eye; elytra elongate; third joint of anterior tarsi distinctly broader than second..... *B. longulus* Gyl.

PHACEMASTIX TRINOTATA, sp. nov.

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

Colour black, with very sparse white setiform scaling, the elytra with one apical and two basal patches of dense creamy-white scales.

Head closely punctured and with sparse white scaling beneath; eyes subcontiguous and occupying almost the entire upper surface in the ♀, more widely separated in ♂. *Rostrum* strongly curved, its sides subparallel, the basal half compressed, coarsely strigosopunctate, squamose, and with a high smooth central carina ascending between the eyes; the apical half depressed, bare, shiny, and very finely punctured in ♀, more coarsely so in ♂. *Antennae* ferruginous, with the club fuscous and about equal to the last four joints of the funicle. *Prothorax* slightly broader than long, broadest at base, sides almost straight and gradually converging to near apex, which is strongly constricted, base bisinuate, apical margin truncate; upper surface subdepressed, with deep close and subreticulate punctuation throughout and a very short smooth

central carina; colour dull black, with very sparse white scales above and much denser yellowish scaling on the under parts. *Elytra* jointly sinuate at base, broadest at the shoulders, which are roundly prominent and thence gradually narrowed to apex; upper surface flattened in the basal half but convex posteriorly, with deep strongly punctured striæ, the intervals narrow but plane and rugosely punctured; colour black, with very sparse white scaling, a subquadrate patch of dense creamy scaling at the base of intervals 2 to 4 and an elongate sutural patch near apex; under parts with dense creamy-white scaling. *Legs* black or piceous, evenly clothed with rather thin white scaling; all femora with a large sharp tooth.

MASHONALAND: Salisbury and Umcheki R. (*G. A. K. M.*).

TYPE in the British Museum.

PHACEMASTIX PARDALIS, sp. nov. (Plate LXVII. fig. 3.)

Long. $7\frac{1}{2}$ – $8\frac{1}{2}$, lat. $3\frac{1}{2}$ – $3\frac{3}{4}$ mm.

Colour dull black, with numerous large white spots, which are fewer on the thorax; underside with uniform dense white scaling except on the apical segments of the abdomen, which are black with three white spots.

Head subconical, closely and coarsely punctured, black, with a large subquadrate patch of white scales below each eye; eyes closely approximated above but not contiguous. *Rostrum* about as long as prothorax, distinctly curved, broadest at base and gradually narrowed to beyond middle, thence slightly widening to apex, apical portion flattened, shining, and with fine scattered punctuation leaving an impunctate central line with a short central stria between the antennæ; basal portion compressed dorsally, with a prominent shiny central ridge ascending the forehead between the eyes; the sides closely and coarsely punctured, but covered with dense white scaling. *Antennæ* black, with the base of scape red; the club ovate, very large, about as long as the last six joints of the funicle. *Prothorax* rather broader than long, sides somewhat rounded, broadest near base and gradually narrowed to near apex, where it is strongly constricted; upper surface almost plane, rugosely and evenly punctured throughout, without any central carina; dull black with the following white spots: two large lateral ones (subapical and median), both uniting with the inferior white scaling, then a sublateral longitudinal row of three smaller spots, and two small spots placed transversely in the centre of disk, with sometimes a similar pair behind and another pair in front of them. *Elytra* broadest at shoulders, which are roundly prominent and thence gradually narrowed to apex; upper surface plane, shallowly depressed near the scutellum, with broad striæ containing large deep punctures, the intervals plane and rugose; colour dull black, with numerous irregular, usually subquadrate, white spots, often forming transverse patches, and with a broad white apical patch

containing a few small black spots. *Legs* black, with dense white scaling, posterior pairs of femora with a black spot towards apex, tibiae with apex and a central patch black; all femora armed with a large triangular tooth.

MASHONALAND: Salisbury and Umcheki R. (*G. A. K. M.*).
MATABELELAND: Matopos (*P. A. Sheppard*), Plumtree (*Father O'Neil*).

TYPE in the British Museum.

PHACEMASTIX POULTONI, sp. nov. (Plate LXVII. fig. 2.)

Long. $6\frac{1}{5}$ – $7\frac{1}{2}$, lat. $2\frac{1}{2}$ – $3\frac{1}{4}$ mm.

Colour black, prothorax with a ring of sparse white or yellowish scaling round the entire apical margin and a small patch of similar scales at each basal angle; elytra dark red, with the base and apex broadly black and with two broad transverse bands of white scales, one at the extreme base and the other dividing the red from the apical black; under parts black, with more or less sparse white scaling, forming denser patches on the meso- and metasternum.

Head subconical, closely punctured; eyes large, convex and meeting dorsally in both sexes. *Rostrum* as long as prothorax, curved and strongly deflected, its sides subparallel; apical portion flattened, bare and coarsely punctured throughout; basal portion somewhat compressed superiorly, with three dorsal carinae, the two outer ones uniting near base with the central one, which is more elevated and ascends the forehead, the sides rugosely punctured and with sparse white scaling. *Antennae* dark ferruginous, with white setae; the club fuscous, shorter, about equal to the last three joints of the funicle. *Prothorax* as broad as long, sides scarcely rounded, broadest at base and gradually narrowed to near apex, where there is a sharp constriction, base deeply bisinuate, apical margin shallowly sinuate dorsally; upper surface moderately convex, with deep subreticulate punctuation throughout and with only a trace of a central carina. *Elytra* jointly sinuate at base, broadest at shoulders, which are roundly prominent, and thence gradually narrowed to apex; upper surface almost plane, depressed near the scutellum, which is black, bare, and rugosely punctured; the striae broad and deep, containing rows of large shallow punctures, the intervals not broader than the striae, plane and coarsely punctured. *Legs* black, evenly covered with rather sparse depressed white setae; all the femora with a large sharp tooth.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

It is with much pleasure that I dedicate this species to my kind friend Prof. E. B. Poulton, F.R.S., the Hope Professor of Zoology at Oxford, to whom I am deeply indebted for much invaluable aid in my entomological work.

P. baridioides Fähr. is the only other described species of this genus, and has a strikingly different coloration from any of the foregoing insects.

APLEMONUS ZIZYPHI, sp. nov. (Plate LXVII. fig. 11.)

Long. 3-3 $\frac{1}{4}$, lat. 1 $\frac{1}{4}$ -1 $\frac{1}{2}$ mm.

Head porrect, elongate, subcylindrical, coarsely punctured except on extreme vertex, with a shallow impression between the eyes, black with a few sparse white depressed setæ; eyes lateral, round, subdepressed. *Rostrum* stout, subcylindrical, narrower, but a little longer, than head, not curved, but slightly deflected; upper surface coarsely punctured throughout and with depressed white setæ, except at extreme apex, which is smooth and shiny. *Antennæ* black, inserted behind middle. *Prothorax* longer than broad, truncate at apex and base, cylindrical, with a slight constriction near apex; upper surface convex, coarsely and evenly punctured, with a deep elongate median fovea at base; colour black, with sparse depressed white setæ. *Elytra* pyriform, much broader than prothorax at shoulders, which are obliquely prominent, sides strongly rounded, broadest well behind middle; upper surface very convex, gibbous, deepest behind middle, the posterior declivity very steep, with nine broad and deep striæ containing rows of strong punctures; the intervals broad and plane, coarsely coriaceous, and often with a faint central stria, but with no tubercles or carinæ; colour black, occasionally with a dark reddish tinge, with sparse depressed white setæ. *Legs* stout, black, punctate, and with scattered white setæ.

NATAL: Malvern (*C. N. Barker*), Estcourt (*G. A. K. M.*).

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPE in the British Museum.

This insect feeds on various species of *Zizyphus*, as also does its congener *A. gibbipennis* Fähr. This latter species has a very different appearance, owing to the elongate tubercles on the intervals of its elytra. *A. aurivillii* Fst. (Stett. ent. Zeit. xlix. 1888, p. 296—type in the Stockholm Museum) from Damaraland is very closely allied to *gibbipennis*, and differs only in its smaller size and in having the rostrum parallel-sided and not constricted at base.

EUOPS CYANEUS, sp. nov.

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

Head subconical, dark blue, convex on vertex, and with distinct scattered punctuation; eyes brown, large, prominent and broadly united above. *Rostrum* a little longer than head, narrow at base and strongly dilated from there to apex, convex above, dark blue, closely and distinctly punctured; antennæ black, quite similar to those of *E. morio* Boh. *Prothorax* about as broad as long, sides slightly rounded, broadest rather behind middle, apical margin broadly rounded, much narrower than base, which is bisinuate and has a distinct narrow margin; upper surface very convex, dark blue, very shiny, evenly set with fine scattered punctuation and without any central furrow or carina. *Elytra* subquadrate, jointly sinuate at base, much broader than prothorax at shoulders, which are roundly prominent, sides straight,

broadest at shoulders and very gradually narrowed posteriorly; upper surface slightly convex, with regular rows of small but distinct punctures, the intervals broad, plane, and impunctate; colour dark blue, shining. *Legs* dark blue, finely punctured.

NATAL: Malvern (*C. N. Barker*).

TYPE in the British Museum.

Its shining blue colour will at once distinguish this insect from the only other described South African species, *E. morio* Boh., which is of a bronze-black colour and not nearly so shiny; the thorax is much more coarsely punctured, and the elytra have deep coarsely punctured striæ, the intervals being narrower and more convex. *E. semiviolacea* Fst. (Deut. ent. Zeit. 1895, p. 234, note) has the thorax less shiny and more strongly punctured; the intervals on the elytra are also much narrower and more convex.

BALANINUS NUBIFER, sp. nov.

Long. 6–7 $\frac{2}{5}$, lat. 3–3 $\frac{3}{5}$ mm. Rostrum ♂ 2 $\frac{1}{2}$, ♀ 6 mm.

Colour dark ferruginous brown, densely but vaguely mottled with dark brown, light brown, and white scales.

Head globose, with dense greyish-brown scaling; eyes moderate, a little larger in the ♂. *Rostrum* slender, dark brown, bare; in ♂ subporrect and coarsely strigoso-punctate up to the insertion of antennæ, apical portion curved, smooth, and finely but distinctly punctured; in ♀, porrect for two-thirds its length, then gently curved, distinctly punctured as far as the antennæ, anterior portion finely punctate at the sides only. *Antennæ* brown, with the scape paler, inserted a little beyond middle in ♂ and a little behind middle in ♀; terminal joints of funicle slightly longer than broad, 7 conical, longer and broader than 6; club shortly ovate, the two basal joints transverse and transversely truncate, the second quadrate. *Prothorax* transverse, sides rounded, broadest behind middle, scarcely narrowed towards base, strongly narrowed anteriorly; upper surface finely coriaceous and without any carina; scaling dense, variegated brown, white, and grey above and laterally; prosternum uniform greyish white. *Elytra* ovate, broadest at shoulders, which are roundly prominent; sides scarcely rounded, rapidly narrowed to apex, especially in ♂; upper surface convex, with fine but distinctly punctured striæ, intervals plane and very finely coriaceous; scaling dense, irregularly variegated with dark brown, yellowish brown, and white; underparts uniform greyish white. *Legs* ferruginous brown, with dense pale scaling; all femora armed with a stout simple tooth, tibiæ strongly uncinatæ.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in British Museum, ♂ in Oxford Museum.

BALANINUS FICORUM, sp. nov. (Plate LXVII. fig. 5.)

Long. 4 $\frac{2}{5}$ –5, lat. 2–2 $\frac{2}{5}$ mm. Rostrum (in a straight line from base to apex) ♂ 2–2 $\frac{1}{5}$, ♀ 3 $\frac{3}{5}$ –4 mm.

Colour ferruginous brown, scaling on thorax dark fawn on disc and paler at the sides, scaling on elytra dark fawn variegated with dark brown marbling and spots of white or pale fawn.

Head globose, closely punctured, with fawn-coloured scaling above; eyes comparatively small in ♀, distinctly larger and closer together in ♂. *Rostrum* elongate, moderately stout, strongly and regularly curved throughout, rufo-testaceous, bare, mandibles black; in ♂ strongly strigoso-punctate in basal half, apical half shiny and minutely punctured; much longer in ♀, strigoso-punctate to only one-fourth from base, apical half impunctate. *Antennæ* comparatively short, testaceous, with the club fuscous, inserted slightly behind middle in ♀ and slightly beyond middle in ♂; terminal joints of funicle short, scarcely longer than broad; club short ovate, the two basal joints transverse and transversely truncate, the second joint being quadrate. *Prothorax* transverse, sides strongly rounded, broadest behind middle, constricted at apex; upper surface with fine reticulate punctation and a faint short central carina; scaling dense, dark fawn on disk, with sides and a spot in front of scutellum paler, prosternum white in the middle and dark brown laterally. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides slightly rounded and rapidly narrowed to apex, the striæ fine but distinctly punctured, the intervals plane and coriaceous; scaling moderately dense, fawn-coloured, marbled with dark brown and with scattered white or yellowish spots; scutellum white; under parts with rather thin whitish or yellowish scaling and a denser patch on the mesosternal epimera and at the apex of the metasternal episterna. *Legs* testaceous, with fairly dense yellowish scaling; all femora armed with a stout simple tooth; tibiæ distinctly uncinatae.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in British Museum, ♂ in Oxford Museum.

Found on a species of wild fig.

BALANINUS AURIVILLII, sp. nov.

Long. $4\frac{2}{3}$ – $4\frac{1}{3}$, lat. $2\frac{1}{3}$ – $2\frac{2}{5}$ mm. Rostrum ♂ $2\frac{1}{3}$ – $2\frac{2}{5}$, ♀ 4– $4\frac{2}{5}$ mm.

Colour ferruginous, evenly covered with creamy white or pale yellow scales and with a broad transverse band of denser scaling on the elytra, behind middle, varying from pale to bright yellow.

Head globose, with dense creamy scaling above and below; eyes large, scarcely smaller in the ♀. *Rostrum* elongate, very slender, dark ferruginous; in ♂, subparallel to beyond middle, thence curved to apex, strigoso-punctate in the basal half and squamose close to base, apical half shiny and minutely punctured; in ♀, parallel for four-fifths of its length, then sharply curved downwards, base shiny and impunctate throughout. *Antennæ* elongate, slender, testaceous, with the club fuscous, inserted beyond middle in ♂ and well behind middle in ♀; terminal joints of funicle elongate, sublinear, 6 and 7 equal in length and

breadth; club elongate, the two basal joints obliquely truncate and a little longer than broad, the second joint slightly narrowed basally. *Prothorax* transverse, broadest at base, much narrowed and faintly constricted at apex, sides strongly rounded; upper surface finely and reticulately punctured, and without any central carina; scaling creamy white or yellow, rather sparse, but forming a dense narrow edging to the base of brighter yellow. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides slightly curved and rapidly narrowed to apex; upper surface convex, with fine punctured striæ, the intervals plane, coriaceous; scaling not very dense, cream-coloured, with a broad transverse band just behind middle of denser yellow scales and with similar denser scaling along the suture from the base to the transverse band; under parts squamose as above, the mesosternal epimera and metasternal episterna with denser brighter scaling. *Legs* ferruginous, with rather sparse pale scaling; all femora armed with a distinct simple tooth; tibiæ not uncinatæ.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♀ in British Museum, ♂ in Oxford Museum.

Found on a species of wild fig.

I have much pleasure in dedicating this species to the distinguished Swedish entomologist, Prof. Chr. Aurivillius, to whom I am indebted for his kind and valued assistance on several occasions.

BALANINUS BARKERI, sp. nov. (Plate LXVII. fig. 7.)

Long. $4\frac{1}{4}$ – $5\frac{1}{2}$, lat. 2– $2\frac{1}{2}$ mm. Rostrum ♂ 3, ♀ $4\frac{1}{2}$ –5 mm.

Colour black, with thin grey scaling and the following markings of bright orange: on thorax a central stripe and a basal lateral spot; on elytra a short sutural stripe and an interrupted transverse discal band; a transverse lateral band on meso- and metasternum.

Head globose, with dense grey scaling above and below in ♂, in ♀ the interocular space is orange; eyes very large in ♂, rather smaller in ♀. *Rostrum* black, bare, porrect to beyond middle; in ♂, sharply curved apically, moderately stout, strigoso-punctate in basal half, apical half minutely punctured; in ♀, very slender, gently curved apically, shiny and impunctate throughout. *Antennæ* long and slender, fuscous, with the scape and basal joint of funicle ferruginous, inserted well beyond middle in ♂ and with the scape equal in length to the first five joints of the funicle, inserted close to base in ♀ and with the scape very short, equal to the first joint of funicle only; terminal joints of funicle elongate and slender, club more elongate than in *B. aurivillii* Mshl., the two basal joints similar in size and shape, broad and obliquely truncate at apex and strongly narrowed basally. *Prothorax* transverse, sides strongly rounded, broadest behind middle, much narrowed anteriorly and slightly so behind; upper surface slightly convex, evenly coriaceous, with a broad central stripe of bright orange and a spot of the same colour at each basal angle in both

sexes: the ♀ also has a vertical lateral orange band close to apex and a central spot on the prosternum. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides scarcely rounded and rapidly narrowed to apex; upper surface with fine shallowly punctured striae; the intervals plane and coarsely coriaceous, covered with fine grey scaling and having a short basal orange stripe along the suture, which also extends shortly along each side of the base; each elytron with a median transverse orange band extending from near the margin up to the third interval, but sometimes abbreviated or interrupted; under surface with a broad transverse lateral orange band on both the meso- and metasternum, and a lateral orange spot on the second abdominal segment. *Legs* black, with rather thin grey scaling; all femora armed with a sharp simple tooth; in ♂ the anterior femora have a fringe of long white hairs along the basal half of the under surface; tibiae not uncinatae, the anterior pair in ♂ strongly curved at apex and with a sharp median tooth.

NATAL: Malvern (*C. N. Barker*).

TYPES, ♂ in British Museum, ♀ in Oxford Museum.

I have much pleasure in dedicating this pretty and distinct species to my friend Mr. C. N. Barker, who has done so much to increase our knowledge of the insects of the Natal Coast. He informs me that he has found it feeding on a small thorny tree, known as the "Impafa" (*Zizyphus mucronata*).

BALANINUS DIVERSICORNIS, sp. nov. (Plate LXVII. fig. 9.)

Long. 3, lat. $1\frac{2}{5}$ mm. Rostrum ♂ $1\frac{4}{5}$, ♀ $3\frac{2}{5}$ mm.

Colour castaneous; scaling on thorax dark brown (sometimes with a slightly coppery reflection), with a central white stripe which is broader basally; scaling on elytra castaneous, with a clouding of white scales, which are denser laterally and round the scutellum.

Head globose, closely punctured and with sparse pale scaling; eyes comparatively small and distant, scarcely larger in ♂. *Rostrum* very slender, dark testaceous; in ♂, porrect in basal half, which is strigoso-punctate and sparsely squamose, apical half curved, bare and minutely punctured; in ♀, porrect for two-thirds of its length, then distinctly curved, bare and impunctate except at extreme base. *Antennae* testaceous, inserted beyond middle in ♂ and well behind middle in ♀; joints 3-7 of funicle equal, very small, transverse and submoniliform; club extremely elongate, as long as the whole funicle; joint 1 elongate, longer than first joint of funicle, narrow and only slightly broadened apically; joint 2 of equal length, but distinctly narrower at base and strongly clavate apically, being closely appressed to the two very short terminal joints. *Prothorax* as long as broad, subconical, broadest at base and narrowed to apex, sides slightly rounded and with a faint constriction near apex; upper surface convex, evenly coriaceous throughout; scaling dense, dark chestnut-brown, with a pale central stripe gradually widening from apex

to base; prosternum with uniform white scaling. *Elytra* ovate, broadest at shoulders, which are roundly prominent, sides gently rounded and rapidly narrowed to apex; upper surface convex, with rather strong and distinctly punctured striæ, the intervals plane and coriaceous; scaling rather sparse, castaneous, the lateral margins and a large area about the scutellum dusted with white scales; the scutellum with dense, the under parts with sparse, white scaling. *Legs* testaceous with thin pale scaling; all the femora armed with a stout tooth which is denticulate internally; tibiæ not uncinatæ.

MASHONALAND: Salisbury (*G. A. K. M.*).

TYPES, ♂ in British Museum, ♀ in Oxford Museum.

Found on a species of wild fig.

The aberrant form of the antennal club in this species is very remarkable, and owing to the unusual diminution of the funicular joints the slender basal joints of the club might at first sight be mistaken for a portion of the funicle. In all other respects the insect is a typical *Balaninus*, and this structure cannot be considered as having a generic value owing to the fact that a gradual development of the club in this direction may be traced through *B. aurivillii* and *B. barkeri*.

The foregoing five species of *Balaninus* all belong to the typical form of the genus characterised by the evident lateral angulation of the second abdominal segment, the strongly appendiculate tarsal claws, the widely separated intermediate coxæ, the basally porrect rostrum, and the excessive length of the latter organ in the ♀ sex only.

Of this group only a single South African species has been previously described, viz. *B. suturifer* Fähr. The following key will perhaps facilitate the identification of the six species:—

- | | | |
|----------|---|---------------------------------------|
| 1. (2.) | Femora unarmed | <i>B. suturifer</i> Fähr. |
| 2. (1.) | All femora armed with a strong tooth. | |
| 3. (6.) | Second joint of antennal club strongly transverse; tibiæ uncinatæ. | |
| 4. (5.) | Joint 7 of funicle much longer than 6, appressed to the club; size larger..... | <i>B. nubifer</i> , sp. nov. |
| 5. (4.) | Joints 6 and 7 of funicle subequal, the latter not appressed to the club; size smaller | <i>B. ficorum</i> , sp. nov. |
| 6. (3.) | Second joint of antennal club longer than broad; tibiæ not uncinatæ. | |
| 7. (12.) | Antennal club much shorter than funicle; femoral tooth simple. | |
| 8. (11.) | Scape much longer than first joint of funicle. | |
| 9. (10.) | Anterior tibiæ with no median internal tooth; prothorax without a central stripe of orange scales . | <i>B. aurivillii</i> , sp. nov., ♂ ♀. |
| 10. (9.) | Anterior tibiæ with a sharp median internal tooth; prothorax with a central orange stripe..... | <i>B. barkeri</i> , sp. nov., ♂. |
| 11. (8.) | Scape only as long as first joint of funicle... | <i>B. barkeri</i> , sp. nov., ♀. |
| 12. (7.) | Antennal club as long as whole of funicle; femoral tooth denticulate internally | <i>B. diversicornis</i> , sp. nov. |

Of the remaining *Balanini* described from South Africa, the majority will have to be assigned to the genus *Timola* Pasc., of which the type is *Balaninus suturalis* Boh. This species has

been redescribed by Pascoe (Journ. Linn. Soc., Zool. 1886, vol. xix. p. 332), but fortunately under the same name as that given by Boheman.

EUDERES NATALIS, sp. nov. (Plate LXVII. fig. 6.)

Long. 7, lat. $2\frac{3}{5}$ mm.

Colour entirely dark red-brown, with sparse recumbent yellow setæ.

Head hemispherical, rugosely punctured, with a shallow impression between the eyes and with scattered depressed yellow setæ; eyes lateral, large, subdepressed and coarsely faceted. *Rostrum* as long as the prothorax, curved, narrowed from base to middle, apical half parallel-sided and somewhat depressed; upper surface bare, coarsely punctured at base but more finely towards apex. *Antennæ* ferruginous, with dense pale setæ. *Prothorax* transverse, apical margin slightly sinuate dorsally, base evidently bisinuate, sides subparallel from base to beyond middle, thence strongly narrowed to apex; upper surface sparsely setose, with large irregular shallow punctures, the intervals between which form depressed undulating longitudinal carinæ. *Elytra* oblongo-ovate, jointly trisinuate at base, which is a little broader than the prothorax, sides subparallel from base to about middle, thence narrowed to apex; upper surface convex, with deep striæ containing large oblong separated punctures, the intervals broad, plane, and rugosely punctured; setæ sparse, rather more dense round the scutellum and at the humeral angles. *Legs* ferruginous, with depressed yellow setæ; femora with a small tooth; tibiæ with four fine carinæ on the outer surface.

NATAL: Drakensberg (*G. A. K. M.*).

TYPE in the British Museum.

Nearly allied to *E. lineicollis* Wied., which, however, may at once be distinguished by its prothorax, which bears fifteen very distinct straight and smooth carinæ; the intervals of the elytra are also less closely punctured. In both species the anterior coxæ are only slightly separated and the prosternum is very shallowly excavate. *E. lineicollis* I have found in *Protea* flowers on Table Mt., and it is apparently confined to the Western Districts of Cape Colony.

EUDEROIDES, gen. nov. (Euderinæ.)

Head retracted, almost invisible from above; eyes large, elongate, lateral, coarsely faceted and widely separated above. *Rostrum* short, straight, deflected, slightly depressed and rounded laterally; scrobes deep, almost straight, oblique, reaching the eyes and not uniting inferiorly. *Antennæ* short, scape just reaching eyes; funicle 7-jointed, joints 1 and 2 elongate and conical, the former being a little longer and much thicker, 3-7 short transverse and closely set; club broadly ovate and evidently 3-jointed. *Prothorax* rather longer than broad, base bisinuate, apex broadly produced over the head, sides rounded; prosternum

with a broad deep furrow having elevated sides but not continued beyond the anterior coxæ, which are broadly separated. *Scutellum* small, punctiform. *Sternum* elongate, mesosternal process broadly truncate and deeply vertical anteriorly, metasternal epimera not upwardly produced. *Elytra* elongate, jointly sinuate at base, covering the pygidium, convex, with ten complete striæ. *Abdomen* with the segments truncate, 2 much longer than 3 and 4 together. *Legs* short, the posterior tibiæ only just exceeding the apex of elytra; femora stout, scarcely clavate, all armed with a strong tooth; tibiæ slightly curved at base, subcompressed, unciniate, not carinate externally, their corbels open, elongate and very oblique; tarsi with the third joint broadly lobate, claws strongly appendiculate.

TYPE: *Euderoides mossambica*, sp. nov.

In general facies this genus very closely resembles *Euderus* Schh., but differs in the following important particulars: the retracted head, the more widely separated eyes, the deep post-sternal furrow, the broadly separated anterior coxæ, the non-carinate tibiæ and the obliquity of the corbels in the posterior pairs.

EUDEROIDES MOSSAMBICA, sp. nov. (Plate LXVII. fig. 4.)

Long. 8, lat. $3\frac{1}{2}$ mm.

Colour uniform piceous black throughout, with sparse depressed, golden setæ.

Head retracted, hemispherical, rugosely punctured and without impressions. *Rostrum* shorter than the anterior tibiæ, scarcely curved, gradually dilated from base to apex; upper surface slightly convex, shallowly punctate and with a narrow smooth central line. *Antennæ* short, dark ferruginous, with the club fuscous. *Prothorax* a trifle longer than broad, base bisinuate, much broader than apex, dorsal apical margin broadly and roundly produced over the head, sides moderately rounded, broadest about middle; upper surface almost plane, rugosely punctured throughout and with a fine abbreviated central carina. *Elytra* elongate, oblongo-ovate, jointly sinuate at base and there slightly broader than the base of the thorax; shoulders oblique, sides parallel from there to beyond middle; upper surface convex, with broad striæ containing shallow punctures, the intervals plane, finely rugose and with short depressed golden setæ. *Legs* rather short and stout, rugose and sparsely setose, all the femora armed with a short tooth.

PORTUGUESE E. AFRICA: Beira (*P. A. Sheppard*).

TYPE in the British Museum.

NEIPHAGUS MASHUNUS, sp. nov. (Plate LXVII. fig. 10.)

Long. 9-12, lat. $5-6\frac{1}{2}$ mm.

Head deeply and rugosely punctured, with scattered setiform

scaling, forehead flattened; eyes coarsely faceted. *Rostrum* rather longer than prothorax, gradually dilated apically, rugosely punctured throughout, with a shallow lateral furrow from insertion of antennæ to eye filled with pale scaling; scrobes short, oblique, rapidly disappearing beneath rostrum. *Antennæ* with the three basal joints of funicle elongate, 2 being the longest, 5-7 very short, 4 half as long again. *Prothorax* shorter than its width at base, subtriangular, broadest at base and rapidly narrowed to apex, its sides slightly rounded, base bisinuate, apex strongly produced above the head, and with small but distinct ocular lobes; upper surface rather convex and with a low blunt prominence on each side of disk before middle, deeply and rugosely punctured throughout and with brownish and yellowish setiform scaling, which is directed forwards. *Elytra* very broad, subquadrate, the sides slightly rounded, half as broad again as the prothorax at the shoulders, which are produced into a blunt prominence, base gently trisinuate; upper surface very convex and steeply declivous behind, with regular shallow sulci containing rows of large subreticulate foveæ, the intervals closely and rugosely punctured, rather convex, except the first which is plane; intervals 2, 4 and 6 each with three distant tubercles bearing tufts of erect black, or dark brown, setæ, the tubercles being so placed as to form three strongly curved transverse rows on each elytron; colour black or dark ferruginous, variegated with rather thin brownish or whitish setiform scaling. *Legs* comparatively slender, rugosely punctured and with dense pale setæ and scaling; anterior femora not dentate; anterior pairs of tibiæ slightly curved and with two sharp spurs above the apical spine; tarsi with the third joint much broader than the others, onychium elongate.

MASHONALAND: Salisbury (*G. A. K. M.*), Umtali (*A. Bodong & G. A. K. M.*).

TYPE in the British Museum.

A very distinct species, differing from its congeners in its less angulated elytra, much thinner legs, unarmed femora and elongate onychium. In general appearance it comes nearest to *N. fascicularis* Pasc., a Central African species which has recently been taken by Mr. P. A. Sheppard at Amatonga's on the Beira Railway.

PACHYONYX NIVEUS, sp. nov.

Long. 8, lat. 3 mm.

Head subglobose, closely punctured and with dense white scaling; eyes large, coarsely granulate and meeting inferiorly. *Rostrum* about as long as prothorax, subcylindrical and slightly curved; upper surface bare, shining and with small scattered punctures; colour castaneous. *Antennæ* inserted a little in front of middle, entirely light ferruginous. *Prothorax* a little shorter than the basal width, broadest at base, the sides gradually

narrowed to near apex where there is a broad constriction, base slightly rounded, apex broadly produced above the head; upper surface convex with four sharp discal prominences on the anterior part, the finer sculpturing being entirely hidden by very dense scaling; the entire underparts and sides, up to, and including, the outer half of the discal prominences, pure white; the central portion light brown, leaving a mere trace of a central carina in the middle and having a large T-shaped white marking on the basal half. *Elytra* oblong, jointly sinuate at base, much broader than prothorax at shoulders, which are sharply and obliquely prominent, sides straight and parallel to far beyond middle, apices separately produced into very short but sharp processes; upper surface convex, gibbous, deepest at shoulders and rapidly declivous posteriorly, with regular rows of deep foveolæ, the intervals somewhat uneven and with low rounded tubercles, the most prominent on each elytron being: a short curved basal row of three, a longer very oblique median row of three, a juxta-sutural tubercle on the summit of the declivity and a larger discal one on the declivity; the sculpturing is, however, largely hidden by dense snow-white scaling which covers the whole surface except the extreme apex, which is light brown, and a small quadrate dark brown patch round the scutellum, which is itself covered with light brown scales. *Legs* covered with whitish-brown scales and short depressed white setæ, the femora with a white band not far from apex.

ORANGE RIVER COLONY: Bothaville (*Dr. H. Brauns*). MATABELELAND: Plumtree (*Father O'Neil*).

TYPE in the British Museum.

Its remarkable white coloration, the absence of fascicles on the elytra, and the thinner and less coarsely punctured rostrum will at once distinguish this insect from *P. affaber* Boh., hitherto the only other described South-African species.

PACHYONYX TRIANGULARIS, sp. nov. (Plate LXVII. fig. 8.)

Long. $5\frac{1}{2}$ -6, lat. $2\frac{1}{2}$ - $2\frac{3}{4}$ mm.

Head subglobose, closely punctured and with sparse depressed fulvous setæ; eyes large, coarsely granulate and meeting inferiorly. *Rostrum* as long as prothorax, cylindrical, curved, dark piceous but becoming paler at apex, evenly and strongly punctured, bare, moderately shining. *Antennæ* inserted a trifle in front of middle, ferruginous. *Prothorax* rather shorter than the basal width, broadest at base, the sides rapidly narrowed to apex where there is a broad but shallow constriction, base rounded, apex broadly produced above the head; upper surface convex, with four blunt discal prominences on the anterior part, the posterior part with large shallow punctures more or less hidden by fine whitish-brown scaling, having a low bare central carina; the prominences clothed with denser yellowish-brown scaling. *Elytra* jointly sinuate at base, obliquely truncate at

apex, broader than prothorax at shoulders, which are rounded and very sloping, and from there very gradually narrowed to apex; upper surface convex, gibbous, deepest just behind shoulders and rapidly declivous posteriorly, with regular rows of large deep foveolæ; the intervals narrow, finely aciculate and without any trace of tubercles or fascicles; sculpturing partially hidden by fine scaling which is light brown on disk, becoming indefinitely paler towards apex, with a triangular yellowish-white patch round scutellum, and a large white triangular lateral patch, the base of which extends along almost the entire margin, the apex reaching the fifth stria. *Legs* punctate, covered with dense light brown scaling.

NATAL: Verulam (*G. A. K. M.*).

TYPE in the British Museum.

Apart from its very different coloration, this species differs from *P. affaber* Boh. in its very sloping shoulders (in the latter they are roundly rectangular), in its narrower and more finely punctured rostrum, in the absence of any tubercles or fascicles on the elytra, and the smaller and more regular basal foveolæ on the basal half.

P. niveus may be distinguished from the present species not only by its striking colouring, but also by its more elongate, parallel-sided and tuberculate elytra, which, moreover, are not so much produced apically as in *affaber* or *triangularis*.

ENDEUS FLORALIS, sp. nov. (Plate LXVII. fig. 1.)

Long. $3-3\frac{2}{5}$, lat. $1\frac{2}{5}-1\frac{3}{5}$ mm.

Colour entirely dark fulvous, with only the eyes black; evenly clothed with fine recumbent yellow pubescence, which is not, however, sufficiently dense to conceal the sculpturing.

Head convex; eyes rather prominent, the space between them about half the width of the rostrum. *Rostrum* as long as the prothorax in ♂, distinctly longer in ♀, subcylindrical, slightly curved, strigoso-punctate and finely pubescent above. *Antennæ* comparatively short and stout, inserted about middle in ♀, but well in front of middle in ♂. *Prothorax* much broader than long, strongly constricted close to apex, which is obliquely truncate, base much broader and subtruncate, sides strongly rounded, broadest behind middle; upper surface convex, with close distinct punctuation throughout. *Elytra* oblongo-ovate, comparatively broad ($2\frac{2}{5} \times 1\frac{3}{5}$ mm.), with fine distinctly punctured striæ, the intervals almost plane, finely aciculate; pubescence fine, quite recumbent and with a silky appearance. *Legs* with a stout tooth on all the femora, the anterior tibiæ strongly dilated towards apex.

TYPES, ♂ in the British Museum, ♀ in the Oxford Museum.

MASHONALAND: Salisbury (*G. A. K. M.*).

I have found this species in the flowers of *Crinum*, *Protea*, and *Anona senegalensis*, and have also taken it flying at sundown.

ENDEUS BAUHINIAE, sp. nov.

Long. $3-3\frac{3}{5}$, lat. $1\frac{1}{5}-1\frac{3}{5}$ mm.

Colour uniform dull ferruginous varying to flavous; eyes black; entire upper surface thinly clothed with short depressed golden yellow pubescence.

Head convex; eyes scarcely prominent, the space between them equal to about one-third the width of the rostrum. *Rostrum* as long as the prothorax in ♂, longer than that of *E. floralis* but otherwise similar. *Antennae* rather more slender than in that species, inserted well before middle. *Prothorax* almost as long as broad, faintly constricted near apex which is obliquely truncate, base evidently broader and truncate, sides rounded, broadest behind middle; upper surface slightly convex, closely and distinctly punctured throughout. *Elytra* oblongo-ovate, more elongate ($2\frac{2}{5} \times 1\frac{2}{5}$ mm.), gently convex, with distinct and strongly punctured striae, the intervals plane, faintly aciculate; pubescence short and recumbent, but distinctly coarser than in *E. floralis*, and thus without the silky appearance. *Legs* similar to those of *E. floralis* except that the anterior tibiae are distinctly less dilated apically.

MASHONALAND: Salisbury (G. A. K. M.).

TYPE in the British Museum.

Found on the leaves of a species of *Bauhinia*.

ENDEUS HISPIDUS, sp. nov.

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

Colour dark ferruginous, the suture and eyes black; legs and antennae paler, antennal club fuscous; upper surface with short erect pale setae which are longer on the elytra.

Head convex; eyes more widely separated, the intervening space being nearly as broad as the rostrum. *Rostrum* as in *E. floralis*. *Antennae* more slender, inserted not far from apex in ♂. *Prothorax* a little broader than long, evidently constricted near apex, slightly broader at base, sides moderately rounded, broadest about middle; upper surface convex, with close even punctation and fairly dense suberect pale setae. *Elytra* oblongo-ovate, convex, with rather deep strongly punctured striae, the intervals plane and almost impunctate, bearing regular rows of short erect pale setae. *Legs* as in *E. floralis* except that the anterior tibiae are not at all dilated apically.

MASHONALAND: Salisbury (G. A. K. M.).

TYPES, ♀ in the British Museum, ♂ in the Oxford Museum.

Found on leaves of *Protea* and *Brachystegia*.

The only other described species of *Endeus* of which I am aware are *E. castus* Boh., from Sierra Leone (the type of the genus), and *E. parilis* Fst. (Deutsch. ent. Zeit. 1898, p. 28), from Cameroon. Of the latter I have seen no examples, but I examined the type

of *castus* at Stockholm a few years ago. The five species may be discriminated by the following characters:—

- | | | |
|---------|---|-------------------------------|
| 1. (6.) | Elytra with recumbent pubescence, and without rows of erect setæ. | |
| 2. (5.) | Prothorax much broader than long, the sides strongly rounded. | |
| 3. (4.) | Anterior tibiæ strongly dilated towards apex; eyes approximated, prominent; prothorax strongly constricted at apex. | <i>E. floralis</i> , sp. nov. |
| 4. (3.) | Anterior tibiæ scarcely dilated; eyes more distant, not prominent; prothorax only slightly constricted at apex. | <i>E. castus</i> Boh. |
| 5. (2.) | Prothorax almost as long as broad, its sides only moderately rounded | <i>E. baubinia</i> , sp. nov. |
| 6. (1.) | Elytra with rows of erect or suberect setæ. | |
| 7. (8.) | Space between the eyes almost as broad as the rostrum. | <i>E. hispidus</i> , sp. nov. |
| 8. (7.) | Space between the eyes only as broad as the scape of the antennæ | <i>E. parilis</i> Fst. |

ACANTHORRHINUS CARINATUS, sp. nov. (Plate LXVII. fig. 12.)

Long. $8\frac{1}{2}$, lat. 3 mm.

Head short, strongly punctured on vertex, forehead with a broad and deep central furrow which is continued on to base of rostrum. *Rostrum* about as long as anterior tibia, subcompressed, broadest at base and somewhat narrowed anteriorly, slightly curved; upper surface convex, finely and evenly punctured throughout, with a short deep central impression at base (continuous with that on head) and a short lateral impression in front of each eye; under surface with two longitudinal furrows uniting at base, but with no prominences; antennæ black, glabrous. *Prothorax* longer than broad, base rounded and much broader than apex which is truncate, sides subparallel in the basal half, then roundly narrowed and with a constriction at apex; upper surface almost plane, with very deep, subremote punctures leaving a smooth central line; colour dull black, bare. *Elytra* jointly sinuate at base, rather broader than prothorax at shoulders, which are sloping, and from there very gradually narrowed posteriorly, the apices separately rounded; upper surface slightly convex, with regular deeply punctured striæ; the intervals narrow and impunctate, the 2nd, 4th and 6th depressed, the others elevated and carinate; colour dull black, bare. *Legs* black, bare, strongly punctured; femora and tibiæ with a fringe of pale setæ along their lower edges.

NATAL: Malvern (*C. N. Barker*), Estcourt (*G. A. K. M.*). MASHONALAND: Salisbury (*G. A. K. M.*). PORTUGUESE E. AFRICA: Beira (*P. A. Sheppard.*)

TYPE in the British Museum.

A very distinct species owing to the alternate elevation of the intervals on the elytra; the fringe of setæ on the femora is also a character peculiar to it.

ACANTHORRHINUS ZAMBESIANUS, sp. nov.

Long. 10, lat. 4 mm.

Head subglobose, vertex convex, black, shining and with fine scattered punctuation. *Rostrum* slightly curved and not angulated, rather ascending the forehead at base, with a slight rounded dilatation above the insertion of the antennæ and gradually narrowed anteriorly, finely and closely punctured throughout, with a deep subtriangular central impression at base which is continued to the apex, in the ♂ as a deep narrow furrow, in the ♀ as a faint shallow stria; sides with a deep furrow from the eye to apex, but narrowly interrupted not far from base; scrobes produced anteriorly as a broad shallow furrow; underside with a broad central furrow, in the ♂ the carina on each side of it bears a short but distinct tooth in front of the antennæ, which is quite wanting in the ♀. *Prothorax* much longer than broad, broadest at base, very gradually narrowed to beyond middle, then more rapidly so to apex where there is a shallow constriction; upper surface slightly convex, black, bare, shining, with close, but fine and faint, punctuation throughout. *Elytra* jointly sinuate at base, broader than prothorax at shoulders, which are very sloping, and from there gradually narrowed posteriorly (less so in ♀); upper surface rather convex, with very deep and strongly punctured striae; the intervals narrow, subcarinate, impunctate, the third rather broader than the others. *Legs* black shiny, almost impunctate; the tibiae only with a fringe of yellow setæ along their inferior edges.

MASHONALAND: Salisbury (*G. A. K. M.*).

Types, ♂ in the British Museum, ♀ in the Oxford Museum.

Apart from its much smaller size and the obsolete punctuation on both surfaces, this species differs from *A. dregei* in its much straighter, slightly curved rostrum. The rostral tooth is also much smaller and does not curve forwards in the ♂; while the rostrum of the ♀ entirely lacks the two inferior tubercles which are present in *dregei*.

CYRTORRHINUS CASTANEIPENNIS Boh.

Sphenophorus castaneipennis Boh., Schh. Gen. Curc. viii. 2, p. 249 (1845).

Cyrtorhinus baridioides Lac., Gen. Col. vii. p. 293, note 1, pl. 76, f. 3 (1866)—colour variety.

Cyrtorhinus caffer Fähr., Öfv. K. Vet.-Ak. Förh. 1871, p. 282.

Liocealandra nuda Chev., Ann. Soc. Ent. Belg. 1881, p. 92—local race.

Polyaulax castaneipennis Boh., Chev. Ann. Soc. Ent. Fr. 1885, p. 95.

When at Stockholm in 1902 I had an opportunity of com-

paring the types of *C. caffer* Fähr. and *Sphen. castaneipennis* Boh., and there can be no question as to their specific identity.

The form *baridioides*, described by Lacordaire as the type of his genus *Cyrtorhinus*, offers no structural difference whatever from the typical Natal form of *castaneipennis* and differs solely in the black colour of its elytra, a character which cannot be here regarded as of specific value. The form *nuda* Chev., however, from Equatorial Africa presents a striking structural difference from the Natal type in the complete, or almost complete, absence of punctuation on the thorax and the intervals of the elytra; and at first sight it would appear to be a good and distinct species. But an examination of Rhodesian examples shows this character in an exactly intermediate condition, and as some specimens of *nuda* show distinct traces of punctuation it is only possible to regard that form as an extreme local race of the southern species. The occurrence of red elytra in the *nuda* form appears to be unusual, most specimens being of a rather intermediate piceous brown colouring; whereas in the south there is a sharp division between the black and red forms. In *nuda* the legs vary also from piceous to red, whereas in South Africa all the varieties have black legs only. The punctuation of the thorax does not diminish progressively northwards, for the most heavily punctured specimens I have seen come from Beira; and the Nyasaland examples appear generally to be intermediate between those of Rhodesia and Natal.

The two genera *Liocalandra* and *Polyaulax* founded by Chevrolat must be sunk as synonyms of *Cyrtorhinus* Lac.

NOTES ON SYNONYMY &c.

Alcides (mouffleti Est.), Ann. Soc. Ent. Belg. 1899, p. 14 = *A. glanvillei* Pér., Trans. S. A. Phil. Soc. 1885, p. 143.

(*Attelabus*) *carneolus* Pér., Trans. Ent. Soc. 1896, p. 188, is an *Apoderus*.

(*Rhynchites*) *algoensis* Pér., Trans. S. A. Phil. Soc. 1888, p. 176, is an *Attelabus*.

Synthocus (sagittarius Pér.), op. cit. 1885, p. 139 = *S. nigropictus* Pasce.

Ithyporus (capensis Boh.) = *I. stolidus* F., the type of the latter being in the British Museum (coll. Banks).

Brachycerus (frontalis Fähr.), the type of which is in the Oxford Museum, = *B. hystrix* Schh. This name was applied by Schönherr to "*B. cornutus* Oliv." (nec L.), which was described and figured by Olivier from a specimen, still extant, in the Banksian collection.

Theates (cristatus Pér.), Trans. S. A. Phil. Soc. 1888, p. 163, pl. 3, f. 14 = (*T. magus* Auriv.), Ent. Tidsk. 1888, p. 153, t. 2, ff. 1-3 = *T. angusticollis* Wied. (*Brachycerus*).

- (*Megaproctus*) (*zanzibarinus* Desbr.), C. R. Soc. Ent. Belg. 1891, p. 361, note 1 = *Stenophida* (*linearis* Pasc.), Journ. Linn. Soc., Zool. xix. 1886, p. 336 = (*Liocalandra*) *pygialis* Fairm., C. R. Ent. Belg. 1884, p. cxlviii.
- (*Cychoironus*) *viduatus* Pasc., Journ. Linn. Soc., Zool. xi. 1871, p. 163, is a *Chaunoderus*.
- Hipporrhinus* (*bertinæ* Fst.), Stett. ent. Zeit. 1891, p. 385 = *H. varius* Fähr. In my revision of *Hipporrhinus* (Proc. Zool. Soc. 1904, i. p. 141) I erroneously attributed this species to the genus *Stramia* Mshl., but through the kindness of Dr. Heller, of Dresden, I have now been able to examine Faust's type.

Dr. Heller's kind assistance has also enabled me to clear up the following synonymy:—

- (*Hypomeces*) (*impressicollis* Pér.) Trans. S. A. Phil. Soc. 1885, p. 125 = *Dereodus vagabundus* Fst., Ent. Nachr. 1885, p. 7; and (*H. modestus* Pér.) l. c. p. 126 = *Dereodus schönherri* Fst., l. c. p. 5. Faust's paper was published in March, while Péringuey's was only read on the 27th May. So far as I am aware the genus *Hypomeces* does not occur in Africa.

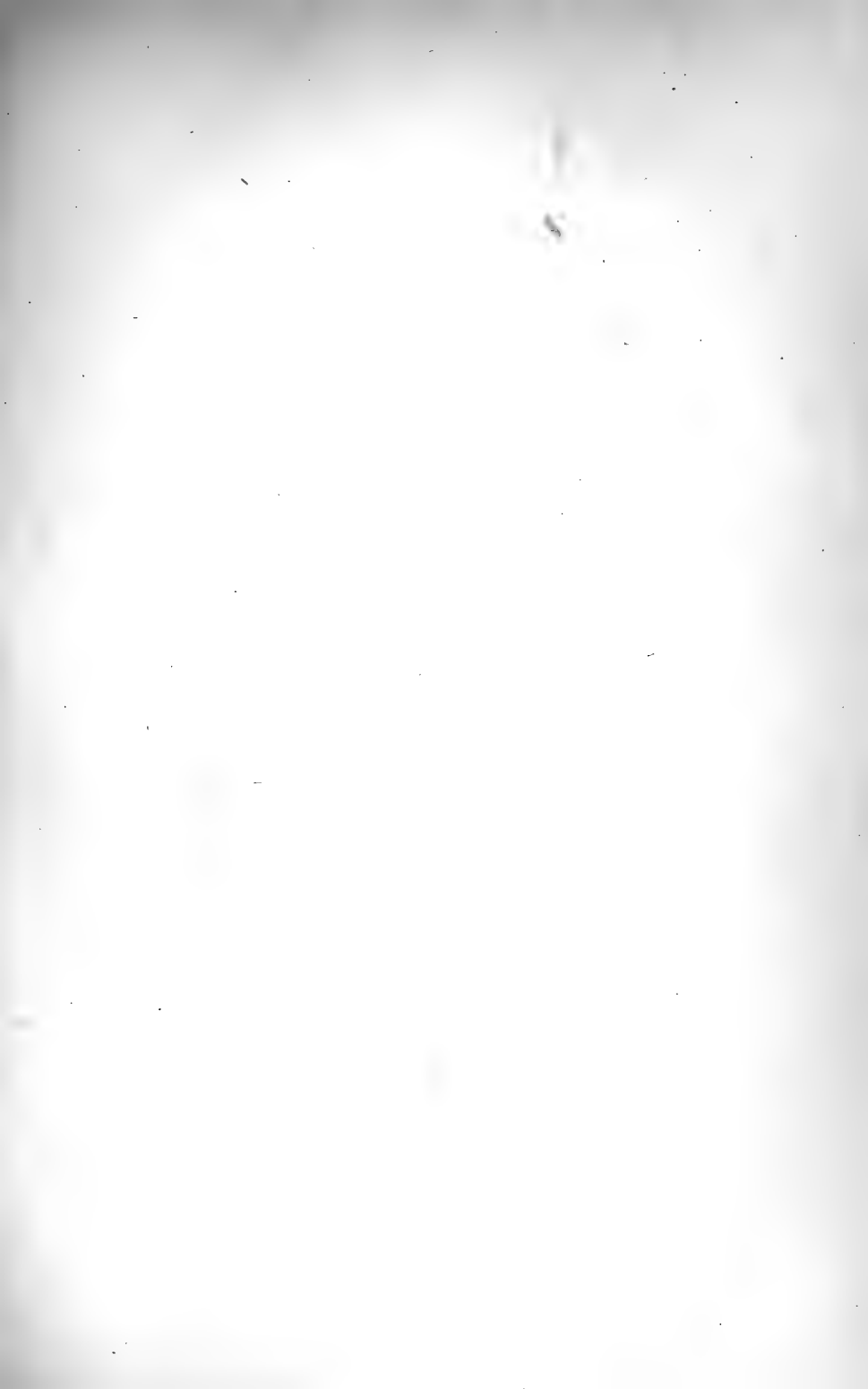
EXPLANATION OF THE PLATES.

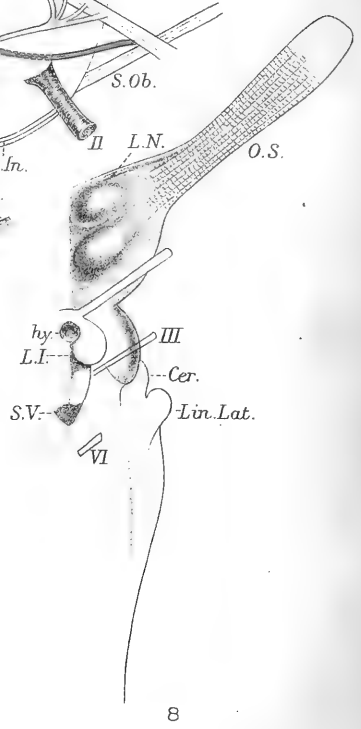
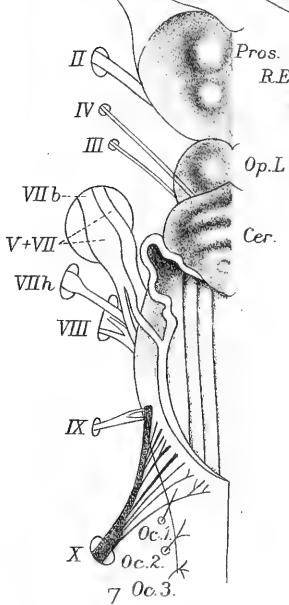
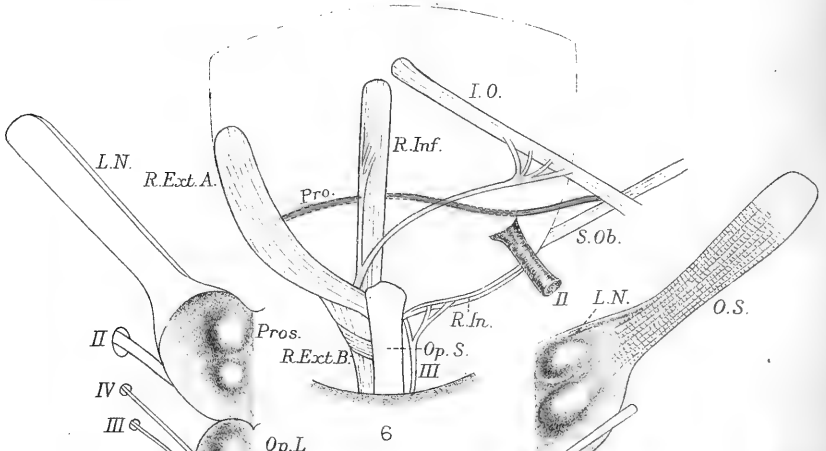
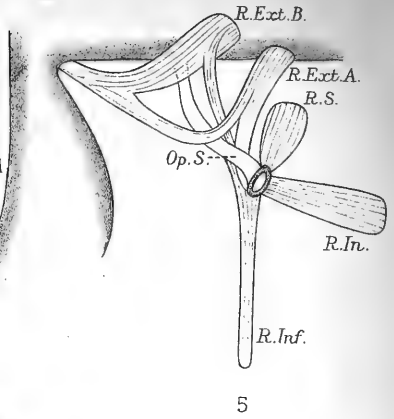
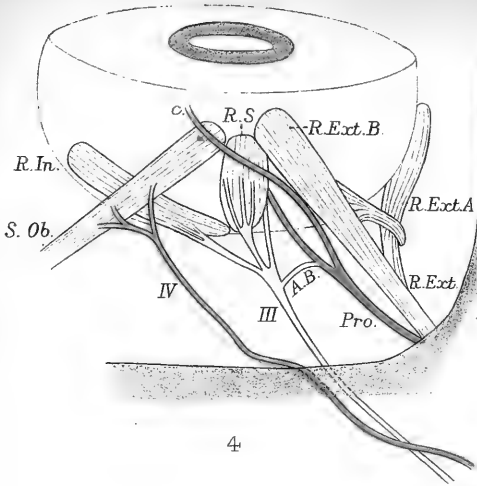
PLATE LXVI.

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| Fig. | | Fig. |
| 1. <i>Ectatops sheppardi</i> ♀, p. 911. | | 7. <i>Cyclomus simplex</i> ♀, p. 931. |
| 2. <i>Strophosomus sulcatifrons</i> ,
p. 914. | | 8. <i>Rhyparosomus mashunus</i> , p. 933. |
| 3. <i>Strophosomus acuticollis</i> , p. 914. | | 9. <i>Diabuthrarius velutinus</i> , p. 934. |
| 4. <i>Rhinosophus mutabilis</i> , p. 920. | | 10. " <i>setulosus</i> , p. 934. |
| 5. <i>Systates dentipes</i> ♂, p. 921. | | 11. <i>Hypsomus parvus</i> , p. 935. |
| 6. <i>Cyclomus algoensis</i> ♀, p. 930. | | 12. <i>Bagus punctipennis</i> , p. 936. |

PLATE LXVII.

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| Fig. | | Fig. |
| 1. <i>Endeus floralis</i> , p. 953. | | 8. <i>Pachyonyx triangularis</i> , p. 952. |
| 2. <i>Phacemastia poultoni</i> , p. 942. | | 9, 9 a. <i>Balaninus diversicornis</i> ♀,
p. 947. |
| 3. " <i>pardalis</i> , p. 941. | | 10. <i>Neiphagus mashunus</i> , p. 950. |
| 4, 4 a. <i>Euderoides mossambica</i> , p. 950. | | 11. <i>Aplemonus zizyphi</i> , p. 943. |
| 5, 5 a. <i>Balaninus fitorum</i> ♀, p. 944. | | 12. <i>Acanthorrhinus carinatus</i> , p. 943. |
| 6. <i>Euderus natalis</i> , p. 949. | | |
| 7. <i>Balaninus barkeri</i> ♀, p. 946. | | |





3. The Cranial and Spinal Nerves of *Chlamydoselachus anguineus* (Gar.). By Mrs. O. A. MERRITT HAWKES, M.Sc. (Zoological Laboratory University of Birmingham)*.

[Received November 8, 1906.]

(Plates LXVIII. & LXIX.†, and Text-figures 140, 141.)

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A. INTRODUCTION.

The following research was undertaken on the advice of Mr. F. J. Cole of Liverpool University, who, somewhat more than a year ago, sent me a specimen of *Chlamydoselachus anguineus* (♀), suggesting that I should dissect the cranial nerves. The specimen had been preserved in alcohol, but unfortunately the finer branches, or branches which were deeply situated, were not well preserved. Professor Bridge then kindly wrote for a formalin-preserved specimen (♂) from Japan, of which he allowed me to dissect the viscera and one side of the head. Mr. G. A. Boulenger, of the Natural History Museum, South Kensington, allowed me to examine the specimens in his charge and to dissect the last branchial arch of one specimen.

The alcohol-preserved specimen was in such a condition that microscopical work was quite useless. A number of stains were tried without success.

Unfortunately the cranium had not been opened in the formalin-preserved specimen, but it has been possible to do some partially successful microscopical work on the nerves. I am hoping later to continue this microscopical work in order to add to and verify

* Communicated by Professor T. W. BRIDGE, F.R.S., F.Z.S.

† For explanation of the Plates, see p. 990.

the results arrived at by the less reliable method of macro-dissection. The formalin had made the subcutaneous tissue so hard that thin sections of the skin have at present been impossible, hence the observations made by means of such sections on the lateral-line canals and the ampullæ of Lorenzini have not been satisfactory. I expect, however, to obtain better results in time.

Mr. Cole hoped that the nervous system of so low a species would throw some considerable light upon the nerve-component theory. The external relations of the nerves have proved of great interest, and have given some new and unexpected data, but the nervous system of *Chlamydoselachus* cannot be considered known until small specimens have been completely sectionised and the animal thus reconstructed.

Not only the nerves, but every part of *Chlamydoselachus* has proved of interest, owing to the combination of primitive and specialised characteristics. These points will, I hope, be eventually submitted to the test of embryological investigation.

A small bibliography only is appended, as a complete list of papers on nerves can be found in the works of Herrick, Cole, and Johnston.

I wish to heartily thank Professor Bridge for his continual help during the progress of this work and for his valuable revision of the MS.; Mr. Cole not only for the gift of the specimen, but for suggestions and help on the completed work. Thanks are also due to Professor K. Mitsukuri, of Tokio, who sent the *Chlamydoselachus* to Mr. Cole in order that its nerves and sense-organs might be investigated, and to Mr. G. A. Boulenger for references and for loan of books and for permission to examine the specimens in his charge.

B. THE LATERAL LINE SYSTEM.

The Lateral Line System comprises canals upon both the head and body, the former being much more complicated than is usual among Elasmobranchs (except Rays and Skates). The parts of the body over which the canals pass were the only relations Garman (10. p. 82) considered in naming the canals, and thus his nomenclature depends upon the apparent instead of the real relation of parts. As Garman's names are valueless in comparative anatomy, it is now necessary to rename the canals in accordance with Cole's method, *i. e.* with reference to the innervation. And as we may take it that a canal innervated by a well-defined nerve represents one unit of the system, this method of nomenclature brings analogous parts of the system of different species into line with one another.

The *Supra-orbital canal* (Plate LXVIII. fig. 1, B, C, D), which includes the cranial, rostral, and subrostral canals of Garman, and is innervated by the superficial ophthalmic branch of the *Facialis*, passes forward along the top of the head, just above the eye. Like all the closed canals of *Chlamydoselachus*, it lies immediately under the skin, from which it is not easily dissected. In front

of the eye, the canal bends outward towards the nostril, then curves upward and forward almost to the end of the snout, where it suddenly turns backward, passes above the nostril, and finally bends ventrad to join the Infra-orbital canal at D. In the supra-orbital canal of one specimen there were 55 neuromasts and openings on one side and 49 on the other. A second specimen had 41 on one side and 40 on the other. The sense-organs, as judged by the point of entrance of the nerve, are usually opposite the canal-openings in the supra-orbital as well as in the other canals. The openings may be at the end of short tubules, or on the canal itself. The longest tubules on this canal are less than 5 mm. in length, and these are found near the point of union with the Infra-orbital canal. Throughout the head-canals the neuromasts are placed at approximately regular distances (5 mm.) apart. According to Garman's figure (10. pl. xvii.) there is a canal uniting the anterior end of the Infra-orbital canal with the most anterior point of the supra-orbital canal. This additional canal is called by Garman, the prenasal canal. It was not present in the specimens dissected by me, and there was no trace of its openings in the specimens examined externally. From Garman's description it is not possible to determine whether the prenasal canal joins the infra-orbital. In Garman's figure (10. pl. xvii.) the supra-orbital (rostral and subrostral canals) curves forward much higher up the snout than in the specimens examined, in which case an additional canal would probably extend on to the snout. But it is improbable that this canal would join with the infra-orbital.

The *Infra-orbital canal* (A, B, E, D, F), which includes the occipital, orbital, orbito-nasal, and nasal canals of Garman, innervated by the buccalis and otic branches of the Facialis, begins at A as a direct continuation of the main lateral canal. It gives off the supra-orbital canal, and then passes downwards behind the eye. This portion is curved, the first third being directed forward and the remainder backward. The backward curve was probably produced by the lengthening of the jaws. At a point above the mouth (E), but not as caudad as the angle, the canal bends sharply forwards and runs along the upper jaw under the nostril to terminate at the median line, close to its fellow of the opposite side, from which it is separated only by a thin wall. In one specimen this canal had 52 neuromasts and openings on one side, and 50 on the other. In a second specimen the numbers were 47 and 46 respectively. The longest tubules in *Chlamydoselachus* occur on this canal, in the first part of its post-orbital ventral course. Here a few tubules reach a length of 1 cm.

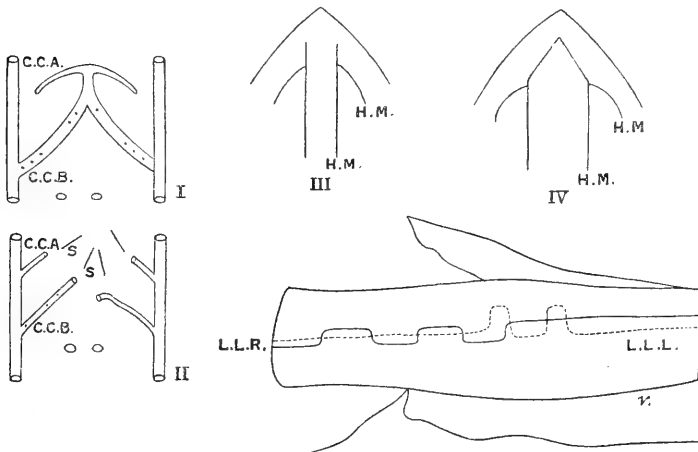
The *Hyomandibular canal* (E, G, J, L, K, I), which includes the angular, jugular, spiracular, oral, and gular canals of Garman (10), innervated by the external mandibular branch of the Facialis, is the most extensive and complicated part of the canal system. It branches out from the infra-orbital canal to run backwards above and beyond the mouth, with a somewhat tortuous

course, for a distance of 5 cm. This portion of the canal, which is closed, is probably the original hyomandibular canal, to which the other parts have subsequently been added. In one specimen there were here 15 neuromasts. Tubules are present in the first part of the canal only. Somewhat caudad to the mouth a branch (G, H, I) is given off, which, curving round the mouth, runs along the lower jaw to the symphysis (Plate LXVIII. fig. 1, H, L, A). This branch is an open canal, and in one case had 19 neuromasts. On the left side of one specimen 1 cm. of this canal was closed. It may be mentioned that in this closed region, although there were four neuromasts, there were no external openings corresponding to them. A second open canal (J, L, K, H) leaves the main hyomandibular canal at J. This branch (H, L, B) makes a wide curve downward and then forward to meet the last-mentioned canal at H, shortly before its termination. One side of one specimen had 42 neuromasts in this branch. In six out of the seven specimens examined externally, the hyomandibular canals of the two sides appeared to join at I. In the seventh specimen, however, the regions H, I, of the two sides were parallel and unconnected. Doubtless this was the original condition. The branch H, L, B, on one side of a single specimen, had a break of 1 cm. At first sight this break might seem to indicate that this was the point where the two branches G, H, K and J, L, K united, but when we see the canals in relation to their nerve supply, it is obvious that this cannot be the case. Undoubtedly the two canals met and united at H. There is a dorsal branch canal (L, M), narrow, shallow, and superficial, which curves upward and forward towards the lateral canal. In one specimen 10 neuromasts were present. One of the specimens had, on both sides, another small hyomandibular branch (N) and a curious partial twist in the region J, L, which terminated in a fine branch (O). Branches N and O are no longer functional. There is only a very slight depression in the skin, bordered by the usual triangular scales which functionally close the "open" canals. In the depression there is neither sensory tube nor neuromast. No nerve could be traced to these canals. It may be, however, that microscopical work would discover what macroscopical methods have failed to disclose. If these, probably degenerate canals occurred in a large number of specimens they would indicate that the canal-system of *Chlamydo-selachus* in this region had become simplified by the partial atrophy of certain of its branches. As, however, these canals were found in only one specimen out of seven, they must, for the present, probably be regarded as an individual variation.

The *Commissural or Supra-temporal canal* (or canals), the aural canal of Garman, is placed, as noticed by Garman, anterior to the openings of the ductus endolymphaticus. It is never the usual straight, transverse canal connecting the right and left lateral canals. It varies considerably, as shown in text-fig. 140. There are indications of two instead of one commissural canal, but it is

impossible to state whether the present condition of these canals is vestigial or rudimentary. It is certain, however, that the condition of all the canals, but especially those in this region, is very unstable. The canals vary in their length, course, and diameter. The neuromasts, both as regards number and position, are very variable, but in every case they are supplied by dorsal branches of the lateralis vagi. In the specimen from which II. (text-fig. 140) was taken, lines (*s, s*) appeared to be drawn on the skin; these were found to be due to the scales, which were triangular in shape and arranged in two parallel interlocking lines, exactly as the scales are arranged above all the open canals. These "lines" may represent either the first step towards the formation of new canals or the last step in the degeneration of canals. The latter is the more probable, as if the former were the case we should expect to find neuromasts present, but so far neither neuromasts nor nerves have been traced.

Text-fig. 140.

Variations in Lateral Line Canals of *Chlamydoselachus*.

- I., II. Commissural canal.
 III., IV. Ventral view of Hyomandibular canal under the lower jaws.
 V. Lateral canal in region of dorsal fin.
 C.C.A., C.C.B. Anterior and posterior portions of Commissural canal.
 H.M. Parts of Hyomandibular canal.
 L.L.R., L.L.L. Lateral canal on right and left sides.

It is worth noting that the specimen from which II. (text-fig. 140) was drawn had also covering scales arranged in lines, dorsal to, and at right angles to, the lateral canal. These "lines" occurred at irregular intervals for a distance of 3 cm. The scales, which produced the appearance of lines, may be remnants of a condition in which the main canal had lateral branches. This

suggestion is perhaps confirmed by finding one such lateral branch, nearly 1.5 cm. in length, in the tail-region of another specimen.

The *Lateral canal* runs in the usual position from the head to the end of the tail, and is noteworthy owing to the fact that only the first inch is closed. The neuromasts occur at much more irregular intervals than is the case in the head-canals. In all the specimens examined there is a tendency in the region of the dorsal fin (text-fig. 140, V) to a departure from a straight line. In two specimens this tendency produced four distinct undulations. Similar undulations have been found in *Callorhynchus* (Cam. Nat. Hist., Fishes, T. W. Bridge, fig. 269, p. 470). In other cases the canal undulated slightly. No explanation of this phenomenon can be offered. This same region had on one side, in one specimen, a complete break of 5 mm. There was in this space no trace of canal or of covering scales. Garman also found curves and breaks on this canal in the tail-region.

The conclusion arrived at from these facts is that the lateral line system of *Chlamydoselachus* is primitive as regards (1) the open condition of a portion of the canals; (2) the cutaneous rather than subcutaneous position of the canals; (3) the entire absence of tubules in many places. In the occipital and hyo-mandibular regions, however, the system tends to a considerable complexity. Again there are indications, in the occipital and lateral canals, of either a vestigial or rudimentary complexity.

The innervation is an additional difficulty in the determination of the relations of this system. The lateralis branches of the Facialis present no difficulty, but if there are proved to be fibres of the ninth nerve innervating a few lateralis sense-organs, these must be regarded as an additional proof of the comparatively primitive nature of the system. The lateralis nerves in origin were probably related morphologically to a number of segments, and later became concentrated into the main trunks of the Facialis, Auditory and Vagus nerves. The fact that *Chlamydoselachus* has four lateralis roots, two for the buccalis, one for the external mandibularis, and one for the r. lateralis vagi, probably indicates a comparatively primitive condition for this system.

C. THE AMPULLÆ OF LORENZINI.

In *Chlamydoselachus* the anatomy and the arrangement of the ampullæ differ from those of the higher Elasmobranchs.

The anterior, latero-dorsad surface of the head, from the level of the eye to the end of the snout, is covered by ampullary openings which are divided into two groups by the Supra-orbital canal. The ampullæ of this whole region are innervated by the r. superficialis ophthalmicus VII. and are therefore probably homologous with the usual supra-orbital group of ampullæ. This group may, in *Chlamydoselachus* also, be called the supra-orbital.

A second group of ampullæ is found between the post-orbital portion of the infra-orbital lateral line canal and the spiracle. It

begins somewhat above the level of the eye, but does not extend quite as far ventrally as the level of the mouth. This group cannot be considered the equivalent of the mandibular ampullæ, for it is innervated by a number of small branches from the ramus buccalis. It may be called a postero-buccal group of ampullæ in order to bring its nomenclature into line with that of the other group innervated by the r. buccalis. This group may correspond to the occipital row of ampullæ in *Chimæra* (3. p. 655), parts of which were innervated by a branch of the r. oticus. There is in *Chlamydoselachus* no representative of the mandibular group. The latter may in Elasmobranchs have arisen as a caudad offshoot of the postero-orbital group, which, owing to its position, acquired a hyomandibular innervation. On the other hand, the mandibular group may have arisen independently of a group such as the postero-orbital, coincident with the disappearance of the latter.

A third, very diffuse group of openings occurs along the upper jaw immediately above the mouth. It extends from the anterior extremity of the head almost to the angle of the mouth. The group is innervated by numerous branches from the r. buccalis, and is no doubt homologous with both the outer and inner buccal groups of ampullæ of the higher Elasmobranchs, if we are to consider with Allis (1. p. 93) "that the surface ampullary pore represents approximately the place of origin of the ampullary organ." The group may be called the buccal group.

A fourth, very small group occurs at the symphysis of the lower jaw. The number of openings in this group varied from one to nine in the specimens examined. This group is innervated by a branch of the hyomandibular nerve, and represents the hyoid group of the Elasmobranchs.

It is evident, on close inspection, that what appears to be a single ampullary opening is in reality a group of openings placed closely together in an area devoid of scales. The number of openings in each group is usually four, but may be reduced to two or increased to six. When traced inwards each opening is found to lead into a thin-walled tubule, the tubules from each group of openings being united. Each tubule terminates in a number of ampullary pouches. A complete group is never more than 5 mm. long and lies almost parallel to the surface of the body. Each group is independent, so that the term "group of ampullæ" represents in this species a very different anatomical entity from what it does in the majority of Elasmobranchs. In *Chlamydoselachus* there are many superficial scattered groups of minute compound ampullæ, which together represent the usual, single deep-seated group of much longer simple ampullæ. The small groups here may be compared with those described by Collinge in *Chimæra* (5. fig. 9, B). The tubules are almost transparent, having very thin walls, consisting of a single layer of flattened cells. The cells pass gradually into the columnar cells which line the ampullary pouches. The latter cells have the granular

appearance of secreting cells. Each tubule ends in a group of ampullary pouches, which are joined with those of the other tubules into a compact mass. Unfortunately, it has not been possible to determine certainly whether the lumen in the pouch-region of each tubule remains distinct, or whether the lumina of this region of the tubules communicate. On the whole, the evidence indicates the former.

It is impossible to state the exact homology of these ampullæ with those such as are found in, say, *Læmargus*, as the development of both is unknown. But, judging from the work of Coggi, it seems possible that each compound group of ampullæ in *Chlamydoselachus* and in *Chimæra* is produced by what Coggi (2. p. 295) calls the "stadio di ampolla individualizzata," whilst *Læmargus*-like tubules are each produced by the direct development of one of the above "ampolla individualizzata." Hence, from the embryological point of view, each group of compound ampullæ in *Chlamydoselachus* may be regarded as the homologue of a single ampullary tubule such as is found in *Læmargus*, &c.

D. THE EYE, EYE-MUSCLES, AND NERVES.

The eye is deeply seated in a socket, the external outline of which has the shape of a biconvex lens. There are both upper and lower eyelids, but no nictitating membrane. The infolding of the skin in both cases is sudden and distinct, that of the lower lid is remarkable for its depth, extending almost to the back of the eye. The infolded membrane both above and below the eye is deeply pigmented, the lower being also provided with fine scales. This pigmentation, which on the under side of the eye is as deep as that of the surface of the body, together with the presence of scales, indicates that the infolded portions become, at times (that is when the eye is protruded), a part of the superficial skin. Those portions of the inner surface of the eyelids which are never evaginated are quite smooth and of a light colour. The eye can easily be protruded, and when in this position does not look outwards but upwards, a position made possible by the large conjunctival fornix. It is known that *Chlamydoselachus* is a deep-sea fish, in which case an eye which could look upwards would be of the greatest advantage. This protrusible eye no doubt also explains the marked cephalad position of the optic nerve, which is thus placed because the movement is not only upwards but slightly anterior.

To keep the eye well out in the socket there is an optic stalk or rod of cartilage, common amongst Elasmobranchs (12. p. 25), which also serves here as a base of origin for the recti muscles. The eye-stalk is somewhat more than 1 cm. in length and about 3 mm. in diameter. It is attached to the side of the cranium, near the base, just in front of the trigemino-facialis foramen. The stalk is directed forwards in a curved line and ends in a flattened, enlarged knob which is applied to the inner

surface of the eyeball without, however, being attached to it. The *Torpedo*, for example, has an eye-stalk which differs considerably from that of *Chlamydoselachus*, inasmuch as it is attached to the cranium in a more anterior region of the orbit, is permanently fixed to the eyeball, and does not serve as a basis of attachment for any of the eye-muscles. The eye-stalk of *Torpedo* keeps the eye permanently protruded, while in *Chlamydoselachus* its function is two-fold — to prevent the eye sinking too far into the socket, and to supply a more lateral basis for the attachment of the muscles.

The *External Rectus* muscle consists of two parts which have separate origins and insertions. The two parts of the muscle are, however, not independent, for they are united by strands of muscle-fibres passing from one to the other. Division A (Plate LXIX. figs. 4, 5, 6, R.Ext.A) of the muscle is the smaller. Its origin is on the outer part of the optic stalk, its insertion on the posterior surface of the eyeball, *i. e.* the normal insertion of an undivided externus rectus. Division B (R.Ext.B) is twice as large as A. Its origin is from the basis cranii, just anterior to the auditory capsule and beneath the foramen for the ganglia of the trigeminal and facial nerves, as well as along the proximal part of the optic stalk. The insertion is on the dorsal side of the eyeball, somewhat more external than that of the rectus superior, which it partly overlaps. From the position of its origin and insertion, division B (R.Ext.B) must be considered as a secondary or derivative portion of the rectus externus. The innervation supports this view. The main portion of the sixth nerve passes over division B to end in small branches in A, whilst several small, but side branches are given off to supply B. This secondary muscle was probably split off from a normal external rectus and acquired a more proximal origin, to aid the rectus superior and the superior oblique in tilting the eye upwards. It seems almost to form a pair with this latter muscle. Another modification in connection with this rotation is the shortening of the rectus superior and the lengthening of the rectus inferior, the latter being almost three times the length of the former.

The *Superior* and *Inferior Oblique* muscles are both long and narrow. Their attachment is to the median anterior wall of the orbit immediately to the inner side of the orbito-nasal foramen. The superior oblique is attached a little more dorsally than its fellow, and is inserted nearly in the mid-dorsal line of the eyeball, close to the rectus superior and the B (R.Ext.B) division of the rectus externus. The inferior oblique is inserted nearly in the mid-ventral line of the eyeball near the rectus inferior.

The *Patheticus* or *fourth nerve* has its origin in the usual position, on the dorsal side of the brain, between the optic lobe and the cerebellum; it runs outwards and upwards to pass by a special foramen into the orbit, where it reaches the superior oblique muscle after a sinuous course.

The *Oculo-motor* arises from the ventral surface of the brain

between the optic lobes and runs outwards and slightly upwards to pass into the orbit through its own foramen. In the orbit it soon divides into the typical three branches, one branch going to the rectus internus, the second to the rectus superior, and the third dividing into a short and a long branch, of which the former supplies the rectus inferior and the latter the inferior oblique.

The *Recti Superior, Internus, and Inferior* are all attached to the top of the optic stalk, just below its flattened head. The rectus superior is a short wide muscle with a narrow attachment to the stalk and a wide insertion upon the eyeball. This muscle is inserted somewhat to the caudad side of the median line of the eyeball, and is partly overlapped by the superior oblique and the dorsal division of the rectus externus. The rectus internus is both longer and broader than the rectus superior. It passes under the superior oblique to be inserted on the anterior wall of the eyeball, more to the dorsal than to the internal side. It thus has a somewhat unusual insertion, and can therefore help in the extra pull given to the dorsal side of the eyeball, when the latter is twisted upwards. It will be seen from the figure (Plate LXIX. fig. 4) that the dorsal side of the eyeball has practically four, instead of the usual two muscles. The rectus inferior is longer and narrower than the rectus internus. It has a double attachment to the optic stalk, one immediately under the knob and the other, the smaller, at a distance along the stalk itself. This muscle is inserted into the eyeball in the median ventral line, to the inner side of the inferior oblique.

The eye of *Chlamydoselachus* has practically three groups of muscles: a dorsal group of four inserted near the angle of the eyeball; a posterior "group" of one inserted also near the angle; and a ventral group of two elongated muscles three times the length of the dorsal group, acting on the median ventral line, at a distance from the angle of the eyeball. The dorsal group is strengthened to move the eye upwards, while the ventral group merely pulls the eyeball back into the position of rest, and hence does not need to be so powerful.

E. THE TRIGEMINO-FACIAL COMPLEX.

The Trigeminal and Facial nerves are in parts of their course indistinguishable at first sight. This impression, although merely superficial, at the same time undoubtedly expresses a very strong tendency towards the union and confusion of these two nerves. No complete union between the nerves has been found, except for a distance of about 1 cm. on the left side, where a branch of the r. buccalis and of the r. maxillaris are inseparable. The appearance of union occurs chiefly in the region just beyond the orbit, where there are plexiform connections between the buccalis VII., mandibularis V., maxillaris V., and their branches. Here, when two or more nerves

come into close contact, they are loosely or tightly bound together by connective tissue, but, in all cases except the one mentioned above, in such a way that a separation can be effected by careful dissection. The smaller branches and these pseudo-unions vary considerably on the two sides of the same specimen and in different specimens. The variability, which is met with in every system of *Chlamydoselachus*, suggests that the species has considerable anatomical instability.

1. *The Trigeminal Nerve.*

The Trigeminal nerve originates by one broad root from the side of the medulla, at a lower level than the first and second roots of the Facialis, but on a level with the auditory and hyo-mandibular roots. This root is almost completely hidden in a side view by the buccalis ganglion. Shortly after the root leaves the brain it swells into the Gasserian ganglion, which is rounded on the inner, but flattened on the outer side, where it is covered by the buccalis ganglion (Plate LXVIII. figs. 2 & 3). The presence of one root only is surprising when it is known that both sensory and motor components are present. It is probable that serial sections would demonstrate two roots. On the inner side, somewhat anteriorly, there is a small swelling from which the profundus and the superficial ophthalmic V. are given off side by side as nerves of equal size, to pass forward parallel to one another for a short distance (Plate LXVIII. figs. 2 & 3).

The maxillary and mandibular rami are immediately given off from the end of the ganglion, there being no common maxillo-mandibular trunk.

(a) The *maxillaris*, the smaller of the two branches, passes obliquely downwards across the orbit, sending many branches ventrally. These, together with the branches into which the main nerve itself divides, supply somewhat more than the anterior half of the upper jaw with the associated tissues. The smaller maxillary branches divide into a great number of small branches at the outer part of the masseter muscle, over which the majority pass, to terminate just above the mucosa of the roof of the mouth and along the under and outer side of the upper jaw cartilage. Although this nerve does not usually contain communis fibres, the distribution of some of the above branches suggests that such may be present. No visceral branches have been found which might correspond with those of the maxillaris V. and mandibularis V. which Cole describes in *Chimara* (3. p. 650). But the many small branches which terminate in the mucosa of the roof of the mouth probably consist of communis fibres, and therefore represent the visceralis branch of the maxillaris V. of *Chimara*. Herrick, who in his *Menidia* paper regards the Trigeminal as a branchiomic nerve, says (13. p. 414):—"The pretrematic ramus, or r. maxillaris, has typically only general cutaneous fibres;" "the absence of a prefacial fasciculus

communis and communis root of the trigeminus involves the lack of a r. palatinus for this segment. Functionally this is replaced by the forward extension of the r. palatinus VII." This statement is supported by Johnston, who says (15. p. 208) there is "no communis component in the Trigemini and no viscerosensory center in this segment." These statements are probably generally true, but there are some apparent exceptions to it, for in Amphibia, in *Amia*, in *Gadus*, in *Amiurus*, in *Chimera*, and here in *Chlamydoselachus*, there are trigeminal visceral branches. It will, however, probably be proved in all these species, as it has been in *Amia*, that this communis component belongs to the Facialis, and has only secondarily become united with the Trigemini. If the Trigemini were a branchiomic nerve we would expect to find a representative of the ramus visceralis, and as such we might have interpreted the visceralis elements which occur in the above-named species; but if, as Johnston says, the segment to which the Trigemini belongs has no viscerosensory centre and little or perhaps no entodermal area, this nerve cannot be branchiomic at all, for a typical branchiomic nerve should contain (15. p. 262) "a communis component distributed by way of the post-trematic, pre-trematic, and pharyngeal rami to the mucosæ" of its entodermal area.

(b) The mandibular branch, which is almost twice the size of the maxillary, passes obliquely backwards, giving off ventrally a number (3 or 4) of branches which supply the posterior half of the upper jaw, and must therefore be regarded as representing a portion of the maxillaris. On the caudad side, it sends off numerous small nerves into the masseter muscle. As the r. mandibularis passes along the lower jaw it sends more branches into the masseter muscle, which extends towards the mid-ventral line. At a point just before the insertion of this muscle a nerve is given off which soon divides into two equal branches: one of these supplies the perichondrium of the mandibular cartilage, whilst the other branch divides into numerous small branches which terminate in the skin near the symphysis. The mandibular ramus does not supply the large median muscles which lie in the angle made by the two sides of the lower jaw. The components in the mandibular ramus are motor and sensory (general cutaneous), the latter predominating.

It is somewhat exceptional for the maxillary and mandibular rami to come off directly from the Gasserian ganglion. Does the arrangement indicate (1) a primitive condition, or (2) a specialised condition due to the backward rotation of the angle of the jaw? Regarding the Trigemini as a branchiomic nerve, it must be borne in mind that the pre- and post-trematic rami come immediately from the ganglion, a condition still to be found in the Facialis and in many branchial nerves; later, the pre- and post-trematic branches tend to join for a short distance. The result of this union in the supposedly branchiomic trigeminal nerve was to produce the usual maxillo-mandibular trunk. But in

Chlamydoselachus an intermediate condition is found, for the mandibular ramus has bound up with it a portion of the ramus maxillaris. If the upper and lower jaws in this species were of normal length it might be thought that maxillary and mandibular rami were taking the first step towards union, but on account of the great length of the jaws, which have undoubtedly considerably pulled back the mandibular as well as pushed back the hyomandibular and following nerves, it seems more probable that this backward extension of the jaw has either incompletely torn apart the maxillary and mandibular rami or prevented their complete union. If, however, the Trigeminal is to be regarded as of cerebro-spinal rather than of branchiomic type, it might be considered as primitive indeed, consisting of a dorsal sensory ramus (r. maxillaris) and a ventral mixed ramus (r. mandibularis); but again, when we consider the influence of the specialised jaw, we have as much ground for supposing that the jaw has produced a splitting of a common sensorio-motor trunk as that the condition now found is a remnant of a primitive state in which each cerebro-spinal "nerve" was represented by two distinct rami.

(c) The *profundus* nerve, or ramus, originates, as stated above, from a small enlargement on the inner side of the Gasserian ganglion; hence, as in *Chimera* (3) and *Petromyzon* (16), there is undoubted evidence that, at the present time, the profundus is a branch of the Trigeminal, although in origin it belongs to a more anterior segment (15. p. 206). On entering the orbit the nerve passes between the large rectus externus muscle and the cranial wall, sending dorsally a long ciliary nerve which ends around the upper part of the eyeball. The main nerve then passes outward, parallel with the oculo-motor nerve, to which it sends or from which it receives an anastomosing branch. Five mm. beyond the origin of the ciliary branch the profundus passes somewhat ventrally between the eyeball and the external rectus muscle to disappear in the eyeball, near the point of insertion of the ventral part of the external rectus muscle. The profundus passes for about 1 cm. under the covering membrane of the eyeball, emerging near the point where the optic nerve originates from the eyeball. The nerve then passes anteriorly and out of the orbit immediately to the outer side of the attachment of the inferior oblique muscle. Almost at once the nerve divides into a number of branches, which spread over the olfactory capsules immediately below the skin. No motor fibres were found in this region. No fusion with the superficial ophthalmic facialis (as in *Chimera* and other cartilaginous fishes) has been found, nor with the superficial ophthalmic trigeminal (as in *Amia*). In *Petromyzon* (15) Johnston states that one complete branch of the profundus is derived from the VIIth ganglion, and "would correspond with the typical ramus ophthalmicus superficialis VII." of Selachians. He also found a second branch, of which the fibres are supposed to be derived from the trigeminal ganglion;

this branch he considers "would correspond to the ramus ophthalmicus superficialis V. of Selachians" (15. p. 157). This being the case, the profundus of *Petromyzon* combines the conditions found both in *Chimæra* and *Amia*. Perhaps microscopical work would show some connection between these nerves in *Chlamydoselachus*, unless, indeed, the condition of the profundus is here more primitive even than in *Petromyzon*.

The anastomosing branch (Plate LXIX. fig. 4) between the profundus and oculo-motor nerves, mentioned above, is interesting in its relation to the theory that the latter is the motor representative of the primitive profundus nerve, for it may represent a connection which originally existed between these two nerves. But if this relationship does not exist, what may this connection signify? May it not be suggested that, as the radix brevis has not been found and may not be present, this connection between the profundus and oculo-motor nerves represents the fibres which connect the ciliary ganglion and the oculo-motor nerve, which here pass not directly to the ciliary ganglion, but by way of the profundus nerve?

(d) The *superficial ophthalmic V.* passes from the Gasserian ganglion side by side with the profundus nerve, which it equals in size. It at once passes dorsally and enters the same groove as the superficialis VII., with which, however, it does not unite. About as far forward as the external nares, but nearer the median line, it spreads out into many branches, which lie immediately under the skin. This nerve apparently contains only cutaneous elements, and hence has "the primary composition of this nerve" (13. p. 365). The condition of the s. ophthalmic V. in *Chlamydoselachus* is similar to that found by Cole and Dakin (4) in one specimen of *Chimæra*, where the ophthalmicus superficialis trigemini was in no way connected with the ophthalmic VII., and arose "from the main trunk of the trigeminus."

II. *The Facialis Nerve.*

The *Facialis* is made up in *Chlamydoselachus*, as in all fishes, of two distinct and yet united parts, the lateralis element and the usual factors of a branchiomic nerve; of these parts the former is the more obvious, for the branchiomic branches are of comparatively inconsiderable proportions. The anterior part of the *Facialis*, which consists of the buccal ganglion and of two nerves, the ramus superficialis ophthalmicus facialis and the ramus buccalis, is entirely lateralis. The posterior portion of the *Facialis* consists of the truncus hyomandibularis, which contains a large lateralis element as well as parts of a branchiomic nerve.

The buccalis ganglion (Plate LXVIII. figs. 2 & 3), which overlies and is partly united to the Gasserian ganglion, arises by two roots of approximately equal diameter: of these one (A) is more anterior and somewhat more dorsal in position and also longer than the other (B), which arises just above the roots of the

t. hyomandibularis. On the inner and caudad side the trigemino-facial ganglion sends three fine nerve-strands to the hyomandibular ganglion. There is to the naked eye no indication of a separate ganglion for the superficialis ophthalmicus VII., which is given off at right angles from the anterior end of the composite ganglion. Roots A and B, which are undoubtedly lateralis, give rise to the buccalis and ophthalmic-facialis rami, whereas the corresponding roots of *Chimæra* (4) give rise not only to these lateralis nerves but also to the external mandibularis. It will be interesting to know whether in *Chlamydoselachus*, as well as in *Chimæra*, each of these lateralis rami is made up of fibres from both roots.

(a) The *superficialis ophthalmicus* VII. passes forward and slightly upward. The nerve lies at first in a groove in the cartilage, but soon this groove becomes a complete canal. At frequent intervals from the very origin, the nerve gives off branches to the supra-orbital lateral-line canal. When, somewhat beyond the anterior wall of the orbit, the nerve makes a bend outwards, it sends off a great number of branches to supply the two groups of supra-orbital ampullæ of Lorenzini and the neuromasts in the anterior loop of the supra-orbital canal. The main nerve here bends downwards to supply the last 15 neuromasts of the supra-orbital canal.

(b) The ramus *buccalis* originates from the inner posterior angle of the buccal ganglion. It passes obliquely downward and forward across the orbit and the side of the head, towards the mouth in the region of the external nares. Beginning at its origin, the nerve gives off many small branches, which pass backward and downward to supply the neuromasts of the infra-orbital canal. There are about eleven principal branches, nearly all being distributed both to ampullæ of Lorenzini and to neuromasts. The first branch is probably the equivalent of the ramus oticus (Plate LXVIII. fig. 1, R.O.). It passes upwards and caudad, and divides into two branches outside the orbit, one of which supplies the first neuromasts of the infra-orbital canal, while the other bends outwards to supply neuromasts in the post-orbital portion of the same canal. Two minute branches (Plate LXVIII. fig. 1, R.O.c.) were traced to the skin, so that the ramus oticus contains general cutaneous fibres. Herrick thinks that the r. oticus is the dorsal branch of the Facialis, to which lateralis fibres have been added, and that the presence of cutaneous fibres determines the identity of this ramus. From the relations of the r. oticus to the buccalis—a lateralis ganglion—it seems more probable that the ramus was primitively lateralis, and that to it cutaneous fibres have been added. Should we not be more likely to find the dorsal branch of the Facialis in connection with the other portions of the true facial nerve? If the term r. oticus is to be confined to a ramus which supplies neuromasts in the first portion of the infra-orbital canal but does not supply any neuromasts in the descending post-orbital part of

that canal, then this ramus in *Chlamydoselachus* is equivalent to the *true* ramus oticus *plus* a few more nerve-fibres. The r. oticus does not supply all the sense-organs which occur in the region of the canal anterior to the commissural canal, but apparently two of these are supplied by a dorsal branch of the Glossopharyngeus and the remainder by a dorsal branch of the Vagus.

The branches of the ramus buccalis are arranged approximately in two groups: one group being associated with the maxillary branches of the mandibularis V., and the other with the branches of the maxillaris V. The branches not only supply the diffuse group of ampullæ which occurs above the mouth, but also a group which lies between the descending portion of the infra-orbital canal and the spiracle. This group is not usually represented in Elasmobranchs. It is noteworthy that each of the branches supplies both ampullæ of Lorenzini and neuromasts. This fact, and the diffuse condition of the buccalis branches seem to indicate that the nerve under discussion is in a primitive condition. The anastomoses, which are so conspicuous in dissecting the branches of the buccalis, indicate the first step from a primal to the secondary condition, such as is found in most Elasmobranchs, where the single buccalis of this species is represented by two or three main branches. There are similar anastomoses in that portion of the external mandibularis VII. where it is at some distance from the neuromasts supplied. The anastomoses in the case both of the buccalis and external mandibularis VII. indicate a secondary simplification of the nerve-supply.

(c) The truncus *hyomandibularis* of the Facialis originates from the medulla by two roots at the same level as the roots of V. and VII. It passes at first into the large foramen common to the whole trigemino-facial complex, then bends backward and passes outward through its own foramen. The distal end of the cephalad root, which is probably the external mandibular lateral line root, is connected with the Gasserian ganglion by several small strands—the rami communicantes (Plate LXVIII. fig. 2, R.C.): posteriorly, the complex hyomandibular ganglion is connected with the auditory nerve by the pars intermedia (fig. 2, P.I.). General cutaneous fibres enter the hyomandibular ganglion from the Gasserian ganglion by the rami communicantes. About 5 mm. from the brain, just as they emerge from the chondrocranium, the hyomandibular roots unite and swell into a large ganglion, bilobed at its distal extremity. The cephalad portion—the geniculate ganglion—gives rise to the pre- and post-trematic VII. rami (fig. 1, Pr.F. & Pt.F.). The caudad portion, which is the smaller, is the external mandibular ganglion—that is, the most caudad lateralis ganglion of the Facialis. This ganglion gives rise to the truncus hyomandibularis, which contains the lateralis components which separate out as the rami externi mandibulares, as well as some components of a branchiomic nerve.

There may be, in a form as low as *Chlamydoselachus*, general cutaneous fibres belonging properly to the Facialis root, as well as

those belonging to the Trigeminal; but, even there, a large cutaneous component could not be expected, for Johnston writes (15. p. 185): "That even in *Petromyzon* the dorsal and lateral portions of this area" (the cutaneous region of the hyoid segments in non-operculate forms) "are being encroached upon by the branches of the Trigemini."

After a course of about 4 cm. the truncus hyomandibularis divides into three branches, which vary slightly on the two sides. The most cephalad, the r. externus mandibularis A (fig. 1, E.M. VII. A) passes forwards to supply that closed portion of the hyomandibular canal (H.L.) which lies above the mouth, and which is the nucleus of the whole complicated hyomandibular canal of *Chlamydoselachus*. This branch innervates neuromasts only. The second branch (E.M. VII. B) passes downwards and forwards to supply the open lateral-line canal (H.L.A.) which lies along the side of the lower jaw. The nerve is continued beyond the canal to break up into a number of small branches, part of which supply a very small group of ampullæ (H.A.), the remainder being distributed to the skin. Two fine twigs (E.M. VII. D & E) are given off on the caudad side near the origin of this branch. The first (E.M. VII. D) curves upwards to supply the dorsal extension (L to M) of the hyomandibular canal; the second (E.M. VII. E) passes caudad to supply a few neuromasts in the first part of the hyomandibular canal B (J to H). These two twigs are not constant in their origin. Another branch of the t. hyomandibularis, the largest and most caudad (E.M. VII. C), passes downward and then cephalad to supply the large open lateral line canal (H.L. B) which lies towards the middle line of the lower jaw. During the first part of its course this branch lies at some distance from the canal, to which it sends numerous fine nerves. The latter anastomose frequently, recalling the condition of the long fine branches of the r. buccalis. It supplies neuromasts principally, but also sends a number of fine twigs to the skin (C.F.). Johnston finds that in *Petromyzon* (15) "The hyomandibularis certainly innervates the ventral cutaneous area of this segment." He further adds in the same paper: "It is to be expected that the same will be found in other Cyclostomes and in Selachians, and it is not surprising to find in a ganoid (*Amia*) this component persisting in the VIIth root." It still remains to be found whether the sense-organs supplied are general cutaneous or communis, and whether, if they are the former—which is probable,—that component is present in the facialis root itself or derived from the trigeminal. The former seems more likely, as there is no anatomical reason why the trigeminal cutaneous components should pass to the lower jaw by the truncus hyomandibularis when they could more easily pass directly by the ramus mandibularis V., which is typically both motor and sensory (general cutaneous). About halfway between its origin and termination r. externus mandibularis C gives off ventrally a nerve nearly as large as itself (H+M), which after a course of 4 cm.

divides into two rami. One of these (R. H.) passes to the intermandibular muscles. It was not possible to determine satisfactorily if any cutaneous fibres were present. This nerve is the ramus hyoideus. The second ramus passes inwards and forwards to be distributed to the floor of the mouth, in front of and at the sides of the tongue; presumably this consists of communis fibres, and is therefore the r. internus mandibularis.

Two nerves originate side by side from the *geniculate* ganglion, the cephalad being about twice the size of the caudad. The former is the r. pre-trematicus facialis; the latter the remnant of the r. post-trematicus facialis.

(d) The r. *post-trematicus* VII. (Pt.F.) passes somewhat backward, and at a distance of 5 mm. from its origin sends a fine branch posteriorly to be distributed to the top of the spiracle. At a further distance of 5 mm. three branches originate—two of these pass along the top and to the caudad side of the spiracle, whilst the third passes inwards and anteriorly to supply tissues of the upper jaw. The remainder of this r. post-trematicus then bends suddenly cephalad to unite with the r. pre-trematic VII. This ramus probably represents the original position of the complete r. post-trematicus VII., part of whose fibres are now united with lateralis elements to make up the t. hyomandibularis. The small size of this ramus is due to the disappearance of the spiracular gill and the reduction of the spiracle, which, in this species, is merely a pouch opening into the hyobranchial cleft. Like other degenerating nerves, it has a tendency to coalesce with neighbouring nerves: thus, here it joins the r. pre-trematicus, whilst in other cases it has coalesced with the r. mandibularis V. (13. p. 413). In a second specimen the post-trematicus divided into seven fine branches which had no connection with the pre-trematic ramus.

(e) The r. *pre-trematicus* VII. passes cephalad and downward, giving off three fine branches (fig. 1) which can be traced for only 1 cm. towards the snout into the connective tissues. After the union of pre- and post-trematic rami the two palatine branches (fig. 1, P.) are given off, and then the nerve continues its course as the chorda tympani (Pr.F. (ch.)).

(f) The rami *palatini* VII. pass cephalad on to the mucosa of the mouth, running parallel to one another, the one near the median line, the other more laterad.

(g) The *chorda tympani*, which is a direct continuation of the r. pre-trematicus, passes caudad and ventrad, immediately under the mucosa of the anterior wall of the first gill-cleft—that is, it passes along the upper jaw between the latter and the hyoid arch. The chorda was traced on to the ventral part of the mouth. On the way it gave off branches to the hyoid mucosa and a few to accompany the cartilages of the mandibular arch. This nerve fulfils every requisite for the chorda as determined by Cole (3. p. 657 on), viz. :—(1) in arising from the base of the r. palatinus; (2) in entering into branchial relations with the mandibular arch; (3) in consisting of special sensory fibres; (4) in

having a representative of the lingual branch—*i. e.*, the nerve is continued ventrally on to the pharynx. It should be pointed out, as Herrick justly says (13. p. 324), that as both pre- and post-trematic nerves must originate from the base of the geniculate ganglion, this point of origin cannot be considered a diagnostic feature for the chorda. The remaining conditions, however, are sufficient to determine the chorda, and agree also with the characters required by Herrick (13. p. 321).

Allis (1. p. 182 *seq.*) has discussed the subject generally, and comes to the conclusion that it is still uncertain whether the chorda is pre- or post-trematic, and that the whole chorda literature is in a nebulous condition. With our present knowledge Allis's conclusion cannot be considered justifiable, and for the most reliable conclusions we may still read Herrick (13. p. 316 *seq.*).

F. THE GLOSSOPHARYNGEUS.

The *Ninth* Nerve arises from the medulla by two roots. These roots, of which the cephalad is the smaller, arise in the same vertical plane, but on a lower level than the first large root of the Vagus. This first vagal root is the principal lateralis root, so that here, as "in all cartilaginous fish," the ninth nerve "arises from the medulla . . . under cover of the anterior rootlets of the lateralis" (3. p. 664). These relative positions are important, because they probably indicate that in origin the lateralis fibres arise from a segment or segments anterior to that to which the fibres of the ninth nerve belong. The cephalad root is motor, the caudad is sensory. The latter contains a strand of large medullated fibres on its cephalad side, which strand consists without doubt of the lateralis component which passes into the dorsal branch to be described later.

The roots, which soon unite, pass through the chondrocranium by a special foramen. At a distance of 1.5 cm. from the origin, and outside the chondrocranium, the nerve swells into a large ganglion. About halfway between the exit from the brain and this ganglion there appears on the nerve a somewhat elongated but obvious swelling, from the distal end of which is given off a branch which passes dorsally and somewhat inwards through the cartilage of the cranium. Shortly after entering the cartilage this dorsal branch gives off a fine twig, which passes caudad, but which unfortunately was not traceable in any case to its destination. The main dorsal branch then passes somewhat cephalad, and near the surface of the chondrocranium divides into two fine branches. One of these apparently led to a neuromast, but serial sections would be necessary to definitely demonstrate this. The other branch proceeded to the succeeding neuromast. Transverse sections were made of the dorsal branch of the Glossopharyngeus, and, for comparison, also of the dorsal branch of the Vagus. Both branches were found to consist chiefly of large medullated fibres

of the same diameter, which stained in the same way. As it is certain that the dorsal branch of the Vagus supplies neuromasts, these large fibres are no doubt lateralis fibres in the dorsal branches of both the Glossopharyngeus and Vagus. On histological grounds, therefore, the innervation of neuromasts by a dorsal branch of the Glossopharyngeus may be considered certain. Both dorsal branches, especially that of the Vagus, contained smaller medullated fibres, probably general cutaneous. The next following neuromast was supplied by the lateralis vagi. The position of these two neuromasts, which are supplied by this dorsal branch of the ninth nerve, are in approximately the same position as those innervated by the ninth nerve in some Siluroids. It should be noticed that in *Amia* the dorsal branch of the ninth nerve had a separate root and ganglion, and that this dorsal branch must be regarded as a part of the lateral-line system (3. p. 666). The portion of the nerve which it was not possible to trace probably supplied the dorsal cutaneous area, and partly represented the general cutaneous elements of a dorsal ramus. Cole (3. p. 664), speaking of the condition in *Chimera*, gives no explanation of this dorsal branch, but merely says: "a dorsal branch . . . passes straight up to the skin of the occipital region." In species in which there is no lateralis dorsal branch on the ninth nerve, these neuromasts are doubtless innervated by the r. lateralis vagi. A similar dorsal branch of the Glossopharyngeus is described by Ewart and Cole (6. p. 476) for *Leomargus*, which divided into two branches, one supplying neuromasts (three), and the caudad, which was not traced in *Chlamydo-selachus*, supplying "fibrous tissue between the muscles and the cranium."

From the inner side of the glossopharyngeal ganglion a fine nerve passes outwards above the space between the hyoid and the first branchial arches, and next bends suddenly downwards and inwards towards the roof of the mouth. It there divides into three branches, which pass forward along the roof of the pharynx, parallel and equal. In this group of branches we find the equivalent of the single visceral branch of other species.

The *pre-trematic* IX. passes along the inner side of the hyoid arch, contiguous with the efferent branchial blood-vessel. About 6 cm. from its origin the nerve divides into a number of small branches which appear to be distributed throughout the arch. These branches cannot be followed to their terminations, but are probably wholly sensory.

The *post-trematic* IX. is larger than the pre-trematic. It passes along the inner edge of the first branchial arch, sending many small branches into the filaments and two branches over the cerato-branchial cartilage at the outer angle of the arch. The main portion of the nerve terminates ventrally on the pharynx in a number of fine branches.

On the right side of one specimen the glossopharyngeal ganglion and a small portion of the post-trematic IX. were bound by connective-tissue to the Vagus. The glossopharyngeal ganglion

was so closely united with the Vagus that it required very careful dissection for separation.

G. THE VAGUS.

The *Vagus* arises by from nine to twelve roots from the hinder end of the medulla. The lateralis root, which is the most cephalad, is invariably large, the remainder are small. These small roots are not symmetrical in number and arrangement even in the same fish, much less do they agree in different fishes. The roots arise at the same level, being arranged in an arc which extends from the side of the medulla to the beginning of the spinal cord. The large lateralis root in one specimen originated 5 mm. in front of the small roots. In another specimen, however, all the roots formed a continuous group. These results both agree with and differ from those of Garman, who states (7. pp. 17 & 18): "The tenth pair (*Vagus*) is somewhat asymmetrical, having eight roots on one side and twelve on the other. There are also four pairs of ventral roots near the median line." There were no traces of any median ventral roots uniting with the vagal complex, but there have been so many differences in the specimens dissected that too much weight must not be attributed to them. On general grounds, however, it would be indeed interesting to find any median roots going to the *Vagus*, for although the *Vagus* is now regarded as a complex of ventral roots, those ventral roots are regarded as consisting of only visceral sensory and motor components. The only nerves which arise in the median position are the third and sixth—that is, two pairs of purely somatic motor nerves. These nerves come from the somatic motor tract, which lies median and ventral. Any other nerves originating in the same region would presumably also be somatic. If Garman were right, his specimen suggests the retention of the somatic motor component of the *Vagus*, whereas, in all cases, so far as is known, the remains of that component has passed into the hypoglossal (14. p. 224 *seq.*). This would indeed be a primitive condition.

The group of vagal roots passes outwards and somewhat caudad towards the vagal foramen, the separate roots uniting just before they enter the cranial wall. This composite nerve swells into a large and apparently indivisible ganglion, which lies half in and half outside the cartilaginous wall. Immediately after the union of the vagal roots, two dorsal branches (A and B) are given off. Branch A passes up through the cartilaginous wall and divides therein. The more anterior part supplies the neuromasts of the second transverse commissural canal. This is a highly variable nerve, as the neuromasts supplied differed in number from one to five even in the two specimens examined. The other and finer branches of A supply the last inch of the closed canal, *i. e.* the region between the neuromasts supplied by the Glossopharyngeus and the beginning of the open canal of the trunk. In this region the number of neuromasts supplied varied from five to eleven.

The small dorsal branches of the Vagus run very near to the dorsal branch of the ninth and it is possible that one might be mistaken for the other. Branch B passes dorsad and soon divides into a number of smaller branches which supply approximately the first 2 cm. of the open body-canal.

The posterior two-thirds of the vagal ganglion can with difficulty be partly dissected. On the inner side it consists mainly of a large portion apparently indivisible, which gives rise to the lateral line nerve and is therefore the representative of the lateral line ganglion. On the outer side it consists of the basal portions of four nerves, which in a side view hide the lateral line ganglion.

The first third of the vagal ganglion is indivisible, and presumably contains the ganglion-cells of the intestinal branch and of those branchial branches which, so far as can be seen by dissection, have no separate ganglia.

In one specimen, branches A and B arose directly from the vagal ganglion instead of between the origin of the nerve and the ganglion. Here branch B passed dorsad and then caudad for about 4 cm., giving off a number of branches which supplied between 20 and 25 neuromasts, which were situated at irregular intervals, in places being only 2 mm. apart. The first 4 cm. of the Vagus is spirally arranged within the nerve-sheath. This allows for the considerable stretching that occurs with movements of the branchial "frills."

From the lateral line ganglion there pass two equal lateral line nerves which unite into a single strand for a distance of 1 to 2 cm. These strands anastomose irregularly. The more dorsal nerve in one case gave off 8 fine branches to the neuromasts. In another specimen it gave off no branches.

(a) The *lateral line* nerve, a wide riband-like strand, passes caudad and somewhat ventrally, giving off dorsally numerous very fine nerves to the neuromasts. After a course of about 5 or 6 cm., the nerve disappears between the longitudinal dorsal muscles and passes alongside the vertebral column about 3 cm. from the surface of the body. At intervals along the body, the main nerve is separated into two strands which reunite at distances varying from 1 to 2 cm. Fine dorsal branches are given off at intervals equal to about one and a half myotomes. The branches supply from about 5 to 9 neuromasts each. They may divide either immediately after leaving the main nerve or not until near the final distribution. They have a long course (4 to 6 cm.), difficult to dissect, each describing approximately a semicircle. In *Chlamydoselachus*, as in the common Dogfish, the lateralis nerve is situated deeply, but in the former more deeply than in the latter. This is curious and difficult to explain, as the lateralis system in this species is primitive relatively to that of a Dogfish.

(b) *Vagus* 1. The first branchial division of the Vagus can be dissected out from the ganglionic mass to a point as far forwards as the first third of the ganglion. At this point the nerve has a flattened ganglionic swelling. Immediately above the second cleft

the nerve divides into the pre-trematic and post-trematic branches, of which the latter is three times the larger.

The *pre-trematic* branch runs along the caudad side of the cartilaginous rays as a single nerve, until an inch beyond the angle of the arch, when it divides. Many minute branches are sent off by the main nerve into the branchial filaments. Near its origin the pre-trematic gives off the *visceralis*, which passes immediately inwards under the epi-branchial cartilage of the first branchial arch, where it divides into two branches. One of these runs caudad, the other cephalad, above the mucosa of the roof of the mouth.

The *post-trematic* divides into two branches 1 cm. from its origin; of these the smaller (B) passes along the anterior base of the branchial filaments of the second branchial arch, the posterior (A) and larger branch also runs along the base of the filaments, but more laterad than the smaller branch. Branch A sends side-branches up into the cartilaginous branchial rays and to the muscles thereof, as well as some branches which pass between the rays, apparently to the pre-trematic filaments of the succeeding cleft. Branch A chiefly supplies the muscles and rays, whilst branch B supplies filaments.

(c) *Vagus 2* also begins in the ganglionic mass with a flattened ganglion. The nerve then passes obliquely backwards for about 4 cm. before it divides into the pre- and post-trematic branches over the third branchial cleft. The pre-trematic is only half the size of the post-trematic. It runs as a main nerve to the end of the arch, and many small branches are sent from it into the filaments. Less than 5 mm. from its origin it gives rise to the small *ramus visceralis*. This branch passes backward and inward over the top of the cleft and under the epi-branchial cartilage, where it suddenly turns forward to be distributed to the mucosa of the dorsal wall of the pharynx. In a second specimen, the *visceralis* arose directly from *Vagus 2*. On the other side of the same specimen there was a transverse connecting-branch between the pre-trematic and the *visceralis*.

The *post-trematic* runs immediately under the mucosa of the cleft at the base of the rays. It divides into two branches about 1 cm. from its origin. The larger branch (A) runs along the arch about 5 mm. from and parallel to the smaller branch (B). These two divisions continue their course nearly to the end of the arch, the distribution of the smaller branches being as in *Vagus 1*. Branch B of *Vagus 2* is in proportion smaller than branch B of *Vagus 1*. This point should be noticed.

(d) *Vagus 3* can be dissected as a separate nerve, as far into the vagal ganglion as *Vagus 1* and 2. Here, however, there is no external trace of the ganglion, but, when the end of the nerve was teased out, a few ganglion-cells were found. The nerve passes backwards and somewhat ventrally for 4.5 cm. before it divides into a very small pre-trematic and a large post-trematic. The pre-trematic, which is very small, has the usual course. As with

Vagus 2, it sends off a visceral branch which has the same course and distribution as the other visceral branches already described. The post-trematic divides into two parts (A and B) of almost equal size, which run parallel to one another as in Vagus 2. The fine side branches which are so numerous in the equivalent nerve of Vagus 2 cannot be traced here. It is probable that branch A has approximately the same function as the branches which Cole calls "accessory skeletal" in *Chimera* (3, p. 667 &c.).

(e) *Vagus* 4, 5, 6 and the truncus intestinalis are so closely united that they cannot be separated for a distance of 2 cm. from the vagal ganglion. There is no external trace of separate ganglia, or of a separate compound ganglion for these four nerves. At a distance of 2 cm. from the vagal ganglion, Vagus 4 can be dissected away. This nerve passes obliquely backward to divide just above the fifth branchial cleft into a very fine pre-trematic and a stout post-trematic. The pre-trematic could be traced only for 15 mm., that is about 1 cm. after it gives off the visceral branch. The post-trematic soon divides into two equal branches which run parallel. There is nothing special about the course of the branches in this segment. The tendency toward a reduction of the pre-trematic is carried further here than in the more cephalic segments. Further, it is noticeable that the pre-trematic of Vagus 4 lies in close association with the two divisions of the post-trematic of Vagus 3. From this association and the reduced size of the pre-trematic branches, it may be deduced that the pre-trematics are being replaced by the post-trematics of the immediately preceding segment. Ultimately such a tendency would lead to the condition found in some Teleosts. As the pre-trematic and post-trematic filaments appear to be equally well developed, the reduction of the pre-trematic nerves can only be accounted for on the supposition that some other nerves are replacing them functionally.

(f) *Vagus* 5 can be dissected from the combined branchial and intestinal nerve about 1.5 cm. beyond the point of separation of Vagus 4. It then passes obliquely downward for about 3 cm. before it divides into the pre- and post-trematics. In one case Vagus 5 divided into the pre- and post-trematic near the branchio-intestinal riband. The two divisions are of unequal size, the pre-trematic being the smaller in two out of three nerves dissected. The large size of the post-trematic is remarkable, as there are *no* filaments upon the posterior wall of the sixth cleft, *i. e.* upon the sixth branchial arch.

The *pre-trematic* passes along the fifth branchial arch immediately under the lining membrane, along the base of the cartilaginous branchial rays. These rays separate this nerve from the two parts of the post-trematic of Vagus 4. Pre-trematic 5 sends small branches outwards among the branchial filaments. On one side, where the forking of Vagus 5 took place at an unusual distance from the cleft, a fine branch united the pre- and post-trematics about 5 mm. from the fork. The *visceralis* is given off

from the pre-trematic in the usual manner. The post-trematic passes along the sixth arch, sending out no branches, but unites, halfway along the arch, with a fine nerve (Pl. LXVIII. fig. 1, V. 6), probably Vagus 6. This combined nerve (fig. 1, V. 5 + V. 6) could be traced along the arch as far as the middle of the cerato-branchial cartilage, where it divides into a number of small branches which supply the arch and muscles attached to it. No fibres have been traced on to the vestigial seventh arch. On one side, not only do post-trematic 5 and Vagus 6 unite completely, but they are also connected by a transverse branch (fig. 1, Con. V. 5).

(g) When the nerve called *Vagus 6* is traced upward, it is found to originate from the vagal riband, between the origin of Vagus 5 and the point where the intestinal trunk divides. Traced from its central connections Vagus 6 passes obliquely downward and caudad, to fork over the anterior cardinal. The anterior part unites with the post-trematic of Vagus 5 and the posterior with one of the first spinal nerves. The origin, course, and distribution of this nerve strongly suggests that it is the remnant of the sixth branchial nerve to the degenerate seventh branchial arch. It is highly probable that serial sections would show that the combined nerve sends branches not only to the sixth arch but also to the vestigial seventh arch, which lies in close proximity to the former. The posterior division of Vagus 6 is very small and unites with a spinal nerve (or nerves), whose main distribution is to the median mandibular muscles.

The anterior cardinal vein in *Chlamydoselachus* lies in the position of the vanished seventh cleft, but in most Elasmobranchs in the position of the missing sixth cleft. In the latter, the vein sometimes lies in the notch, so common on the fifth branchial arch, which in many cases is undoubtedly produced by a remnant of the sixth arch coalescing with the fifth. Probably as an arch and its cleft disappeared the anterior cardinal vein was pressed forward and took up the position of the missing cleft. According to this reasoning, Vagus 6 may be said to theoretically fork above the seventh cleft.

In the formalin specimen, which was a mature female, no trace of the seventh arch was found and Vagus 6 was in a much reduced condition. Vagus 5 divided above the sixth cleft into pre- and post-trematics, which were of almost equal size. The pre-trematic 5 had the usual course. The post-trematic passed along the anterior side of the sixth arch for a short distance, then divided into two branches, a small anterior and a larger posterior. The former continued to course along the anterior side of the sixth arch and must be regarded as the true post-trematic of Vagus 5, whilst the latter passed along the posterior side of the last arch to be distributed chiefly to muscles attached to the unusually enlarged end of the cerato-branchial cartilage. This innervation coincides with that of the nerve described as Vagus 6 in the other specimen. Hence this branch is to be regarded as the remnant of Vagus 6.

(h) The remaining riband of the Vagus is the *ramus intestinalis*. After passing backwards for about 1.5 cm. it divides into three main branches (A, B, C), which are distributed to the heart and viscera. The most dorsal of the branches (C) soon divides into two, which, after a sinuous course around the first spinal nerves, pass on to the stomach. Of these two nerves the ventral again divides into two, one passing caudad on to the stomach, the other forward to the heart. The intestinal nerves soon break up into a fine plexus, immediately under the peritoneum. This plexus can only be traced a short distance.

At the present time there is a general tendency to regard the Vagus as a composite nerve, the component parts being a nerve or part of a nerve for each branchial arch and cleft and one or more nerves or parts of nerves to the intestines. Therefore in a primitive Vagus there would be found a series of ganglionated nerves, each equivalent to the Glossopharyngeus, plus the *ramus intestinalis*, which is probably "the collector of all branchial nerves which may at one time have existed behind the present gill-region" (14. p. 228). The dorsal rami of the collected nerves probably disappeared early, owing to the reduction of the dorsal area. The primitive Vagus of this series of primitive branchial and intestinal nerves perhaps alone retained its dorsal ramus to supply the reduced cutaneous areas of its own and the immediately following segments. The most primitive Vagus yet found is in *Chimæra*. In *Chlamydoselachus* also one would have expected to find the Vagus not one nerve but a series of nerves. This expectation is, however, by no means fulfilled, as appears by the foregoing description. The condition here is intermediate between that of *Chimæra* and *Scyllium*. In *Chlamydoselachus* there is a series of roots which have the appearance of being somewhat pulled forward in order to emerge somewhat anteriorly to their region of origin. This direction in which the roots pass, no doubt indicates a comparatively recent union of these roots into one nerve. In higher forms we find the vagal complex passing backwards out of the cranium, whilst the comparatively new spinal accessory roots are first pulled forward before they can pass backwards and out of the cranium. How the condition in *Chlamydoselachus* may have arisen from a simple *Chimæra*-like condition is best expressed in Johnston's words (14. p. 226):—"It appears that the visceral sensory and motor fibres of the caudal branchial segments, instead of continuing to reach the brain by way of the dorsal roots proper to their segments, have progressively changed their course so as to run to the brain through the root of the next more cephalic segment. This process may have begun as a result of the expansion of the gill-sacs and growth of branchial arch muscles which served to crowd the ventral rami of the nerves at the caudad end of the gill-region. When the shifting had brought the penultimate gill back to the level of the ultimate nerve root, the fibres of the ultimate ventral rami shifted their course to the root of the penultimate nerve. . . . As the process

went on progressively the branchial and pharyngeal rami became united by the common branchio-intestinal trunk which enters the brain by way of the Vagus root" (14. p. 229). "The motor roots must have been collected under the influence of the sensory components. . . . As the motor fibres grow out from their nuclei in the brain they must follow some path of low resistance in travelling to their muscles. Since the motor fibres develop late, they find such a path already provided in the near-by sensory root. The motor fibres follow this and a mixed trunk is formed. When the sensory fibres of a given root shift their course . . . to the root next cephalad, the motor fibres on issuing from the brain find no path in that segment, but must turn forwards to the next cephalic sensory root and follow it. As this goes on gradually from segment to segment there are formed a number of roots emerging from the cord or brain caudad to the complex and running alongside the brain to join it."

The Lateralis root of the Vagus originates, as is to be expected, from a segment anterior to the vagal roots proper. It has an extra-cerebral course backwards for a considerable distance before it joins the branchio-intestinal Vagus. This indicates a comparatively primitive condition, for, as specialisation proceeds, the root would run intra-cerebrally until nearer the origin of the Vagus proper. The loose union of the constituent nerve-strands of the composite Vagus, added to the presence of at least two separate branchial ganglia, show also that the condition, although not primitive, is not highly specialised.

H. THE SPINAL NERVES.

Following the Vagus there are four of the so-called spino-occipital nerves, which pass out of the cranium by four separate foramina. Two of these roots in *Chlamydoselachus*, are placed completely under, the third partly under, the cover of the vagal roots. This origin is not to be explained, Johnston thinks, as due to "a shifting through the long branchial region," and a consequent crowding in the vagal region. He says (14. p. 231): "The dorsal and ventral hypoglossal roots need not be considered as *spinalartige* nerves. They probably are not equivalent to spinal nerves at all, but are only the general cutaneous and somatic motor components of nerves of the vagus region, the visceral and motor components of which have been collected into the single large vagus root. The presence of these nerves in the vagus region, then, does not require the hypothesis that they have shifted forward from the postbranchial region, but is directly opposed to such an hypothesis." If this view, founded upon the study of nerve components, be true, it will to some extent be in opposition to the conclusions of Fürbringer on the metamerism of the head, for his argument is entirely dependent upon the spinal character of such incomplete nerves as the above.

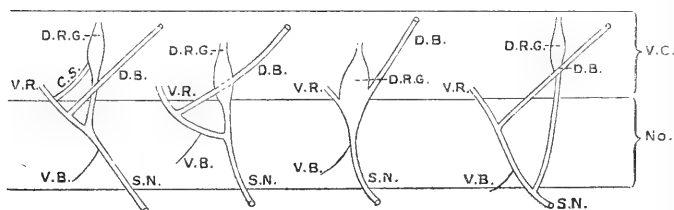
The third and fourth spino-occipital nerves have each a dorsal

branch, which, like the dorsal branches of the succeeding spinal nerves, passes upwards and backwards. No dorsal branches were found on the first two spino-occipital roots. In *Læmargus* there are three spino-occipital nerves, of which the first two had no dorsal roots (6. p. 480). Immediately outside the cranium the nerves unite into a flattened strand, the hypoglossal nerve.

The ventral root of the first true or complete spinal nerve originates between the first and second vertebrae. Spinal nerves 1, 2, 3, 4, 5 (Pl. LXVIII. fig. 1) unite with the spino-occipital nerves into a strand, which passes backwards, then outwards towards the pectoral girdle. Spinal nerves 6 and 7 unite with one another before joining this plexus. Spinal nerve 8 runs by its side, but does not actually join. The spinal plexus gives off anteriorly two branches (s.h. 1 and s.h. 2). Branch s.h. 1, which is connected with Vagus 6, passes forwards and downwards to join branch s.h. 2. The resulting compound nerve passes forward near the median ventral line to supply a portion of the median mandibular or hypoglossal musculature. It is probable that this nerve consists only of fibres from the spino-occipital nerves, and would therefore be the homologue of the hypoglossal nerve of higher forms.

The brachial plexus consists of the remaining parts of the composite strand, *i. e.*, the first eight complete spinal nerves, of which the last remains distinct. The brachial plexus is here in a simple condition, for it consists of but few nerves, and those are not intimately united. The innervation indicates that the pectoral fins of *Chlamydoselachus* are made up of a smaller number of segments than in many species; a fact which, according to Goodrich (11), indicates that the fin here is specialised rather than primitive, for Goodrich states that potentially a fin might extend all along the body, and that it is only in the specialised forms that it is restricted to a few segments, which may not even be homologous in allied species.

Text-fig. 141.

Spinal nerves from anterior, middle, and tail regions of *Chlamydoselachus*.

- | | |
|---|------------------------|
| C.S. Connecting-strands between dorsal and ventral roots. | S.N. Spinal nerve. |
| D.B. Dorsal branch. | V.B. Ventral branch. |
| D.R.G. Dorsal root with its ganglion. | V.C. Vertebral column. |
| No. Notochord. | V.R. Ventral root. |

Each spinal nerve arises by two alternate roots, a dorsal and a ventral. The ventral root arises by three rootlets, then, after emerging from the vertebral column, gives off a large dorsal

branch (text-fig. 141, D.B.) before uniting with the dorsal, ganglionated root. In the anterior and middle regions of the vertebral column, this union takes place at a level with the top of the notochord, but in the tail-region at a level with the base of the notochord, immediately to the inner side of the r. lateralis vagi. The ventral branch (V.B.) is given off at varying points (text-fig. 141).

The dorsal branch (D.B.) of the ventral root runs caudad and upwards, passing over the ganglion of the dorsal root (D.R.G.) to be distributed to the muscles of the middle region of the back. A similar root (ventral-dorsal) has been described by Ewart and Cole in *Raia* (6. p. 479). No dorsal branch was found for the complete spinal nerve or for the dorsal root, as it is probable that the dorsal branch of the ventral root receives fibres from the dorsal root as it passes over the latter on its backward course. In one segment (text-fig. 141) the dorsal branch of the ventral root could be seen by the naked eye running over the dorsal root-ganglion, from which it could not be separated; in the succeeding segment the dorsal and ventral roots were joined in the region of the sensory ganglion, and the dorsal branch appeared to arise from the ganglion itself. The spinal nerves here recall the condition of *Laemargus* (6. p. 480), of *Bdellostoma* (16. p. 176), and of *Myxine**, in that all three have (1) several rootlets for the ventral root, (2) a dorsal branch from the ventral root which unites with the dorsal root-ganglion or with some portion of the dorsal root.

I A. THE BRAIN.

The external features of the brain, having a typical arrangement, need not be described. Two drawings, however, are given (Pl. LXIX. figs. 7 & 8) as those of Garman are not clear. His ventral view is inaccurate, owing to the very badly-preserved condition of his specimen.

Two points only may be noticed: (1) there is a large rhinocœl extending to the end of the olfactory stalk; (2) the dorsal roof of both prosencephalon and rhinocœl is non-nervous. This second point is of considerable interest, as it recalls the condition of *Ammocetes* and of the Teleosts. The non-nervous roof may be regarded as primitive when compared with that of *Ammocetes*, but as specialised when compared with that of the Teleosts. That a non-nervous roof should be found amongst the Elasmobranchs is a point of considerable interest, although its significance is as yet undetermined.

I B. LOCY'S NERVE.

Locy's nerve, which is present in *Chlamydoselachus*, originates near the middle line, somewhat to the ventral side of the fore-brain. It passes outwards, curving upwards along the anterior and upper side of the olfactory stalk to be distributed between

* Mr. Cole kindly showed me some unpublished drawings of the spinal nerves of *Myxine*.

the end of the stalk and the beginning of the olfactory capsule. On reaching this point, the nerve becomes somewhat enlarged by flattening, then breaks up into a number of fine branches which passed towards the olfactory epithelium but could not be traced to their endings.

J. SUMMARY.

1. This paper is the first description of the cranial nerves of *Chlamydoselachus*.

2. The cranial nerves of *Chlamydoselachus* are not in as primitive a condition as would be expected from the low position of the species in the taxonomic series, especially as regards the vagus and the lateralis nerves.

3. The vagus arises by a series of roots, which, however, cannot be assigned to the separate rami.

4. The ganglia of the vagus cannot be separated completely by gross methods.

5. The number of roots by which the lateralis components arise confirms the suggestion that, in origin, the acoustico-lateralis components belonged to a series of segments.

6. The connections between the acoustico-lateralis elements of V., VII., and VIII. show a tendency towards unification of the system.

7. The glossopharyngeus includes a lateralis component.

8. The r. lateralis vagi unites closely with the true Vagus in the ganglionic region.

9. Loey's nerve is large and well-defined.

10. The roof of the prosencephalon and of the olfactory stalk was non-nervous in the immature specimen examined.

11. There is a direct nervous connection between the r. profundus and the oculo-motor nerve.

12. The profundus nerve here appears as a ramus of the trigeminal nerve.

13. The trigemino-facial complex is less primitive than that of *Chimæra*, but more so than that of most Elasmobranchs.

14. The facialis is in an unusually primitive condition, in that it has a remnant of the post-trematic ramus quite separate from the t. hyomandibularis.

15. With our present knowledge, we are justified in stating that a chorda tympani is present.

16. There is a sixth r. branchialis vagi which passes towards the remnants of the seventh arch.

17. There is a tendency towards a reduction of the rami pre-branchialis vagi, thus leading to a condition found in some Teleosts.

18. There is a hypoglossal nerve.

19. The spiracle is small and opens into the hyo-branchial cleft.

20. The ampullæ of Lorenzini are arranged diffusely. There is no hyomandibular group, but there is a posterior buccal group. The ampullæ have a simple structure.

21. Some of the lateral line canals, such as the main lateral canal and parts of the hyomandibular, vary greatly in individuals and on the two sides of the same individual. There are traces of canals which may be incipient or degenerate. The canal-system is in an unstable condition.

22. The lower jaw has been swung back into a reptilian-like position with the results, (a) that it may be due the absence of the typical maxillo-mandibular trunk; (b) that possibly the push-back of the branches of the vagus may have resulted in their unexpected union with one another and with the r. lateralis vagi; (c) the great development of a hypoglossal musculature and the presence of a hypoglossal nerve.

23. The internal rectus muscle consists of two well-defined parts.

24. The pectoral plexus consists of very few nerves, and thus the pectoral girdle may be regarded as specialised, again suggesting a relationship between *Chlamydoselachus* and the Teleosts.

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- H. + M.—The common trunk of the ramus hyoideus and ramus internus mandibularis VII.
- Hy.—Hypophysis.
- I. (A, B, C).—The three principal rami intestinales.
- I.H.—The cardiac branch of the ramus intestinalis.
- I.M.VII.—R. internus mandibularis VII.
- I.O.—Inferior oblique muscle.
- I.O.L.—Infra-orbital lateral line canal.
- I.L.—Lobi inferiores.
- Lin. Lat.—Linæ laterales or restiform body.
- L.L.—Main lateral line canal.
- L.N.—Loey's nerve.
- Mxb.—Branch of the maxillaris which becomes united with a branch of the buccalis.
- Mxb. b.—Two fine nerves which appear to originate from a branch of the buccalis, but which are composed of general cutaneous fibres which have come from Mxb.
- O.S.—Olfactory stalk.
- Oc. 1, 2, 3.—First three spino-occipital nerves.
- Op. L.—Optic lobes.
- Op. S.—Optic stalk or "cartilago-sustentaculum oculi."
- P.—Palatine branches of the facialis.
- P.B.A.—Postero-buccal ampullæ.
- P.I.—Pars intermedia.
- Pr. F.—Pre-trematic facialis.
- Pr. F. (ch.).—The chorda tympani.
- Pr. & Pt.—The pre- and post-trematic rami of IX. and of the vagus.
- Pro.—Profundus branch of V.
- Pros.—Prosencephalon.
- Pt. F.—Post-trematic facialis.
- R.V.—Root of nervus trigeminus.
- R.C.—Ramus communicans.
- R.Ext. A & B.—Two parts of the rectus externus.
- R.H.—Ramus hyoideus VII.
- R. In.—Rectus internus muscle.
- R. Inf.—Rectus inferior muscle.
- R. Man. V.—Ramus mandibularis V.
- R. Max.—Ramus maxillaris V.
- R.O.—Ramus oticus with cutaneous branches R.O.C.
- R.S.—Rectus superior muscle.
- S. (1, 2, 3, 4, 5, 6, 7, 8).—The first eight spinal nerves.
- s. h. (1, 2).—The two branches which make up the hypoglossal nerve.
- S.O.—Occipito-spinal riband.
- S. Ob.—Superior oblique muscle.
- S.O.A.—Supra-orbital ampullæ.
- S.O.L.—Supra-orbital lateral line canal.
- S. Op. V.—Superficialis ophthalmicus V.
- S. Op. VII.—Superficialis ophthalmicus VII.
- S.V.—Sacci vasculosi.
- T.H.—Truncus hyomandibularis.
- V. (1, 2, 3, 4, 5, 6).—The six branchial branches of the vagus.
- V. 5 + V. 6.—The nerve produced by union of the post-trematic of vagus V. and part of vagus VI.
- V.G.—Visceralis branch of IX.
- Vis.—Visceralis branches of the vagus.
- III.—Oculo-motor nerve.
- IV.—Fourth nerve.
- V.—The Gasserian ganglion.
- V. + VII.—The united Gasserian and buccalis ganglia.
- VII. b.—Ramus buccalis.
- VII. h.—Truncus hyomandibularis.
- VIII., VIII. A, VIII. B.—The ganglion and the two principal rami of the eighth nerve.
- IX., IX. g.—The glossopharyngeal nerve and its ganglion.
- X., X. g.—The vagus nerve and its composite ganglion.
- X. A & X. B.—Dorsal branches of the vagus to neuromasts.

4. Descriptions of Two Mammals from the Ituri Forest.
 [With a Supplementary Note on the Buffalo of the
 Semliki district.] By R. LYDEKKER.

[Received November 13, 1906.]

(Plate LXX.*)

From among a collection of mammal skins and skeletons obtained by Major Powell Cotton in the Ituri Forest and submitted to me, at his direction, by Rowland Ward Ltd., two specimens, representing as many species, appear worthy of being brought to the notice of the Society. Before proceeding to their description, I may take the opportunity of mentioning that Major Cotton has generously expressed his intention of presenting to the British Museum the type specimens of any small mammals in his collection which prove to be new, after they have been described.

The first animal for notice is a Cat which I propose to call

FELIS CHRYSOTHRIX COTTONI, subsp. nov. (Plate LXX. fig. 1.)

West Africa and its "hinterland" are, as Professor Paul Matschie has remarked †, the home of a very imperfectly known group of medium-sized and more or less uniformly-coloured Wild Cats, some of which display a tendency to a rufous and others to a grey phase. In this group are included *Felis chrysothrix*, *F. celidogaster*, and *F. aurata* of Temminck, *F. neglecta* of Gray, *F. rutila* of Waterhouse, and *F. servalina* of Ogilby, or Pucheran. Despite the imperfection of our knowledge of the group (which is poorly represented in the collection of the British Museum), one thing is quite certain, to wit, that these six names do not represent a corresponding number of species, whatever may be the case in the matter of races.

Dr. Matschie (whatever may be his present views on the subject) expressed the opinion in the passage cited that there might be two recognisable forms—one, *F. celidogaster*, inhabiting the northern, and the other, *F. chrysothrix*, the southern districts of Guinea. The same view is adopted by Dr. Trouessart in the first edition of his "Catalogus," who regards *F. neglecta* (from the Gambia) as a synonym of *celidogaster*, and gives the range of the species as extending from the Gambia to Upper Guinea and Sierra Leone. In the second edition, apparently by an inadvertence, *neglecta* is, however, given as a synonym of *chrysothrix*. The range of *F. chrysothrix* (which in the first edition is taken to include *aurata* and *rutila*), on the other hand, is given as Lower Guinea, the Congo, Togo, Uganda, and possibly Angola. Of this species, *servalina*, from Sierra Leone, is regarded as a distinct race.

* For explanation of the Plate, see p. 996.

† S.B. Ges. Naturforsch. Berlin, 1895, p. 196.



J. Smit del. et lith

Bale & Daniels:son, Ld imp

1. THE DUSKY AFRICAN "TIGER-CAT" (FELIS CHRYSOTHRIX COITTONI)
2. THE RED AFRICAN TIGER-CAT (F. C. RUTILA.)

Felis chrysothrix, the Red Tiger-Cat or Golden-haired Cat, of which the type (in the Leyden Museum) is figured by Dr. D. G. Elliot in plate xxv. of his 'Monograph of the Felidæ,' is generally described as a medium-sized Cat, with the upper parts reddish brown, passing into bright rufous on the flanks, marked on the sides of the body with black spots; the under parts pure white spotted with black; and the tail reddish brown above and lighter below, without either spots or bars. Although the two face-bars so commonly developed in cats are absent, there is a pair of dark blotches above the eyes.

Waterhouse's *F. rutila*, typified by an imperfect skin from Sierra Leone in the British Museum (Pl. LXX. fig. 2), is wholly bright reddish chestnut above, with indistinct darker spots on the flanks, and white below with large brown spots; the tail being nearly half the length of the body, and reddish brown in colour, having a dark line down the middle of the upper surface, and paler on the sides, with obscure indications of dark rings.

As to *Felis celidogaster*, this appears to have been originally described on the evidence of a specimen, supposed to have come from America, purchased at the sale of Bullock's Museum. It was, however, redescribed by Temminck from a Guinea specimen (in the Leyden Museum, and figured by Dr. Elliot in the plate already cited), now generally accepted as the type.

It is described as measuring 26 inches to the root of the tail, while the tail itself measured 14 inches, or rather more than half the length of the head and body. In colour it is grey above with a reddish tinge, and spotted all over with light brown or chocolate, the spots along the middle line of the back being oblong, but elsewhere circular; below it is white with large brown spots, while the tail is bay-brown, with paler brown rings and a blackish tip. Dark bands occur on the throat and chest and the inner sides of the feet. The ears are black externally.

Gray described his Gambian *F. neglecta* as grey, marked on the head and body with small dark spots becoming larger on the flanks, and white below with large blackish spots; the tail, which is quite half the length of the body, having a dark line on the upper surface, with obscure indications of rings on the paler sides. One is led to wonder how this Cat could have been regarded as specifically distinct from *celidogaster*; although the colour is brownish grey rather than grey.

Although most subsequent writers have regarded *chrysothrix* and *celidogaster* as distinct species, Dr. Elliot suggested that they might more probably be considered respectively as a red and a grey phase of one and the same species. In his plate he figured a third African Cat which he regarded as in some degree intermediate between the two.

Turning to Major Cotton's specimen (Pl. LXX. fig. 1), it is quite clear that it is a member of the *chrysothrix-celidogaster* group, with which it accords in the general type of colouring and in dimensions, the length of the head and body being approximately

27 inches (or, allowing for stretching, possibly rather less), and that of the tail about 13 inches. It is, however, much darker than either of the named forms, and may be regarded as the dusky phase of the group.

Having the black ears, white claws, and fully-spotted light under surface characteristic of the group, this Cat may be described as dark smoky-grey above, darker along the middle line of the back and tail, and darkest of all on the crown of the head, where it approaches black. No distinct evidence of spotting on the dark parts of the body or of barring on those of the face and limbs are observable, but there may be a suspicion of disappearing dark rings on the sides of the tail. The under parts and inner sides of the limbs are dirty white, profusely blotched with black.

In the absence of dark markings on the upper parts the Ituri Cat comes nearest to *chrysothrix*, although lacking the face-markings and the spots on the flanks. On the other hand, in colour it is more like *celidogaster*, although much darker, and without the spots on the body and the rings on the tail.

In my opinion, *rutila*, *chrysothrix*, *celidogaster*, and the Ituri Cat (which, as already mentioned, I propose to name after its discoverer) appear best regarded as forms of a single species, which may be severally characterised as follows:—

1. *F. chrysothrix rutila*. General colour bright chestnut-red, distinctly spotted with reddish brown on the flanks which are much lighter than the back; under parts pure white, with large chocolate-brown spots; tail with a dark brown median line or fainter indications of rings.—Gambia and Cameroons.

2. *F. chrysothrix typica*. General colour reddish brown, becoming distinctly rufous on the flanks, where it is spotted with chocolate; under parts pure white with dark spots; tail uniformly reddish brown above without trace of lateral barring.—Lower Guinea.

3. *F. chrysothrix celidogaster*. General colour of upper parts light grey, or greyish brown, spotted all over with brownish; under parts pure white with chocolate spots; tail darker along median line than elsewhere (*neglecta*) with complete or partial dark rings.—Upper Guinea and (?) Gambia.

4. *F. chrysothrix cottoni*. General colour of upper parts dark smoky grey, darker on the middle line of the back and tail and darkest of all on the crown of the head, no spots; under parts dirty white, spotted or (blotched) with blackish; tail without any distinct barring.—Ituri Forest.

Whether any of the other named forms (inclusive of *neglecta*) are entitled to rank as distinct races, I have not sufficient means of forming a definite opinion.

On the assumption that I am right in regarding the four forms

above-mentioned as races, the name of Red Tiger-Cat or Grey Tiger-Cat will be inappropriate to the species as a whole. I would therefore suggest that it should be called the African Tiger-Cat, and the four races here admitted respectively designated the red, the brown, the grey, and the dusky African Tiger-Cat.

The dark hue of the Ituri race is apparently an adaptation to its habitat, and may possibly tend to confirm the view that the Ituri black Ratel described by myself is a distinct species (or race) rather than an individual melanism.

2. *RHYNCHOCYON STUHLMANNI NUDICAUDATA*, subsp. nov.

The second animal in the collection worthy of special notice is a *Rhynchocyon*, represented by a skin and skeleton, which comes very close to *Rh. stuhlmanni* of Dr. Matschie* from the country immediately west of the Semliki-Isango valley. The present animal came from the Mawambi district.

Rh. stuhlmanni (of which there is no example in the British Museum) is described as being dark brown mingled with yellowish brown above, with two longitudinal rows of blackish spots, connected by a black stripe on their inner sides, and running from the shoulder to the root of the tail; between the dark markings are light brownish spots, and externally to this black-and-light spotted area on each side are two rows of light spots, of which the outermost is very indistinct. In old examples all the markings become obscure. The claws and a streak along the middle line of the belly are whitish; the flanks are like the back; the abdomen is nearly bare, carrying only a few sparse hairs of an ocherey colour; the legs are rusty brown; the tail is yellowish white; and the ears are rusty red.

It will be observed that nothing is stated as to whether the ears and tail are hairy or naked. Since, however, the species is contrasted with *Rh. petersi* and *Rh. cirnei*, in both of which the basal half of the tail and the roots of the ears are hairy, it would seem highly probable that if such points of difference had occurred in the type of *Rh. stuhlmanni*, they would have been mentioned. Again, it is difficult to understand how an animal in which the ears are completely naked could be described as having rust-coloured ears.

The two points in which Major Cotton's *Rhynchocyon* agrees with *stuhlmanni*, and thereby differs apparently from every other member of the genus, are its generally dark colour and the wholly white tail. On the other hand, it differs from the type of that species by the ears being wholly black, by the presence of a patch of bright rufous hair immediately behind each ear, by the absence of any distinct spotting or striping on the body, except for a few light flecks near the rump, and by the brown claws. It is further probable that the naked ears and tail are also distinctive.

* S.B. Ges. Naturforsch. Berlin, 1893, p. 66, and 'Die Säugethiere Deutsch-Ost-Afrikas,' Berlin, 1895, p. 31.

Provisionally, I propose to regard this Elephant-Shrew merely as a race of Dr. Matschie's species, with the title of *Rh. stuhlmanni nudicauda*; leaving it open whether it may not really claim specific rank.

In its completely naked tail, and apparently also ears, this Elephant-Shrew is distinct from all other Rhynchocyons, unless it be the typical *stuhlmanni*; the one which comes nearest to it in the former respect being *Rh. chrysopygus*.

[POSTSCRIPT.]

[Since the foregoing paper was read Major Powell-Cotton has sent home two skins and skulls of the Buffalo of the Semliki Valley, in regard to which I communicated the following note to the 'Field' newspaper of January 5th, 1907 (vol. cix. p. 87 *).

These specimens indicate an animal to a large extent intermediate between the great black buffalo of South Africa and the dwarf red buffalo of the west coast, and thus serve to strengthen the view that these (and all other African) buffaloes are merely races of one and the same species. The general colour of the Semliki buffalo (which is well haired) is tawny, with the tip of the tail black, but the tint gradually darkens towards the shoulders, till it becomes blackish-brown on the neck and head. The tips of the ears are, however, fringed with pencils of tawny hair. In size the animal approaches the Cape buffalo, but the horns, which are thin and much flattened, are, as in all the more northern races, widely separated at their bases. The black tail-tip at once separates the Semliki buffalo from *Bos caffer matthewsi* of the Albert Nyanza district, in which that appendage is white (Proc. Zool. Soc. 1904, ii. p. 163). With regard to the buffalo from Ankole, South Uganda, described by Mr. O. Thomas (Proc. Zool. Soc. 1904, i. p. 464) as *B. caffer radcliffei*, it appears from specimens in the Natural History Museum that the hair of that race is wholly black. Among the numerous buffaloes recently described by Professor P. Matschie (S.B. Ges. Naturforsch. Berlin, July 1906) none came from the Sem'iki district. The Semliki buffalo is therefore apparently a new race, and it is appropriate that it should be named, after its discoverer, *Bos [Bubalus] caffer cottoni*. Old individuals, I have recently found, become black.]

EXPLANATION OF PLATE LXX.

Fig. 1. The Dusky African Tiger-Cat, *Felis chrysothrix cottoni*, p. 992.

Fig. 2. The Red African Tiger-Cat, *Felis chrysothrix rutila*, p. 993.

Major Cotton's specimen was obtained from the Ituri Forest, Central Equatorial Africa, in the Mawambi district. Both are drawn about $\frac{1}{2}$ nat. size.

* In the original note the specimen was stated to be from the Ituri Forest; but this, I am informed by Major Cotton, is incorrect.

5. On the Occurrence of the Bruang in the Tibetan Province. By R. LYDEKKER.

[Received December 4, 1906.]

(Text-figure 142.)

That the eastern end of the Tibetan area, that is to say the Moupin district of Tibet proper and the western portions of the Chinese provinces of Kansu and Sze-chuan, contain, in addition to their own peculiar mammalian types, a large element of the Indo-Malay fauna, is becoming more and more evident. As examples, may be cited the Monkeys *Macacus arctoides tibetanus* and *M. vestitus*, the Sze-chuan Sambar, *Cervus unicolor dejeani*, and several Gorals and Serows. I have now to add to the list a representative of the Bruang, or Malay Bear (*Ursus malayanus*); a type hitherto not known to range northwards of the Garo Hills, so far at least as I am aware.

At the time when the British Museum acquired from Rowland Ward Ltd. the Serow described by myself in the Society's 'Proceedings' for 1905* and an example of the Tibetan Takin, that firm had in its possession the skull of a Bear reputed to come from the same district (viz., either Eastern Tibet or the north-western provinces of China). This skull was that of a Bruang, but since I had some doubt whether it was really from the Tibetan area, I gave it no further consideration.

I have since learnt that the skin of the same animal came with the skull; and that the entire specimen was mounted and sold to the Bergen Museum as *Ursus torquatus*. The skin, I am informed, had much longer black hair than the ordinary Malay Bear, with the usual white gorget on the throat.

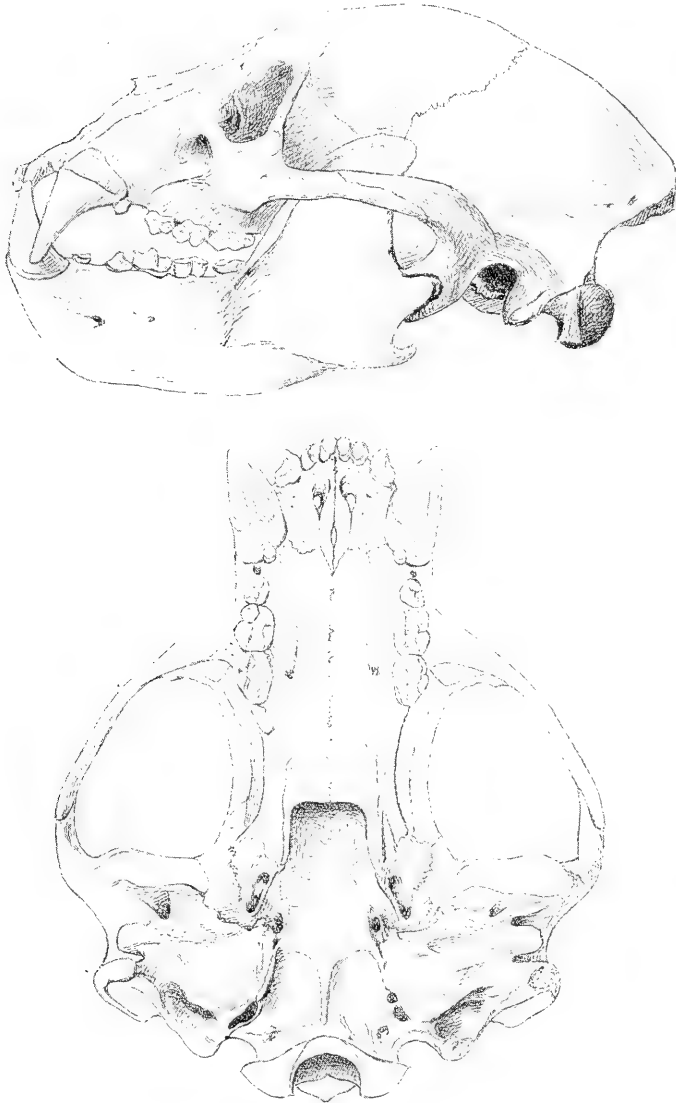
Quite recently the same well-known firm has received another bear-skull of similar type from the Tibetan area, which came with a skin of *Felis scripta*, and has been presented by Mr. Ward to the British Museum. As to its being Tibetan (in a wide sense) there can, I think, be no question. This skull, of which the lateral and palatal aspects are shown in text-fig. 142 (p. 998), belonged to a fully adult Bear of the *Ursus malayanus* type, as is perfectly evident from its great width and relative shortness. Its extreme basal length is 8.75, and its maximum width 8.5 inches; these dimensions comparing with 8.5 and 8.3 inches in a very old and large skull of the typical *U. malayanus* measured by Dr. W. T. Blanford †. So far as I can see, there are no characters by which this skull (in a limited series of specimens) can be distinguished from that of the typical *U. malayanus*; and if this were the only evidence available, there might be some hesitation in giving a separate name to the Tibetan animal. The statement as to the much greater length of the hair of the Bergen specimen,

* Vol. ii. pp. 329 *et seq.*

† 'Fauna of Brit. India—Mamm.' p. 199.

as compared with that of the typical race of the species, seems, however, to justify the racial separation of the Tibetan Bruang,

Text-fig. 142.



Lateral and palatal aspects of the type-skull of the Tibetan Bruang (*Ursus malayanus wardi*). About $\frac{1}{2}$ nat. size.

which may be appropriately named *Ursus malayanus wardi*, the figured skull being taken as the type.

[Since this paper was read I have received from the Director of the Bergen Museum some notes on the Bruang purchased from Rowland Ward Ltd., together with a photograph of the specimen. The skin and hair are wholly black, with the exception of the nose, which is ferruginous, the chin, which is greyish white, and the cream-coloured gorget. Although the head is shorter, the general appearance of the animal seems very like that of *U. torquatus*, the ears being much larger than in *U. malayanus*. In fact, had I not been assured by Rowland Ward Ltd. that both skin and skull came together, I should have thought that a skull of the last-named species had been mounted in a skin of the former. As it is, I hesitate to draw any further conclusions with regard to the distinctness of the Tibetan Bruang from the characters of the skin.]

6. On the Nudibranchs of Southern India and Ceylon, with special reference to the Drawings by Kelaart and the Collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne.—No. II. By Sir CHARLES ELIOT, K.C.M.G., F.Z.S.

[Received December 11, 1906.]

Subsequently to the publication of my paper on the Nudibranchs of Southern India and Ceylon, which appeared in the Society's 'Proceedings' (Proc. Zool. Soc. 1906, pp. 636-691), the authorities of the Hancock Museum at Newcastle-on-Tyne were fortunate enough to discover a considerable collection of microscopic slides belonging to Alder and Hancock, and most courteously placed the same at my disposal for examination. The objects preserved are almost entirely the buccal organs of nudibranch. from various parts of the world, and I have lost no time in examining such of them as concern the Indian and Cingalese nudibranchs mentioned in my previous paper. It is a pity that it should have been published before the radulæ were discovered, but the results indicated in it are not materially affected, though several of the identifications are confirmed. The present notes should be regarded as a supplement to it. The same abbreviations are used, and references are not repeated except where it seems necessary.

Some of the slides bear full names, but others inscriptions like *Doris* 113, or a simple number. In most cases it is possible to give the name with certainty, for the number refers to the bottle in which the specimen is preserved. Thus *Doris* 113 corresponds to the bottle marked "*No. 113. Doris formosa—Madras, Walter Elliot, Esq.*" No notice has been taken of those

slides which for some reason (generally the disappearance of the labelled specimen) could not be referred with certainty to a specific name, nor of those (e. g. *Madrella*, *Phyllobranchus*, *Kalinga*) which if described would add nothing to already published accounts.

The slides though very neat are not always of the kind most helpful for studying the details of dentition. Often all the teeth are preserved *in situ* and none are isolated, so that it is difficult to distinguish the exact form, and especially to see any denticles which may be present on the innermost or outermost teeth. Several rows at least are commonly in confusion, and hence the formulæ are given as approximate. A wide rhachis is unusually frequent and may in some cases be the result of artificial stretching. The medium in which the radulæ are mounted has in several instances become an opaque gum which impedes investigation, but I have not felt at liberty to remount the objects.

But in spite of these difficulties there can be little doubt of the general character of the radulæ, and the results obtained from their study may be tabulated as follows:—

Hexabranchus marginatus (Q. & G.) = *Doris gloriosa* Kelaart.

Chromodoris gleniei (Kelaart). The reference of this form to the genus *Chromodoris* is confirmed. It is possibly the same as *Chr. cavæ*, and if so the name *gleniei* has priority.

Casella macCarthyi (Kelaart) = *C. cincta* Bgh.

Halgerda apiculata (A. & H.) = *Halgerda punctata* Farran, in all probability.

Doris picta Kelaart is probably a *Platydoris*.

Doris exanthemata Kelaart is perhaps *Asteronotus hemprichi*, and in any case nearly allied to it. But the genitalia are unknown.

Discodoris concinna (A. & H.) = *Disc. concinniformis* Bgh.

Staurodoris rusticata (A. & H.). So far as the external characters and buccal parts can decide the matter, the reference of the form to this genus seems certain.

Thordisa villosa (A. & H.) = *Th. maculigera* Bgh.

Hervia militaris (A. & H.) = *Eolis militaris* A. & H.

Doris spongiosa and *D. tristis* are probably referable to the genus *Trippa*, and the former is perhaps identical with both *T. areolata* and *T. mephitica*. But it is not known if either form has ptyaline glands.

Some details are given of the buccal parts of *Chromodoris zebrina*, *Platydoris formosa*, *Pl. ellioti*, *Pl. striata*, *Discodoris fragilis*, *Disc. pardalis*, *Goniodoris aspersa*, *G. citrina*, *Trevellyana ceylonica*.

In the above statement the first name given is that by which

the animal should be called, so far as our present knowledge goes; but in the following descriptions I have thought it safer to put first the names written on the bottles by Alder and Hancock, which imply no identifications into which an element of theory may possibly enter.

DORIS GLORIOSA Kelaart.

= *Hexabranchnus marginatus* Q. & G.

The labial armature and radula confirm this identification. The formula of the radula is about $30 \times 60.0.60$ as a maximum. The teeth are hamate and rather erect; the outermost smaller but not degraded; the 4-5 innermost markedly smaller than the rest and almost without hooks, as if the tips were broken off.

DORIS GLENIEI Kelaart.

= *Chromodoris gleniei* (Kelaart).

A labial armature and radula are preserved, showing that Alder and Hancock dissected a specimen, though, so far as I know, they have left no record of their investigations.

The labial armature consists of two grey, roughly triangular plates, distinctly separate but almost touching one another. They are composed of bent rods, slightly swollen at the tips.

The yellow radula has a formula of about $60 \times 70.0.70$. On the rhachis are lozenge-like areas. The teeth are strong and erect and bear at least 6-8 denticles on the outer side. As the teeth are *in situ* and none are isolated, the denticles are nowhere easy to see and become almost invisible in the last 30 teeth, though since they can be seen here and there they are perhaps present on all. The innermost teeth are broad and bear at least one large denticle on the inside and perhaps two or three. The outermost are low, not denticulate on the top, but bearing one jag or denticle at the side.

This radula and labial armature show that *D. gleniei* is a *Chromodoris*, and support the idea that it is closely allied to *Chr. cavæ* Eliot, which may be a variety of it.

CHROMODORIS ZEBRINA.

A. & H. l. c. p. 123.

Alder and Hancock describe the radula as a generic character, but their remarks, confirmed by the slides, show that the description applies to the species *Chr. zebрина*.

The buccal parts as preserved comprise a labial armature and radula. The former consists of two plates, composed of elements arranged in unusually regular rows and apparently mace-like in shape, though none are completely isolated. The outer ones are bifid, but this feature is not so plain in those near the centre of the plates.

The radula is in confusion, but consists of at least 40 rows containing numerous, minute, two-pronged teeth which bear 3-4

denticles beneath the smaller prong. The innermost cannot be seen plainly, but they appear to be lower and broader than the rest, as is usual in this genus, and are probably denticulate on both sides. The outermost teeth also cannot be clearly seen.

DORIS MACCARTHYI Kelaart.

= *Casella maccarthyi* (Kelaart).

C. cincta Bergh.

The buccal parts confirm this identification. The labial armature is composed of hooked rods, bifid in parts but not everywhere. The radula is a close pavement of very minute teeth with a formula of about $250 \times 60.0.60$. Owing to the teeth being erect it is difficult to see the denticles, but there are at least six on the outer side and probably more. The innermost teeth have also at least 2 (probably 2-4) denticles on the inner side. The outer teeth are smooth.

DORIS APICULATA A. & H. l. c. p. 123.

= *Halgerda apiculata* (A. & H.).

? = *Halgerda punctata* Farran, l. c. pp. 339-340.

One radula with the note "no collar." The hinder part is in disorder, but there appear to be about 33 rows, which in the middle of the radula contain 45-50 teeth on either side of the rhachis. Those near the centre are more spaced than the rest; they have long bases and low hooks, and the innermost point towards the rhachis. The general effect is that there is a large bare space in the middle of the radula with a few teeth in it. The teeth increase in size outwards up to the middle of the row. The hooks are strongly bent, and the bases rather long, though proportionally not so long as in the teeth near the rhachis. The last 3-4 teeth are degraded and almost spoon-shaped. In a few cases the upper edge of the outermost tooth bears one or two irregular jags.

This animal will probably prove to be identical with the later *Halgerda punctata* of Farran. Both the radula and the external colour agree fairly well. The mantle of *D. apiculata* is said to have borne "elevated conical centres, each of which bears a delicate style or filament," and the plate represents the same character. The preserved specimen of *H. punctata* bore simple tubercles, which were described as papillæ in the living animal. A more definite description is desirable, but it is quite possible that the filaments mentioned by Alder and Hancock are the same as these papillæ.

DORIS FORMOSA A. & H.

= *Platydoris formosa* (A. & H.).

Formula of radula about $50 \times 120.0.120$. The teeth are hamate, moderately slender, and increase in size outwards. The innermost are lower than the rest and cross one another, meeting

over the rhachis. The 2-3 outermost are degraded but not denticulate, though occasionally jagged.

DORIS ELLIOTI A. & H.

= *Platydorís elioti* (A. & H.).

Radula yellow. Formula about $40 \times 100.0.100$, but the teeth are considerably deranged. The rhachis is narrow. The innermost teeth are low; the outermost 2-3 are degraded, and the outermost of all sometimes bears a few irregular denticulations. The remaining teeth are hamate, erect, and fairly strong.

DORIS STRIATA Kelaart.

= *Platydorís striata* (Kelaart).

Two radulae are preserved. One is white, one yellow; both are broken. The formulae are about $40 \times 100.0.100$ and $45 \times 120.0.120$. The teeth are rather slender, not much bent, and increase from the inside. The innermost are not markedly smaller, but are distinguished by their position on the rhachis. The outermost present suggestions of faint irregular denticulation, which, however, cannot be seen anywhere with certainty.

The dentition supports the idea that this species is a variety of *Plat. cruenta* (= *arrogans*) without the red markings; but see my previous paper, p. 647, for the genitalia, and Bergh, Siboga, p. 139, for *Pl. flammulata*.

DORIS PICTA Kelaart.

?= *Platydorís picta* (Kelaart).

A large radula, but hidden by the thick medium in which it is mounted. It consists of about 40 rows containing on each side of a narrow rhachis 100 or more small, thin, crowded hamate teeth. The outermost cannot be seen plainly, but do not appear to be denticulate or much degraded.

This form is probably referable to *Platydorís*, but the genitalia are unknown.

DORIS EXANTHEMATA Kelaart.

?= *Asteronotus hemprichi* Ehrenberg.

One large radula, brownish in front but otherwise white, badly mounted in a gummy fluid. Formula about $35 \times 55.0.55$, but several rows are imperfect. The teeth are thin, distinctly hamate, and increase consistently up to the end of the rows, where the last 2-3 become degraded but not denticulate. The innermost, and to some extent the second teeth, project into the broad rhachis almost at right angles to the rest.

This dentition is compatible with the view that *D. exanthemata* is *Asteronotus hemprichi*, but Kelaart's energetic language about the ugliness of the animal makes it probable that he had before him if not a distinct species at least a well-marked variety.

DORIS FUNEBRIS Kelaart.

= *Kentrodoris annuligera* Bergh.
 = *K. maculosa* (Cuv.).

One radula is preserved, with a formula of about $22 \times 25.0.25$. The innermost teeth are smaller than the others and much as figured by Bergh.

Label: D. BELLICOSA 32.

Probably = *Discodoris fragilis* (A. & H.).

Two radulae and labial armatures, labelled as above, seem really to belong to *D. fragilis*, for two specimens from which the radulae have been extracted are numbered 32 and distinctly marked as *D. fragilis*. Alder and Hancock's remarks (*l. c.* p. 119) suggest that they originally registered the animal as *D. bellicosa*, and then came to the conclusion that it was distinct.

The labial armature consists of two clearly-cut and symmetrical plates, somewhat wing-shaped, and resembling those of *Disc. boholiensis* figured by Bergh (in Semper's *Reisen*, Heft xvii. pl. dxxxvii. fig. 28). They are yellow and composed of a thatch of straw-like elements, which are sometimes sinuous, especially at the thin ends of the plates.

The two radulae consist of about 30 and 40 rows respectively, and the smaller contains about 55 teeth on either side of the rhachis. The larger is obscured by the medium in which it is mounted. The teeth are hamate, rather erect, and moderately stout; they increase up to the middle of the half row. The last 4-5 are lower, but not degraded or denticulate. The innermost teeth of the two sides meet and almost cross one another, so that the rhachis must be regarded as really narrow; but it appears to be wide, because the teeth near the centre (5-6 on each side) are set much more widely apart from each other than those which follow, and are small with low hooks. Possibly this part of the radula has been artificially stretched.

Disc. fragilis is probably identical with some of the subsequently described species, and the specific name has priority (1864) over all those given by Abraham, Bergh, and later writers, but must yield to *bellicosa* (1857) if the two prove to be identical. Alder and Hancock's statement of the differences does not amount to much, but, on the other hand, there is little resemblance between their plate and Kelaart's.

DORIS PARDALIS A. & H.

= *Discodoris pardalis* (A. & H.).

Labial armature yellow, consisting of rods not jointed, fairly straight but with a slightly undulated outline. The armature was apparently composed of two separate halves originally, but is now somewhat confused.

The radula is also confused, but consists of about 28 rows, containing from 12 to 30 teeth on each side of the rhachis. The

teeth are erect, strong, but not very stout. The last one or two are reduced in size, but not degraded and still hamate. The middle part of the radula is more spaced than the rest, and 4-5 inner teeth on each side, which are lower than the others, seem to be set in the broad rhachis. But it is not clear if this position is natural.

Though this radula is narrow, it is doubtful if the animal described by me (Gardiner, Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii. part I, p. 554) as *Disc. pardalis* var. is really referable to this species. It had a radula of only 13.0.13.

DORIS CONCINNA A. & H.

= *Discodoris concinna* (A. & H.) and
Disc. concinniformis Bgh.

Labial armature composed of two triangular plates, consisting of a dense mass of irregular and sinuous rods.

The radula consists of 17 complete rows and fragments of 3 or 4 others, with 45 teeth on either side of the rhachis in the longest rows. The innermost teeth are markedly lower than the rest and project into the wide rhachis; the outermost are smaller but not degraded.

This radula is not inconsistent with the supposition that *D. concinna* is Bergh's *D. concinniformis*. The formulæ of the radulæ examined by him are $27 \times 44.0.44$; $24 \times 37.0.37$; $31 \times 55.0.55$. Some (but apparently not all) of his specimens had thickenings on the rhachis, which are not visible in Alder and Hancock's preparations.

DORIS OSSEOSA Kelaart.

? = *Sclerodoris osseosa* Eliot, P. Z. S. 1903, vol. ii. p. 380; renamed *Peronodoris*, as this apparently identical genus has priority.

Two radulæ are preserved. They are yellow or brown, and consist of 21 and 26 rows of teeth respectively. On either side of the rhachis are from 35 to 50 teeth. The 5-6 innermost, particularly the one nearest to the rhachis, are short and slender. The rest are hamate, except the two outermost which are degraded. The 5-6 outermost decrease in size.

Since both these radulæ are unusually short, some doubt arises whether *D. osseosa* is really the same as the animal described by me *l. c.* The specimen preserved, though in bad condition, is apparently the same as mine, and, being smaller, may possibly have a shorter radula.

DORIS RUSTICATA A. & H. l. c. p. 120.

= *Stauwodoris rusticata* (A. & H.).

One radula light yellow in colour, consisting of 38 rows with remains of a 39th. There are about 50 teeth on each side of the

rhachis, of which the last 5 are degraded but not denticulate, though perhaps jagged here and there. The teeth are markedly smaller near the rhachis and increase outwards, not becoming smaller again until quite the end of the row. In the front part, as preserved, the rows bend downwards and are crowded in the middle. Behind, the two sides are pulled apart, so that there seems to be a broad rhachis, on which are teeth that may possibly represent rudimentary median plates, though they may also be merely broken teeth out of place.

This dentition supports the idea that *D. rusticata* belongs to the same group as *Staurodoris verrucosa*. The genitalia are unknown.

DORIS VILLOSA A. & H. l. c. p. 119.

= *Thordisa villosa* (A. & H.).

= *Th. maculigera* Bergh.

One radula, consisting of one large piece and two fragments. The formula appears to be about $60 \times 70.0.70$. The teeth increase in size from the rhachis outwards. The innermost are low, with long bases. Those near the end of the row are large, strong, and distinctly hooked. The 3 or 4 outermost are different: thin, not much hooked, and with the tip divided into hair-like denticles. In some rows this formation is obscured by the medium in which the teeth are mounted, but it is quite clear in many cases.

This radula seems to place beyond doubt the identity of *Th. villosa* and *Th. maculigera*, since the type-specimen of the former possesses marginal teeth bearing hair-like denticles.

DORIS SPONGIOSA Kelaart.

Should probably be called *Trippa spongiosa* (Kelaart) = *T. areolata* (A. & H.) and *Trippa (Phlegmodoris) mephitica* Bgh.

One radula, broken and torn into two parts for most of its length. There are only 15-16 rows, each containing about 35 teeth, on either side of the rhachis. The 4-5 innermost are shorter and smaller than the rest, which are hamate, white, and erect. The last 1-2 decrease in size, but appear to be still hamate and not denticulate.

T. areolata ($23 \times 40.0.40$) and *T. mephitica* ($30 \times 55.0.55$) also have short radulae of a similar character, and the identity of the three species is very probable.

DORIS TRISTIS A. & H. l. c. pp. 121-2.

? = *Trippa tristis* A. & H.

The single radula is accompanied by the note "no collar apparently," and is divided down the rhachis into two detached halves. There are only 17 rows, each containing about 28 or 30 teeth, on either side of the rhachis, but it is difficult to state the number of teeth exactly, as the innermost are scattered over the space between

the two halves. The innermost teeth are small and slight; the rest large, strong, and hamate. The last five or six gradually decrease in size.

The shortness of this radula and its other characters make it probable that the animal is a *Trippa*. Alder and Hancock thought it showed "some affinity with *D. spongiosa*," and it apparently had compound tubercles ("swellings . . . and a few tubercular elevations; the surface is also covered with minute tubercles, particularly on the ridges and swellings").

DORIS LEOPARDA Kelaart.

Should probably be called *Trippa leoparda* (Kelaart) = *Trippa monsoni* Eliot.

The animal depicted in my previous paper in figure 1 of Plate XLV. is inadvertently called *Trippa monsoni* in the explanation of the plates on page 690. It should be called *Doris leoparda*, for though the two animals are probably the same, the figure reproduced is Kelaart's sketch of *D. leoparda*, which, if it proves to be a *Trippa*, should be called *Tr. leoparda*.

TREVELYANA CEYLONICA Kelaart.

Eliot, Proc. Zool. Soc. 1904, vol. ii. pp. 86-7.

The radula shows that the animal described by me is, as conjectured, Kelaart's *Trevelyana ceylonica*. It consists of 21 rows, each containing 24-25 teeth, on either side of the rhachis. The first lateral is larger than the rest and differently placed, so as to project into the rhachis. All the teeth are awl-shaped.

GONIODORIS.

The buccal parts of *G. aspersa* and *G. citrina* are preserved, but in both the teeth are covered with flesh, so that the small teeth cannot be seen at all and most of the large ones are only partly visible. No formula can be given.

The large teeth of *G. aspersa* have a kink in the lower part of the back and a distinct ridge or wing at the side, but no denticles or striations. There is a buccal ring studded inside with prominences.

None of the teeth of *G. citrina* can be seen completely, but the upper part clearly bears very fine striations, and it would seem that the outline is not a regular curve but swells outwards both on the back and on the inside. Other parts of the buccal mass are preserved, but there is no trace of an armature.

EOLIS MILITARIS A & H.

= *Hervia militaris* (A. & H.).

Fourteen teeth are preserved. They are of the horseshoe shape, with rather long side-limbs. The central cusp is distinct and well formed: on either side are 7 denticles about half its size and close to one another.

The jaws bear a single row of distinct blunt denticles, set at some distance from one another. Some of them show traces of bifurcation at the tip.

As Farran has observed (*l. c.* p. 331), this species seems to be a *Hervia*, although Bergh (System, p. 1032) suggested it might be a synonym of *Facelina rubrovittata*. But both the description and figure of Alder and Hancock represent the rhinophores as smooth.

DORIDOPSIS and DORIOPSISILLA.

An error occurs in the numbering of the figures representing these genera on Plate XLVII. of my previous paper, as published in the Society's 'Proceedings,' although the numbers are correct in the copies printed separately. Numbers 4 and 5 should be transposed; that is to say, the lower figure represents *Doridopsis nigra* and should be numbered 5, while the upper figure represents *Doriopsisilla miniata* and should be numbered 4.

7. On Variations in the Arterial System of certain Species of the Anura. By LIONEL R. CRAWSHAY, M.A.*

[Received October 22, 1906.]

(Text-figures 143-155.)

In the original and subsequent editions of Ecker's and Wiedersheim's 'Anatomie des Frosches,' the species employed for investigation were exclusively *Rana esculenta* Linn. and *Rana temporaria* auct., and particularly the former. The species *R. catesbiana* Shaw and *R. silvatica* Leconte were also, it is stated, examined by Ecker for comparison, but no reference is made to them in the text. Besides the portion of these works devoted to the subject, which has been so greatly extended by Gaupp in the last edition, there is, so far as I am aware, no other published record dealing with the general arterial system of the Anura, so that the work, it would seem, has so far been practically confined to the two first-named species. While working a short time ago, by the kindness of Mr. Beddard, at the Prosectorium of the Zoological Society's Gardens, I was very greatly indebted to him for enabling me to examine, in addition to the above named, certain other species of the Anura, in some of which a considerable portion of the arterial system was worked out in detail. These comprised single specimens of *Rana catesbiana* Shaw, *R. tigrina* Daud., *R. hexadactyla* Less., *Bufo boreas* B. & G., and *B. mauritanicus* Schleg., and two specimens of *Rana clamata* Daud.

It is true that the extent of variation, sometimes even in important points, to which the arteries are liable in individuals

* Communicated by F. E. BEDDARD, M.A., F.R.S.

of the same species, considerably lessens the importance attaching to such variations as may occur between isolated individuals of different species. Dealing with limited material, the present paper is submitted in the hope that it may not be without value as a contribution to the further study of the subject, and more especially perhaps from the wider aspect of the arterial system of the Anura as a whole.

In the portion of the arterial system here considered, the *Aa. carotis cerebialis*, *occipito-vertebralis*, *brachialis*, and *ischia-dica* are omitted. The species will be considered together as far as possible, the account in Gaupp's edition of Ecker's and Wiedersheim's 'Anatomie des Frosches' being followed as a basis of reference. The nomenclature of the arteries is that adopted in the same work, but in the case of the muscles the system used in the original edition of Ecker is retained. In regard to the latter, among the muscles to be referred to a difference of nomenclature occurs in the following:—

ECKER.	GAUPP.
<i>M. coraco-humeralis.</i>	= <i>M. coraco-brachialis longus.</i>
„ <i>ileo-psoas.</i>	= „ <i>iliacus internus.</i>
„ <i>infraspinatus.</i>	= „ <i>dorsalis scapulae.</i>
„ <i>levator anguli scapulae.</i>	= „ <i>levator scapulae inferior.</i>
„ <i>obliquus internus.</i>	= „ <i>transversus.</i>
„ <i>subscapularis.</i>	= „ <i>coraco-brachialis brevis.</i>
„ <i>transverso-scapularis major.</i>	= „ <i>serratus inferior.</i>
„ „ „ <i>minor.</i>	= „ „ <i>medius.</i>
„ <i>triceps brachii.</i>	= „ <i>anconeus.</i>

The *A. bulbi cordis* had not in all cases the same point of origin. In *R. tigrina*, *R. clamata*, and *R. catesbiana*, it arose from the base of the right carotid arch; in *R. hexadactyla*, the same, but close against the margin of the right systemic; in *Bufo boreas* from the base of the right systemic; in *Bufo mauritanicus* from the base of the left carotid arch. In each case, the artery ran across the base of the three right arches and divided into branches supplying the dorsal and ventral sides of the bulbus but not apparently extending beyond it.

I. CAROTID SYSTEM.

The *A. carotis externa* appeared in *Bufo boreas* to arise from near the centre of the carotid gland, instead of from its proximal margin as in other species.

The *r. musculo-glandularis* was given off a short way from the base of this artery in all the species, supplying vessels to the thyroid gland and hyoidean muscles in this region. The close association of this branch with the thyroid was especially well exhibited in *R. hexadactyla* and *R. tigrina*, where the gland was much broken, and a branch of the artery ran in communication with the several disconnected portions. It is remarkable,

however, that in *Bufo boreas* a large dark reddish compact gland attached ventrally to the distal end of the middle and posterior arches, and similar in appearance to the thyroid, had no connection whatever with this artery, but was supplied on both sides of the body by a branch of the subclavian*.

From the point where the *r. lingualis* passes backwards to the tongue, a small branch of the *carotis externa* is continued forwards in the *M. geniohyoideus* to the edge of the lower jaw. In *R. tigrina* and both species of *Bufo* this vessel ended here, but in the rest of the species examined it formed an anastomosis with the *r. maxillaris inferior* of the *A. occipitalis*.

A. carotis interna.—I was unable to observe the *A. pharyngea ascendens* described and figured by Ecker, and afterwards in the translation of Haslam, as a branch of this artery in any of the specimens examined, but in all cases the first subdivision of the artery occurred just as it enters the inner posterior angle of the orbit and passes into the skull, giving off the *Aa. ophthalmica* and *palatina* with other unimportant small vessels almost simultaneously. There is no reference to such a branch of the carotid in Gaupp's edition, and unless its insertion can have been due to some error, its occurrence as a noteworthy vessel would seem to be abnormal.

The connection of the *A. palatina* with the Harderian gland was always very marked, the main vessel turning inwards to the gland as it reached the anterior border of the orbit. This gland occupied a constant position against the eyeball in close contact with the *M. obliquus inferior*. In *R. hexadactyla* it formed the centre of a complete anastomosis between the *Aa. palatina* and *ophthalmica*, and the *orbito-nasalis* and *maxillaris superior* of the *occipito-vertebralis*, the *palatina* uniting with the *orbito-nasalis* just before reaching the gland. The gland in this case especially was completely suffused with the colour of the injection, as is so noticeable in the spleen, or, less distinctly, in the thyroid (text-fig. 147, *g.h.*, p. 1019).

II. SYSTEMIC SYSTEM.

The *A. laryngea* was constant in occurrence and position, leaving the systemic arch opposite to the carotid gland.

As the systemic arch passes up to the dorsal body-wall, the first trunk to be given off was in all cases the *occipito-vertebralis*, the *subclavia* very soon afterwards branching off from the aorta and crossing the base of the *occipito-vertebralis* dorsally in its outward course.

The *A. œsophagea* seems in most cases to arise from the base of the *occipito-vertebralis*. Such was the case in *R. clamata*, *R. hexadactyla*, *R. tigrina*, *B. mauritanicus*, and *B. boreas*. In *R. tempo-*

* No attempt is made here to discriminate between the several factors which may make up the sometimes very irregular glandular masses in this region, and the term "thyroid" is used for them collectively with some reticence (cp. H. Norris, *Anat. Anz.* vol. xxi. p. 221).

raria it originated in one specimen on both sides of the body in the aorta, just behind the origin of the *subclavia*, while on the left side there was an additional vessel from between the *subclavia* and the *occipito-vertebralis*. In another individual of the same species it arose on both sides from the base of the *occipito-vertebralis*.

In *R. catesbiana* it originated between the *subclavia* and the *occipito-vertebralis*. It divided on the œsophagus, and the main portion ran as a rather large vessel for a considerable way down the right side of the stomach, supplying a large portion of the cardiac region, over which it formed a close network. A branch of this network could easily be traced to the right lung, where it formed an anastomosis with branches of the pulmonary artery. Further back, its ramifications united with those of the *ramus sinister* of the *A. cœliaca*. The point is not without interest as showing how, ultimately, as one may conceive, through the medium of such anastomoses a distinct vessel might arise in a purely secondary manner running either from the *œsophagea* or the *cœliaca* directly to the lung.

A. subclavia.—The branches of this artery distributed to the pectoral girdle are liable to much variation in number, structure, and distribution. I am inclined to think that a careful examination of a large number of individuals is still needed to establish a satisfactory type of arrangement for the Anura. Two figures are appended showing their arrangement on both sides of the body in two individuals of *R. temporaria* which were injected together for the purpose (text-figs. 143, 144, p. 1012). Here, before the radial artery was given off, there were five (in one case four) arteries striking out at irregular intervals into the pectoral girdle, roughly with an anterior and posterior alternation. Retaining so far as possible the nomenclature of Gaupp:—

(1) The *A. thoracica superior*, arising from near the *occipito-vertebralis*, took, in one of these two individuals, the usual course upwards and forwards, supplying the *Mm. intertransversarius capitis superior* and *levator anguli scapulae* on both sides of the body. In the other individual, the artery went on one side to the *M. transverso-scapularis minor*, and on the other side entirely backwards to the *M. obliquus internus*.

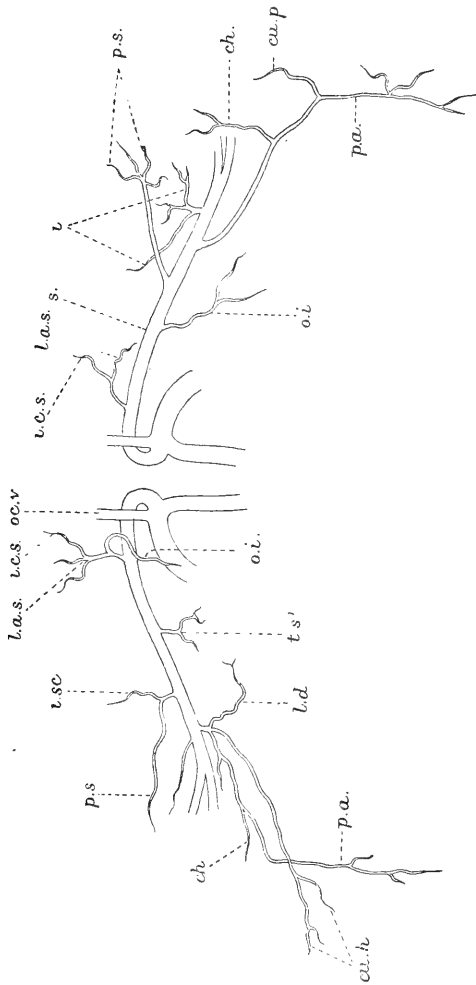
(2) The *A. thoracico-abdominalis* went in three cases almost entirely to the *M. obliquus internus*; in the fourth case to the *M. transverso-scapularis major*.

(3) The *A. coraco-clavicularis*, perhaps the most constant member of the subclavian system, passed mainly in all cases through the coracoid foramen to the *M. pectoralis sternalis*, a branch being given in two cases to the *M. interscapularis*.

(4) This, the largest branch, appeared in all four cases to be a combination of the *Aa. dorsalis scapulae posterior* and *dorsalis scapulae anterior* of Gaupp. In three cases a branch went to the *M. pectoralis abdominalis*, but on all four sides one or more conspicuous branches ran to the skin of the upper arm or that of the

pectoral girdle; other muscles supplied being the *Mm. latissimus dorsi, infraspinatus, coraco-humeralis, subscapularis*, and in one case the *obliquus externus* and *obliquus internus*.

Text-fig. 143.

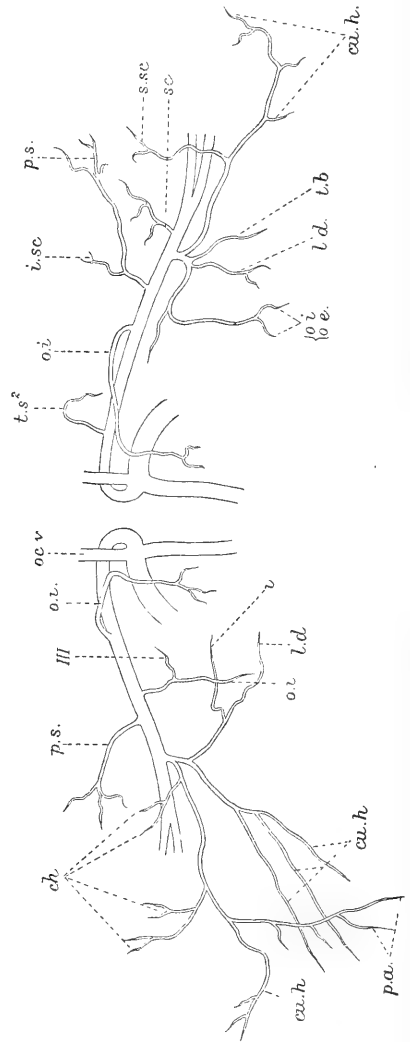


Rana temporaria (x 2).

Ventral view of *Aa. subclaviae*.

(For explanation of the lettering, see p. 1033.)

Text-fig. 144.



Rana temporaria (x 2).

Ventral view of *Aa. subclaviae*.

(For explanation of the lettering, see p. 1033.)

(5) This branch, apparently the *A. pectoralis superior*, was absent on one side in one individual, but in the other three cases went irregularly to the *Mm. scapularis* and *infraspinatus* and the scapula respectively.

With regard to the other species, the two specimens of *R. clamata* (text-fig. 145, p. 1015) agreed with one another and with the above account in the main points. On the (right) side of the body examined, the *a. thoracica superior* had a forward and upward direction, going chiefly in one specimen to the *M. intertransversarius capitis superior* and in the other to the *M. levator anguli scapulae*. The *thoracico-abdominalis* went to the *Mm. obliquus internus* and *transverso-scapularis major*. The *coraco-clavicularis* passed through the coracoid foramen. The fourth branch went to the *Mm. pectorales sternales* and *latissimus dorsi* and to the skin under the pectoral girdle. The fifth, which is omitted from the figure, went to the scapular region.

In *R. hexadactyla* (text-fig. 147, p. 1019) there were the same five branches. The distance between the first two was much exaggerated in the figure to avoid confusion. The *thoracico-abdominalis* after supplying the *M. transverso-scapularis major*, ran back as an exceptionally long vessel in the substance of the *Mm. obliquus externus* and *obliquus internus*. The fourth branch was divided between the *Mm. latissimus dorsi* and *subscapularis*, the cutaneous portion being absent. The fifth branch supplied the *M. infraspinatus*.

In *R. catesbiana* (text-fig. 146, p. 1017) there were nine distinct branches. Their relations will be more easily understood by reference to the figure of this species, where, as elsewhere, though at the risk of confusion, diagrammatic arrangement has been avoided as far as possible. Probably the third, fifth (posterior), sixth, seventh, and ninth branches are to be homologised with the five referred to above; the first, second, fourth (anterior), and eighth being additional ones. On the side of the body that is figured the third branch, presumably the *thoracica superior*, had completely united with the *ramus auricularis* of the *cutanea* so as to be distributed in common with that artery to the tympanic region. On the left side, after passing round the region of the atlas, it formed a fine anastomosis under the hinder border of the tympanic membrane with the same branch of the *cutanea*. A second anastomosis was formed here between the fourth (anterior) branch and a twig from the *coraco-clavicularis*, the latter artery passing almost entirely through the coracoid foramen. The small fourth and eighth branches followed the first and third spinal nerves respectively.

R. tigrina was remarkable for the fact that the *thoracica superior* and the *thoracico-abdominalis* were each of them represented by a pair of arteries, the first pair supplying chiefly the *M. intertransversarius capitis inferior*, and the second pair almost wholly the *M. obliquus internus*. Then followed, thirdly, the *coraco-clavicularis*, passing wholly through the coracoid

foramen; fourthly, the largest branch distributed for the most part to the skin of the upper arm and under the pectoral girdle and to the *M. latissimus dorsi*; and lastly, the branch elsewhere identified as the *pectoralis superior*, to the *Mm. infraspinatus* and *latissimus dorsi*. On the left side of the body there was no difference to mention beyond the fact that the first pair (*thoracica superior*) were closer together and the second pair (*thoracico-abdominalis*) farther apart than on the right side.

In *Bufo mauritanicus* the *thoracica superior* was absent from the *subclavia*, its place being taken by a small branch from the *occipito-vertebralis* just beyond the *oesophagea*. The first branch, moreover, to arise from the *subclavia* was not the *thoracico-abdominalis* but the *coraco-clavicularis*. A branch of this latter artery went through the coracoid foramen, but the greater portion of it passed round the *M. scapularis* to break up over that muscle, the posterior portion of the *M. pectoralis sternalis*, and the skin of the upper arm. Very shortly after this arose the *thoracico-abdominalis*, distributed almost wholly to the *M. obliquus internus*, but sending also a twig to the *M. transverso-scapularis major*. Lastly arose the *pectoralis superior* supplying the *M. infraspinatus* and the scapula. The condition of the left side scarcely differed at all from that of the right.

In this Toad there were, therefore, only three branches from the *A. subclavia*.

In *B. boreas* (text-fig. 153, p. 1029) the branches were five, their arrangement being, roughly speaking, similar to that described above for *R. temporaria*. The *thoracico-abdominalis* went almost wholly to the *M. transverso-scapularis major*, a small twig on the left side only being given to the *M. obliquus internus*. The most remarkable point was that the *coraco-clavicularis* did not arise independently, but in common with quite a new artery which shortly separated from it and ran direct to the gland which has already been referred to as lying upon the distal ends of the systemic and pulmo-cutaneous arches. The condition was identically the same on both sides of the body. A large portion of the fourth branch went to the *M. triceps brachii*. The fifth branch, which was large, arose opposite to the latter branch and supplied the *Mm. infraspinatus* and *deltoideus*, the scapula, and the skin of the humeral region.

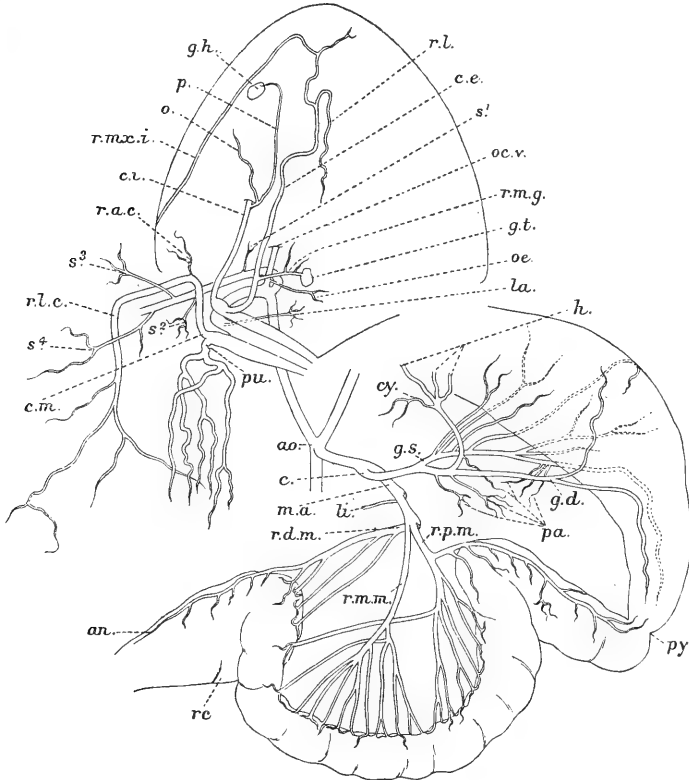
Passing to the consideration of the *Aorta abdominalis*, the *cœliaco-mesenteric* axis arose in all cases from the left side of the point of union of the two aortic arches, that is apparently as a continuation of the left arch.

In *Bufo mauritanicus*, a vessel about as large as the *A. lienalis* arose from near the origin of the *cœliaco-mesenteric* axis and ran back in the mesentery, dividing into two branches, of which the posterior one extended to the anterior border of the left kidney without traversing its substance, and the anterior one went to the mesentery. This would seem to be properly one of the *Aa. urogenitales*, its origin having become displaced from the main

trunk of the aorta. In a specimen of *R. temporaria* the first of the true *Aa. urogenitales* arose so close to the base of the celiacomesenteric axis that it might almost be said to arise from it.

A. cœliaca.—The distinction of *sinistra* (*dorsalis*) and *dextra* (*ventralis*) as applied to the two divisions of the gastric system was clearly marked with few exceptions, the two branches supplying the left and right sides of the stomach respectively. The only exceptions of any importance were both specimens of

Text-fig. 145.



Rana clamata, ♀ ($\times 1\frac{1}{2}$).

Portion of arterial system. Ventral view.

(For branches of *A. subclavia*, s^1 - s^4 , see p. 1013. For explanation of other lettering, see p. 1033.)

R. clamata, in which the right (ventral) side received two or three important vessels from the left artery. Except in *R. tigrina* and both species of *Bufo*, there was no vessel given off before the *A. gastrica sinistra*.

A. gastrica sinistra.—This artery is liable to considerable variation, even in individuals of the same species. In this respect, three specimens of *R. temporaria* were all different. Here, from two to four vessels were given off to the cardiac region of the stomach, sometimes dividing before reaching it. The direction of the main trunk was always towards the median point, about which the artery then either simply bifurcated, or further subdivided while in the omentum, the posterior branch in either case running down the left wall of the stomach to the pylorus.

Within the limits of this variation, *R. clamata*, *R. hexadactyla*, and *R. esculenta* scarcely differed from *R. temporaria*. *R. tigrina* showed a greater tendency to division in the omentum, the artery simply giving off five or six subequal branches in a more or less regular series, the last of which became attached to the stomach not far in front of the pylorus. In this species, the first gastric vessel was given off from the *A. coeliaca* before the origin of the *A. gastrica sinistra*.

In *R. catesbiana*, three minute vessels were first given off anteriorly to supply the omentum, then a single branch to the cardiac region of the stomach, the remainder to the very long pyloric region (in this individual), reaching it in five vessels, of which the last ran down as usual to the pylorus.

In *Bufo boreas* and *B. mauritanicus*, the first gastric vessel was given off before the origin of the *A. gastrica sinistra*. The latter artery then very shortly gave off a single gastric vessel and afterwards divided into two branches, which at once became attached to the stomach near its median point and continued to break up over its substance, the posterior branch following the usual course to the pylorus. There was therefore very little tendency here to early division in the omentum, as also was the case in *R. hexadactyla*.

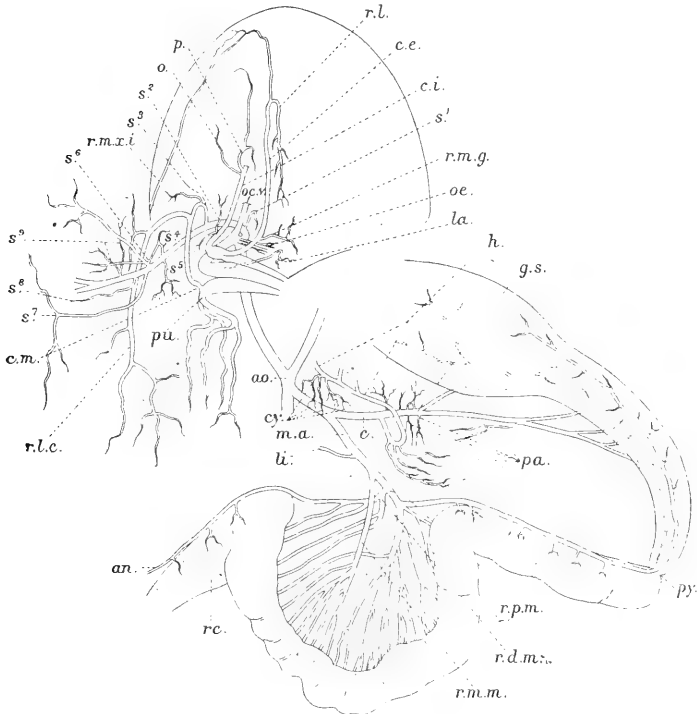
In both specimens of *R. clamata* two or three branches of this artery went to the right side of the stomach. In all other cases it was almost entirely distributed to the left side.

There is no mention made by Gaupp of branches from the *A. gastrica sinistra* supplying the pancreas. The artery, however, commonly sends back one or more small branches to that gland, which vary in number and position. In *R. temporaria* there were two in two individuals and three in a third. In *R. esculenta* one, near the origin of the artery and some way before the first gastric vessel. In *R. catesbiana* two before the first gastric vessel and a third distally. In *R. clamata* four in one individual. In *R. tigrina* five. In *R. hexadactyla* one after the first gastric vessel sending a branch backwards to the pancreas and then following the bile-duct &c. nearly to the liver, also three small ones. In *Bufo boreas* and *B. mauritanicus* three; in the latter species rather close together and from the distal portion of the artery (text-figs. 145, 146, 147, 153).

A. hepatica.—This artery was in all cases given off not far

beyond the origin of the *gastrica sinistra*. In *B. mauritanicus* and *B. boreas* the pancreas received two vessels from it: in the former species both from near the base; in the latter, one from near the base, the other from more than halfway towards the gall-bladder. But I did not observe the presence of pancreatic branches in the other species, except in *R. temporaria*, where one occurred in two individuals and two in a third.

Text-fig. 146.



Rana catesbiana, ♂ (× 3).

Portion of arterial system. Ventral view.

An abnormal individual, with *A. gastrica dextra* absent.

*s*¹-*s*⁹.—Branches of *A. subclavia*. (The numbers have no morphological significance.)

- s*¹ to wall of aorta.
- s*² to *Mm. levator anguli scapulae* and *obliquus internus*.
- s*³ anastomosing with *r. auricularis* of *A. cutanea magna*.
- s*⁴ to hypoglossal nerve.
- s*⁵ to *Mm. obliquus internus* and *transverso-scapularis major*.

- s*⁶ through coracoid foramen to *M. pectoralis sternalis*, with a branch to *M. subscapularis*.
- s*⁷ to *M. pectoralis abdominalis* and skin below pectoral girdle.
- s*⁸ to 3rd spinal nerve.
- s*⁹ to *Mm. transverso-scapularis major* and *deltoideus*.

(For explanation of other lettering, see p. 1033.)

A. gastrica dextra.—A varying number of vessels were given off from this artery to the pancreas and adjacent structures as follows:—In *Bufo boreas* one, some distance beyond the *A. hepatica*; in *B. mauritanicus* one, from near the stomach; in *R. hexadactyla* one; in *R. esculenta* two, opposite the origin of the *hepatica*; in *R. clamata* (two specimens) one, in the same position; in *R. tigrina* two.

(In addition to these vessels, the pancreas also received a single vessel from before the origin of the *hepatica* in *R. esculenta*, *R. hexadactyla*, and *R. tigrina*.)

The specimen of *R. catesbiana* (text-fig. 146, p. 1017) was remarkable for the fact that after the separation of the *gastrica sinistra*, three arteries were shortly given off to the pancreas and then the remainder of the *A. coeliaca* went to the liver and gall-bladder, the *gastrica dextra* being entirely absent. It is conceivable that this abnormality might be correlated with the anastomosis which so frequently occurs on the right side of the pylorus between the normally present *gastrica dextra* and the duodenal branch of the *mesenterica*. In this case, moreover, the latter artery was continued without diminishing in size over the pylorus and up the right side of the stomach; in fact over the region which the *A. gastrica dextra* would normally traverse. In this individual, a male, which was sent to me alive from America, the constricted pyloric region was extremely long. In another, a large female of the same species which was examined for comparison, the condition of the arteries here was quite normal, and in this latter case the constricted pyloric region was very short.

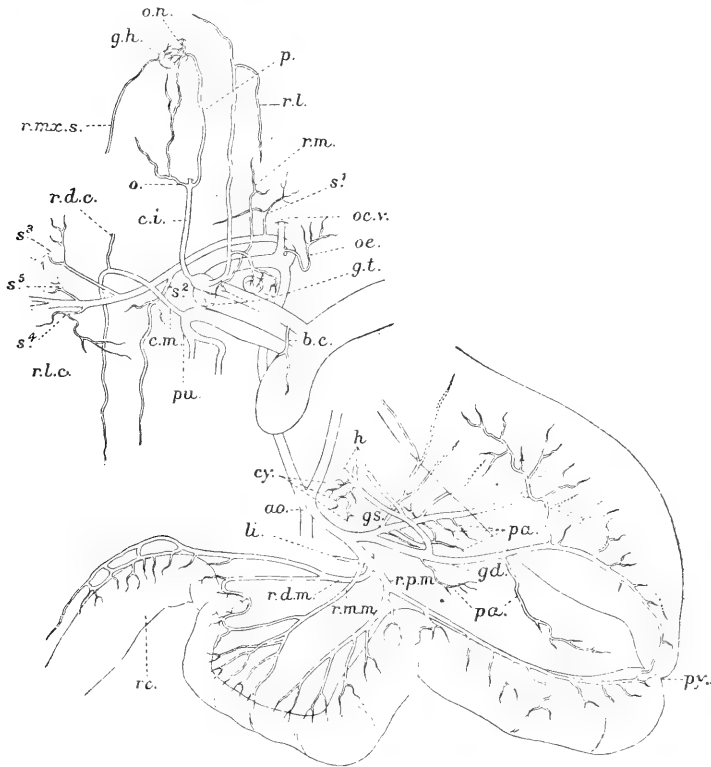
In the other species, the *A. gastrica dextra* was continued as a rather larger vessel than the *A. hepatica* to the right side of the stomach and towards its more distal portion. In three individuals of *R. temporaria* it only varied in the relative points of its division. It divided into two branches at about two-thirds of the way to the stomach, and each branch again divided into two near the latter.

In *R. esculenta*, the first division of the *A. gastrica dextra* took place closer to the stomach and the posterior branch was continued as a compact vessel down to the pylorus. In *R. tigrina*, it began to divide about halfway to the stomach, which it reached in three or four branches. In *R. clamata* and *R. hexadactyla*, it divided into an anterior and posterior branch on or near the surface of the stomach (text-fig. 145, p. 1015; text-fig. 147, p. 1019). *Bufo mauritanicus* somewhat resembled *R. tigrina*, but the subdivision of the artery was more distal. *B. boreas* was very distinct from the rest by the simultaneous division of the artery close to the stomach into five equal-sized branches, the posterior branch running back as usual to the pylorus, the others breaking up at short intervals in front of it (text-fig. 153, p. 1029).

A. mesenterica anterior.—The extent of variation in this artery is so great that it is difficult to draw more than very general comparisons between the species under consideration.

The *A. lienalis* was given off some way before any other branch in *R. temporaria*, *R. catesbiana*, *R. clamata*, and *B. boreas*; and just before or immediately opposite to one or more of the intestinal branches in *R. esculenta*, *R. tigrina*, *R. hexadactyla*, and *B. mauritanicus*, always as a single vessel.

Text-fig. 147.



Rana hexadactyla, ♀ (× 1½).
 Portion of arterial system. Ventral view.

s¹-s⁵.—Branches of *A. subclavia*.

s¹ to *Mm. transverso-scapularis major*, *longissimus dorsi*, and *transverso-scapularis minor*.

s³ through coracoid foramen to *M. pectoralis sternalis*.

(For other branches, see p. 1013. For explanation of other lettering, see p. 1033.)

The intestinal portion of the artery is divided by Gaupp into two portions, distinguished as *rr. intestinales* and *rr. hæmorrhoidales anteriores* respectively. Viewing the species under consideration as a whole, it seems rather to fall into three distinct branches.

The arrangement was rather different in the two species of *Bufo*, but in all the six species of *Rana* it may be said that the independence of these three branches and their association respectively with the proximal, median, and distal portions of the intestine was distinctly marked. For purposes of comparison I will therefore refer to them as the *proximal*, *median*, and *distal* rami.

The *proximal ramus* soon divides in the mesentery near the end of the first loop of the intestine. A large branch is then given off which soon attaches itself to the surface of the gut, running along the duodenum to the pylorus, where it generally anastomoses with the distal portion of the *A. gastrica dextra*. As previously mentioned, in *R. catesbiana* it took up the whole function of that artery, running for a considerable way up the right side of the stomach (text-fig. 146, p. 1017). *R. tigrina* and one specimen of *R. clamata* were the only examples in which no such anastomosis was observed. In *Bufo mauritanicus* a small vessel was given off at the bile-duct (*A. pancreatica posterior*, Gaupp) and ran a considerable way along it, supplying the pancreas, &c. This vessel was also present in one specimen of *R. temporaria*, and may have escaped my notice in other individuals, though I did not observe it. The other portion of this branch of the *mesenterica anterior* runs backwards, and normally, unlike the duodenal portion, shortly breaks up in the mesentery into a variable number of vessels which mostly further subdivide, confining themselves roughly to the first half of the small intestine. Such was the case in *R. temporaria*, *clamata*, *tigrina*, *catesbiana*, and *hexadactyla*. In *R. esculenta*, instead of division in the mesentery, a single vessel ran along the wall of the intestine like the duodenal portion. *Bufo boreas* was the same as *R. esculenta*. In *B. mauritanicus* the intestinal portion took off from the main trunk quite independently of the duodenal portion of this ramus and more distally.

The *median ramus* runs for some distance unbroken and then divides and subdivides rapidly in the mesentery into a number of vessels, which are distributed roughly to the distal half of the small intestine. The variation to which this branch is liable among individuals of a species seems to be too great to admit of comparison being drawn between the species themselves.

The *distal ramus* (*rr. hæmorrhoidales anteriores*, Gaupp) is, as a rule, almost confined in its distribution to the large intestine. *R. tigrina* was exceptional in that about one-third of it went to the small intestine. More often its first vessel reaches the gut nearly on the border line between these two regions. Its independence as a distinct unit of the mesenteric system was clearly shown in all the species except in *B. boreas*, where it was more difficult to differentiate it from the *median ramus*. In *R. tigrina* it was very much broken up in its course through the mesentery. In *R. esculenta* it reached the intestine as a single vessel only. Posteriorly, it usually runs back in close contact

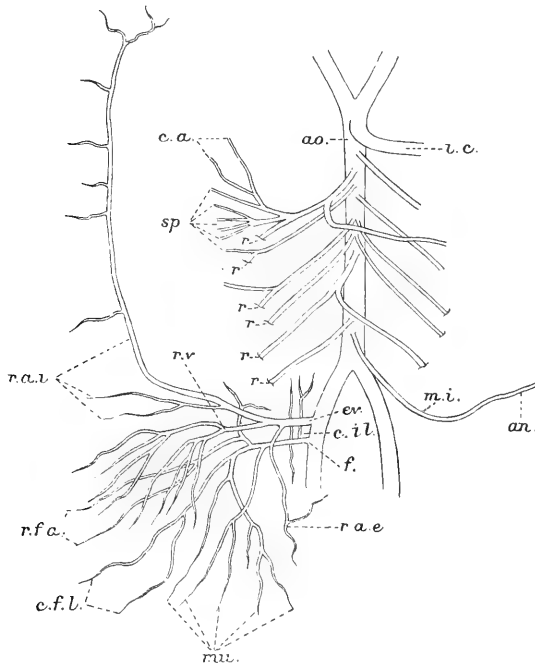
with the large intestine, giving off twigs on the way, to the cloacal region; but in this respect *R. hexadactyla* was an exception, the main vessel running freely in the mesentery beside the gut, while its subdivision formed a series of anastomoses which gave it a fenestrated structure (text-fig. 147, p. 1019). Near the distal end of this posterior vessel an anastomosis is often formed with the *A. mesenterica inferior* from the aorta, but the occurrence or non-occurrence of this seems to be quite accidental.

In connection with the *A. mesenterica anterior* a point may be mentioned here which possibly has not escaped the notice of others, namely, the giving off of a vessel from a branch of the artery to a region of the intestine quite outside the sphere with which that branch and its vessels are concerned. Notwithstanding the approximation of different regions of the intestine that may occur owing to the folding of the mesentery, there is normally no true overlapping of the vessels; that is to say, their respective regions of distribution remain distinct, and even the minor vessels do not cross one another. But in certain cases a departure from this occurred. Thus in *R. clamata* (text-fig. 145, p. 1015) one of the vessels of the *median ramus* crossed under all its fellows behind it and went out of its way, so to speak, to the extreme end of the small intestine; and in a more remarkable degree, one of the vessels of the *proximal ramus* struck across under the whole of the *median ramus* to a point on the intestine behind all the vessels of the latter. Both of these points were repeated in the second specimen of *R. clamata*. In *R. catesbiana* there was no crossing of the vessels of the *median ramus*, but a vessel from the *proximal ramus* passed back under all those of the *median ramus*, reaching the intestine behind them; and the same was the case in *B. mauritanicus*. In *R. temporaria* one individual had the same irregular vessel from the *proximal ramus* only; another individual had two such vessels from the *median ramus* only. In the other species nothing of the kind occurred. There was sometimes a very close attachment between these irregular vessels and those crossed by them, but there was no union between them. In fact, while the extreme distal portions of the arteries often combine, even so as to form a continuous vessel along the wall of the gut, I observed no case of anastomosis where the vessels lie free in the mesentery, excepting the fenestrated arrangement previously mentioned in *R. hexadactyla* near the wall of the large intestine, and a union between two vessels of the *A. gastrica sinistra* close to the stomach in one specimen of *R. clamata*.

Aa. urogenitales.—These arteries have often been inaccurately described as arising from a series of unpaired stems which bifurcate right and left. As pointed out by Gaupp, such an arrangement is subject to much variation. In two of the species under consideration, namely *R. hexadactyla* and *B. boreas* (text-fig. 149, p. 1023; text-fig. 151, p. 1026), they all of them arose from unpaired stems in the aorta, which divided into right and left branches to the urogenital organs on either side. But in all other cases, traces

of the more primitive condition were more or less retained. In a specimen of *R. temporaria* each side received ten arteries, three of which arose independently from the aorta. In *B. mauritanicus* there were four vessels, three of which divided into right and left branches, the fourth going to the right kidney alone. In *R. clamata*, five vessels went to one side and four to the other. Of these nine vessels, five had independent origins (text-fig. 152, p. 1027). In *R. tigrina* on each side there were eight arteries, three of which were distinct in origin. In *R. catesbiana* there were six arteries to each side, four of them arising quite independently from the aorta, so that here there were only two which bifurcated right and left (text-fig. 148).

Text-fig. 148.



Rana catesbiana, ♂ (× 1).

Ventral view of *Aa. urogenitales*, &c.

(For explanation of the lettering, see p. 1033.)

With a doubtful exception and one clear case in a specimen of *R. temporaria*, the *Aa. genitales* did not arise, in any of the individuals examined, independently from the aorta, but always in common with a renal vessel. Generally they separated from the renal vessel a considerable distance from the aorta, but sometimes

close to it, as in the first pair in *R. hexadactyla*. In cases noted the gonads were supplied as follows, the number of urogenital arteries present in each case being placed in brackets:—

(1) TESTES:—

R. temporaria, one specimen (10 pairs): genital arteries from the first four on each side.

B. mauritanicus ($3\frac{1}{2}$ pairs): from the first two on each side.

R. catesbiana (6 pairs): mainly from the first artery on each side, but also partly from the second and third.

R. tigrina (8 pairs): from the first artery on each side.

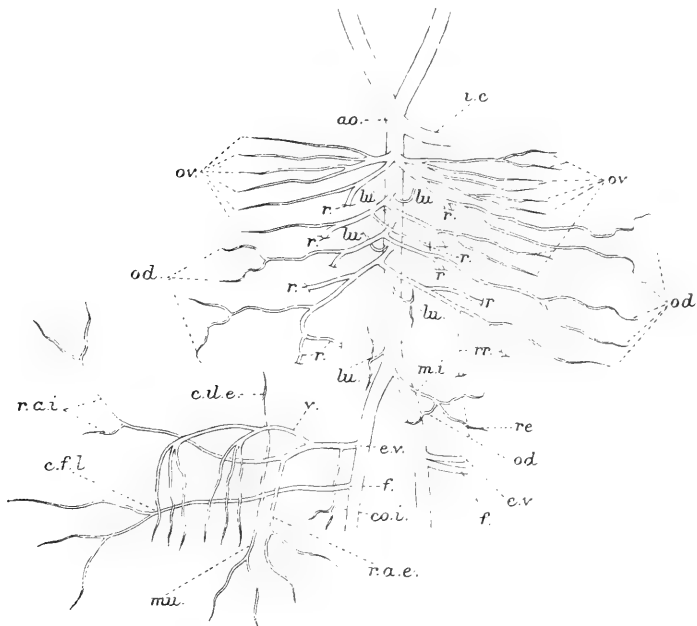
(2) OVARIES:—

B. boreas (5 pairs): from the first four on each side and also on one side from the fifth.

R. hexadactyla ($4\frac{1}{2}$ pairs): from the first two on each side.

R. clamata ($4\frac{1}{2}$ pairs): from the first three on each side.

Text-fig. 149.



Rana hexadactyla, ♀ (× 2).

Ventral view of *Aa. urogenitales*, &c.

(For explanation of the lettering, see p. 1033.)

In the three individuals in which they were examined, the oviducts were supplied by separate branches from the *Aa. renales*,

not from the *Aa. ovaricæ*, otherwise from the *A. mesenterica inferior* (*R. hexadactyla*), or from the *A. epigastrico-vesicalis* (*R. esculenta*); the details being as follows:—

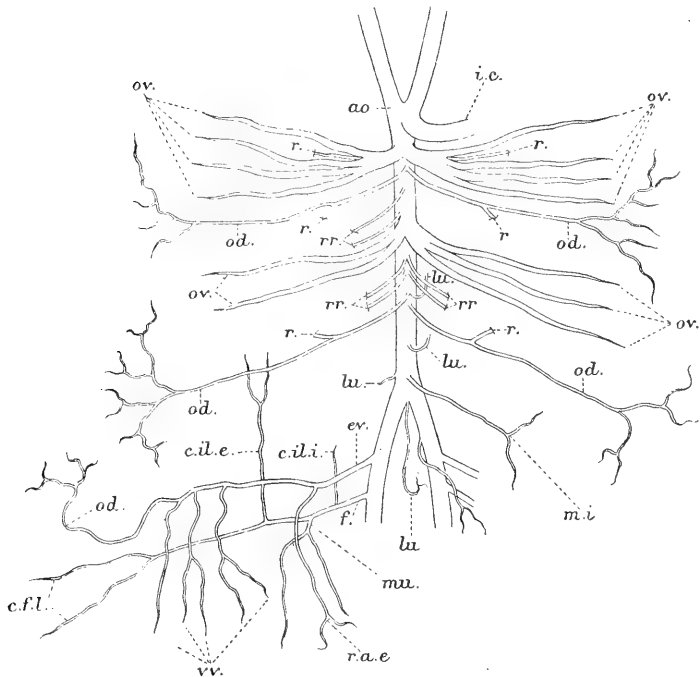
R. hexadactyla: from the first *renalis* on one side, and from the last *renalis* and the *mesenterica inferior* on both sides.

B. boreas: from the first two *renales* on one side, and the fifth *renalis* on both sides.

R. esculenta: from the second and last *renales* and the *epigastrico-vesicalis* on both sides.

The fat-bodies, as observed in three species only, were supplied by branches from the first urogenital pair and, except on one side in *R. temporaria*, direct from a genital vessel. In this exception there was no genital vessel on this side, and the artery arose from a renal vessel.

Text-fig. 150.



Rana esculenta, ♀ ($\times 1\frac{2}{3}$).

Ventral view of *Aa. urogenitales*, &c.

Showing abnormal development of *Aa. ovaricæ*.

(For explanation of the lettering, see p. 1033.)

In the single individual examined of *R. esculenta* (text-fig. 150) the condition of the *Aa. ovaricæ* was very remarkable. They arose

in two paired series, each pair separating close to the aorta from a common origin and forming from two to four branches to each ovary. All of the arteries were invested throughout by a thick muscular coating from the aorta to their fine ramifications in the ovaries. Owing to this, each of the short stalks from which they arose appeared in thickness nearly to cover the diameter of the aorta. The lumen of the arteries themselves was of the usual small size. While all of the *ovarice* were as described, all of the *renales* were quite normal, including the first pair, which separated from a common origin with the first set of *ovarice*. In the figure, these thickenings appear to arise at the aorta, but they were in fact continued closely round this and attached above it by small belts of fibres to either side of the sixth and seventh vertebral centra, being connected at the same time with the sympathetic nervous system. The ovaries were very fully developed. This peculiar condition of the *ovarice* would seem to be an almost parallel case to a condition referred to by Gaupp as first observed by Nussbaum in the same arteries of the same species. But whereas the latter author states that the arteries ran in the primary members only of these "vier bis fünf weissliche Strahlen," and appears to have found them associated with the mesovarium generally, they were certainly in the present case connected with the arteries exclusively; for all of the *Aa. ovarice* were entirely enveloped by them, and, apart from the *Aa. ovarice*, there was no muscular thickening in the mesovarium. They had, in fact, the appearance only of a thick muscular investment of the arterial walls attached dorsally to the sides of the vertebral column.

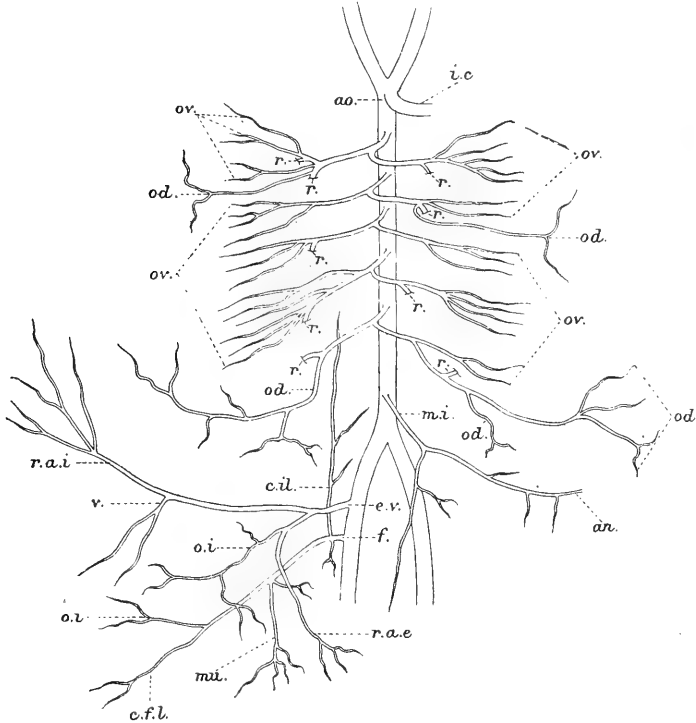
The *Aa. lumbales* were not followed sufficiently for purposes of comparison.

The *A. mesenterica inferior* was given off in all cases from the median ventral line of the aorta, between the last of the *Aa. urogenitales* and the bifurcation of the aorta. Between these two points its position varied considerably. It was close to the former in *R. clamata*, and very close to the latter in *R. hexadactyla*, a considerable space intervening in each case. It formed an anastomosis with the distal branch of the *mesenterica anterior* in *R. clamata*, *R. catesbiana*, and *B. boreas*, but not in the others, though this point is doubtless quite unimportant. Ordinarily it seems to be confined to the large intestine, running down to the cloacal region, but in *R. hexadactyla* two-thirds of the artery went to the oviducts.

The *A. epigastrico-vesicalis* showed a good deal of variation in the arrangement of its branches, but a division into three main portions was always apparent, and I am inclined to think that to divide this artery accordingly would be more satisfactory than its two-fold division by Gaupp into *recto-vesicalis* and *epigastrica communis*. For, owing to the tendency of the *A. recto-vesicalis* to arise between the two rami into which that author divides the *epigastrica communis*, the designation *epigastrica communis* to include these two rami is rendered of little value. While,

however, dissociating these two latter branches from any common origin, it is perhaps more desirable that I should here refer to them merely as the *r. abdominis externus* and *r. abdominis internus* respectively.

Text-fig. 151.



Bufo boreas, ♀ ($\times 1\frac{2}{3}$).

Ventral view of *Aa. urogenitales*, &c.

(For explanation of the lettering, see p. 1033.)

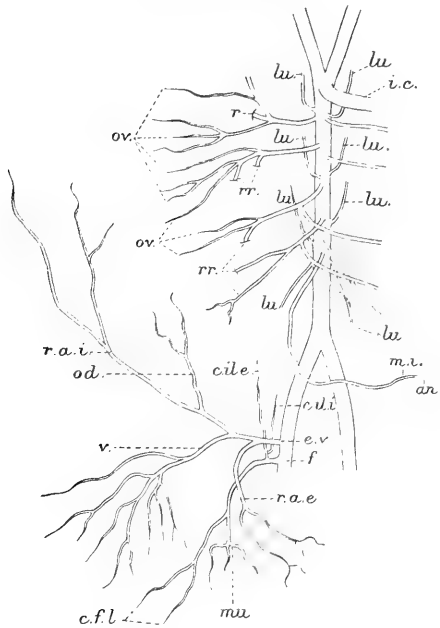
In *R. esculenta*, *R. catesbiana*, *R. clamata*, *B. boreas*, and *B. mauritanicus*, the first branch to arise was the *r. abdominis externus*, running down to the extreme base of the *M. rectus abdominis*, from which as a conspicuous vessel the *A. vesicalis ventralis* went in *R. catesbiana* to the allantoic bladder. In these cases, then followed the *A. recto-vesicalis*, its distribution being mainly or entirely to the bladder.

In *R. tigrina* and *R. hexadactyla*, on the other hand, the *recto-vesicalis* was given off before the *r. abdominis externus*, while in the latter species a small artery ran back first of all to the *M. coccygeo-iliacus* which was not observed in the others.

The *r. clominis internus*, in all but *R. esculenta*, curved forwards over the *Mm. obliquus externus* and *obliquus internus*.

In *R. esculenta* this artery went to the oviduct, and appeared to give no branch at all to the muscles of the abdominal wall (text-fig. 150, p. 1024). In *R. catesbiana* it formed on the right side of the body a very distinct anastomosis with the fourth *r. abdominalis* of the *A. vertebralis dorsi*.

Text-fig. 152.



Rana clamata, ♀ (× 2).

Ventral view of *Aa. urogenitales*, &c.

(For explanation of the lettering, see p. 1033.)

The *A. recto-vesicalis* arose by a single branch in all but *R. esculenta*, where it occurred as three separate offshoots from the main stem. In a specimen of *R. temporaria* the three branches of the *epigastrico-vesicalis* arose simultaneously.

The *A. femoralis* arose in all cases shortly after the above artery. In *R. hexadactyla*, on one side, the two were contiguous, though distinct from one another at their origins (text-fig. 149, p. 1023). The branches of this artery are subject to much variation in their arrangement and distribution, and there is some difficulty in comparing the species with one another. There was, however, in the

eight species under consideration a certain definite arrangement traceable which would seem to form a safe basis of comparison:—

Firstly, in all cases there was an *A. circumflexa ilium*, running directly forwards sooner or later from the main trunk of the *femoralis*, but the existence of two such arteries, arising independently, and distinguished by Gaupp as *interna* and *externa* respectively, I only found in *R. esculenta*. In all other cases, the single vessel was to be identified with the *A. circumflexa ilium externa* of that author. The *A. circumflexa ilium interna* was only represented by a branch or branches from this vessel, running to the *M. coccygeo-iliacus*; and I do not think that this artery will prove to have the value of an independent factor of the *A. femoralis* of the Anura generally. Secondly, there was in all the species an important branch running backwards and ventrally, chiefly to the muscles of the thigh. Thirdly, the outward continuation of the artery, more especially to the skin of the femoral region. The two latter branches I will refer to as the *A. muscularis* and the *A. cutanea femoris lateralis* respectively, preserving so far as possible the nomenclature of Gaupp, though the former includes a number of arteries separately named by him according to their division in the same region, while the latter may, either partly or entirely, strike out into a region other than that implied by its name. This arrangement of the branches of the *A. femoralis* was shown more typically in *R. esculenta*, *R. temporaria*, *R. hexadactyla*, *R. clamata*, and *B. mauritanicus* (text-figs. 149, 150, 152).

In *Bufo mauritanicus*, the *circumflexa ilium interna* was represented by a comparatively large branch of the *A. circumflexa ilium*, running inwards to the *M. coccygeo-iliacus*, and backwards to the cloaca; and in this species there was an additional branch from the base of the *A. cutanea femoris lateralis* to the *m. iliacus externus*. In *R. tigrina* the *cutanea femoris lateralis* was represented by an artery to the base of the *M. rectus abdominis*; while in *B. boreas* the same artery divided its supply between the *Mm. obliquus externus* and *obliquus internus* and the skin of the trunk. In *R. catesbiana* there were two additional branches: the first from between the *circumflexa ilium* and the *muscularis*, running to the skin of the femoral region; the second separating from the *cutanea femoris lateralis* and supplying the *Mm. rectus anticus femoris* and *ilio-psyas*, and also a recurrent branch (absent on the left side) from the *circumflexa ilium* to the *M. iliacus internus*.

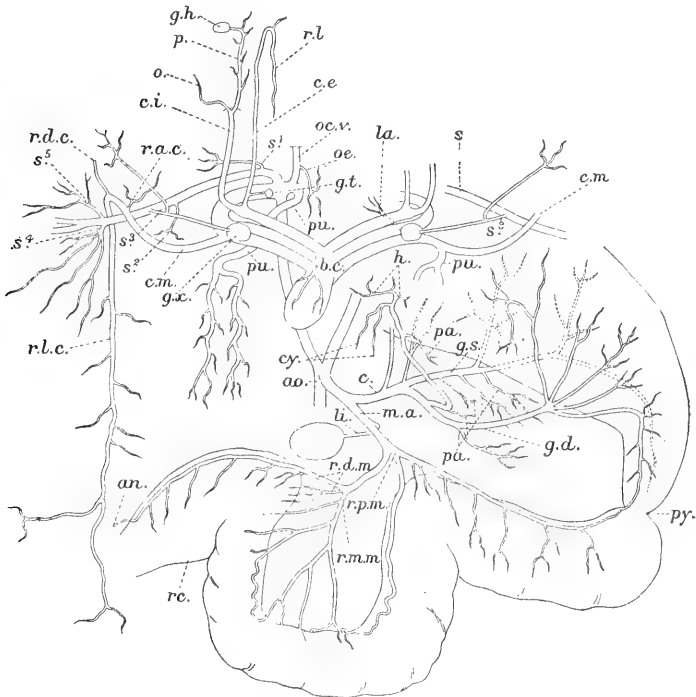
The *circumflexa ilium* originated proximally and before the *muscularis* in *R. temporaria*, *R. clamata*, *R. catesbiana*, *B. boreas*, and *B. mauritanicus*, and either opposite or distal to it in *R. hexadactyla*, *R. tigrina*, and *R. esculenta*.

III. PULMO-CUTANEOUS SYSTEM.

A. cutanea magna.—The threefold division of this artery into *r. auricularis*, *r. lateralis*, and *r. dorsalis* occurred without much

variation in all but *R. hexadactyla*, where the first, which was not observed, may however have been possibly overlooked. The *r. auricularis* in *R. tigrina* subdivided to supply the tympanic membrane and the *Mm. depressor maxillæ, infraspinatus*, &c. In *R. clamata* and *R. catesbiana* it supplied more especially the tympanic region; in *B. mauritanicus* and *B. boreas* almost entirely so. In *R. catesbiana*, as previously stated, this vessel formed, on

Text-fig. 153.



Bufo boreas, ♀ ($\times 1\frac{1}{3}$).

Portion of arterial system. Ventral view.

Showing abnormality of *A. pulmonalis* on the right side of the body.

s^1 - s^5 . Branches of *A. subclavia*.

s^1 to *M. levator anguli scapulae*.

s^4 to *Mm. triceps brachii, pectoralis abdominalis, and subscapularis*.

(For other branches, see p. 1014. For explanation of other lettering, see p. 1033.)

the right side of the body, a complete union near its origin with a branch of the *A. subclavia*, presumably the *thoracica superior*. On the left side of the body it ran independently to the tympanic membrane, where it formed an anastomosis with a very small

twig thrown out to this region by the same branch of the *subclavia*.

A. pulmonalis.—After the separation of the *cutanea magna*, this artery generally divides into two branches, which further subdivide and break up into a thick interlacing network over the lung. But whereas in all the species of *Rana* under consideration these vessels traversed very conspicuously the outer surface of the lung, in both species of *Bufo*, while still external to the venous network, they traversed the inner wall in so marked a degree that it was necessary to cut open the lung to follow them at all.

In *Bufo boreas* (text-fig. 153, p. 1029) there was a very remarkable abnormality on the right side of the body in relation to the origin of the *pulmonalis*. The *cutanea magna* took off as usual from the end of the 3rd arch, opposite, roughly, to the carotid gland; the *pulmonalis*, however, was carried round in common with the systemic arch to the dorsal region as a single large trunk. Reaching the dorsal body-wall, first was given off the *subclavia*, secondly the *occipito-vertebralis*, and lastly the *pulmonalis*, separating from the aorta and descending again round the œsophagus to the lung. A closer investigation by means of a series of transverse sections cut through the arches, showed the true state of things to be that the third arch was concerned throughout with the *cutanea magna* exclusively, having no connection whatever with the *pulmonalis*. The latter simply ran in a common trunk with the systemic arch, in which there was no trace of a septum anywhere.

It is difficult to form a satisfactory inference as to how such a condition can have arisen in the embryo. The exclusive association of the posterior arch, from the outset, with the *cutanea magna* is wholly inconsistent with the generally accepted view that this artery originates, in common with the *pulmonalis*, from the fourth branchial arch of the embryo. On the other hand, the entire absence of any septum in the lumen of the systemic arch leaves little ground for supposing that the third branchial arch has persisted as the *pulmonalis*. It would appear that, under abnormal circumstances, in the embryo a connection had arisen irregularly between the second branchial arch and the lung, and had so persisted, the fourth branchial arch becoming simply the *cutanea magna* of the adult.

The normal arrangement of the pulmo-cutaneous arch on the left side of the body is shown in the figure of this Toad (text-fig. 153, p. 1029).

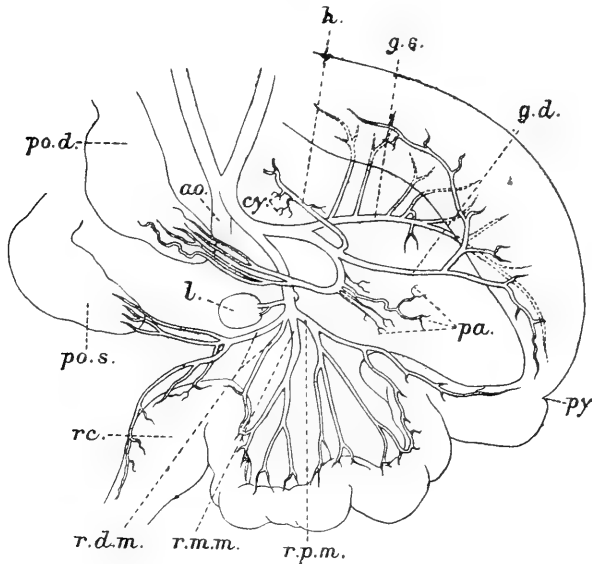
APPENDIX.

[On a direct Vascular Connection between the Mesenteric System and the Lungs in *Rana temporaria*. (Text-figs. 154, 155.)

While this paper was in the press, I received from Mr. W. Woodland a specimen of *Rana temporaria* exhibiting a very remarkable case of a connection between the mesenteric circulatory system and the lungs. Mr. Woodland, who lately observed

this Frog among a number of others that were being dissected by the students in the zoological class at King's College, London, very generously offered to send me the specimen for description, and I am much indebted to him for the opportunity of adding a short account of it here.

Text-fig. 154.



Rana temporaria, ♀ (× 2).

Ventral view of *A. intestinalis communis*, showing abnormal arteries to lungs.
l., spleen; *po.d.*, right lung; *po.s.*, left lung.

(For other lettering, see p. 1033.)

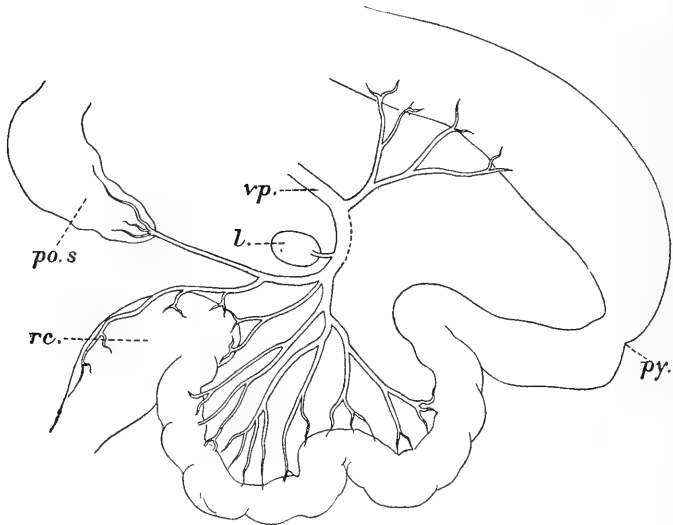
Examples of similar abnormality, recalling the conditions of the swim-bladder of Teleostean Fishes, have, as is well known, been several times observed in the Common Frog. Dr. E. Warren, when writing in 1902 (*Zool. Anz.* vol. xxv.), had himself noticed during the previous four years no less than five examples in about 200 individuals. Mr. B. B. Watson records a case in 1896 (*Zool. Anz.* vol. xix.). Mr. G. P. Mudge describes very fully (*Journ. Anat. Phys.* vol. xxiii.) a most remarkable instance, in which not only were both lungs involved in arterial and venous connection with the systemic circulation, but the *A. hepatica* was absent, its function being discharged by a branch from the left *A. pulmonalis*. In this latter example, a comparison is drawn by the author with the Ophidian type.

In Mr. Woodland's specimen, of which two figures are appended,
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both lungs received apically a well-developed artery from the *A. intestinalis communis*, and one lung (the left) was in equally conspicuous connection with the hepatic portal vein. Both of the normal *Aa. pulmonales* were well developed. The *A. hepatica* appeared to be rather smaller than usual, but there was no connection between either of the *Aa. pulmonales* and the liver.

The abnormal vessels had the appearance on either side of a simple cord lying free in the body-cavity. There was no unusual extension of the mesentery. In the figures, the left lung is drawn out of position to avoid confusion.

Text-fig. 155.

*Rana temporaria*, ♀ (× 2).

Ventral view of hepatic portal vein (*vp.*), showing abnormal vein from left lung (*po.s.*). *l.*, spleen; *py.*, pylorus; *rc.*, rectum.

(The vein is left incomplete in the region of the dotted line owing to the omentum having been much torn at this point.)

The artery to the right lung originated in the *A. gastrica dextra* opposite to the *A. hepatica*, and was about equal in size to the *gastrica dextra* immediately beyond the point where the *hepatica* was given off. It distributed four vessels to the pancreas and then about half way to the lung divided into two branches, each of which divided again before reaching the apex of that organ. There was no vein returning to the mesentery from this lung.

The artery to the left lung arose from the *distal ramus* of the *A. mesenterica anterior*. This ramus first gave off a single vessel to the proximal point of the large intestine and then, some distance further on, the pulmonary artery separated from the

remainder. The pulmonary portion at once bifurcated and the posterior branch of it immediately afterwards gave back a small vessel to the rectum which crossed the rectal artery dorsally. The same branch divided again before reaching the lung; the other did not.

The vein from this lung was about equal in bulk to the two arterial branches combined. It left the apex of the lung as a single vessel, and entered the extreme rectal branch of the *vena portæ* at a point almost coincident with the origin of the pulmonary artery. It was wrapped up closely with the two branches of the latter in a simple peritoneal sheath, so closely, that it required the greatest care in dissection to ascertain the true arrangement of the vessels; and the same was the case in the arteries of the right lung, the separating out of the component factors being only due to the necessity of so figuring them.

It is to be observed in the present instance that the two arteries commence early to subdivide, and produce between them no less than seven branches before reaching in either case a point at the apex of the lung where the branches are still practically non-divergent. In the circumstances, the occurrence of such a consistent process of division within an extremely narrow compass seems to deserve particular notice from an ontogenetic point of view, suggesting the interpretation that the arteries themselves show a predisposition to revert to a remotely ancient type in which such division was necessitated by the character and extent of their destination in the swim-bladder.

In view of the present and similar examples, the question is to be considered whether the abnormality described above in *Bufo boreas* may not fall within the same category as representing an intermediate condition such as that exhibited in the Dipnoan fish *Protopterus*, where the pulmonary arteries have a very similar origin.

Plymouth, Feb. 17th, 1907.

L. R. CRAWSHAY.]

LETTERING OF TEXT-FIGURES.

- an.* Anastomosis between *Aa. mesenterica anterior* and *mesenterica inferior*.
- ao.* Aorta.
- b.c.* *A. bulbi cordis*.
- c.* *A. celiaca*.
- c.a.* Artery to *Corpora adiposa*.
- c.e.* *A. carotis externa*.
- c.h.* Artery to *M. coraco-humeralis*.
- c.i.* *A. carotis interna*.
- c.il.e.* *A. circumflexa ilium externa*.
- c.il.i.* *A. circumflexa ilium interna*.
- c.fl.* *A. cutanea femoris lateralis*.
- c.m.* *A. cutanea magna*.
- co.i.* Artery to *M. coccygeo-iliacus*.
- cu.h.* Artery to skin of upper arm.
- cu.p.* Artery to skin under pectoral girdle.
- cy.* *Aa. cysticæ*.
- ev.* *A. epigastrico-vesicalis*.

- f.* *A. femoralis.*
g.d. *A. gastrica dextra.*
g.h. *Glandula harderi.*
g.t. *Glandula thyroidea.*
g.s. *A. gastrica sinistra.*
g.x. Problematical gland (?).
h. *A. hepatica.*
i. Artery to *M. infraspinatus.*
i.c. *A. intestinalis communis.*
i.c.s. Artery to *M. intertransversarius capitis superior.*
i.sc. Artery to *M. interscapularis.*
l.a.s. Artery to *M. levator anguli scapulae.*
l.d. Artery to *M. latissimus dorsi.*
la. *A. laryngea.*
li. *A. lienalis.*
lu. *Aa. lumbales.*
m.a. *M. mesenterica anterior.*
m.i. *M. mesenterica inferior.*
mu. *Aa. musculares of A. femoralis.*
o. *A. ophthalmica.*
o.i. Branch of *A. epigastrico-vesicalis* to *M. obliquus internus.*
o.i. (in figs. 143, 144). Branch of *A. subclavia* to *M. obliquus internus.*
o.n. *A. orbito-nasalis.*
oc.v. *A. occipito-vertebralis.*
od. *Aa. oviductus.*
œ. *A. œsophagea.*
ov. *Aa. ovaricae.*
p. *A. palatina.*
p.a. Artery to *M. pectoralis abdominalis.*
p.s. Artery to *M. pectoralis sternalis* (through coracoid foramen).
pa. *Aa. pancreaticae.*
pu. *A. pulmonalis.*
py. Pylorus.
r.r. *Aa. renales.*
rc. Rectum.
re. Branch of *A. mesenterica inferior* to rectum.
r.m.c. *Ramus auricularis of A. cutanea magna.*
r.a.e. *Ramus abdominis externus of A. epigastrico-vesicalis.*
r.a.i. " " *internus* " " "
r.d.c. *Ramus dorsalis of A. cutanea magna.*
r.d.m. Distal ramus of *A. mesenterica anterior.*
r.f.a. Branch of *A. cutanea femoris lateralis* to *M. rectus femoris anticus.*
r.l. *Ramus lingualis of A. carotis externa.*
r.l.c. *Ramus lateralis of A. cutanea magna.*
r.m. *Ramus muscularis of A. carotis externa.*
r.m.g. *Ramus musculo-glandularis of A. carotis externa.*
r.m.m. Median ramus of *A. mesenterica anterior.*
r.m.x.i. *Ramus maxillaris inferior of A. occipito-vertebralis.*
r.m.x.s. " " *superior* " " "
r.p.m. Proximal ramus of *A. mesenterica anterior.*
r.v. *A. recto-vesicalis.*
s. *A. subclavia.*
s¹-s⁹. Rami of *A. subclavia.*
s.sc. Artery to *M. subscapularis.*
sc. Artery to scapula.
sp. *Aa. spermaticae.*
t.b. Artery to *M. triceps brachii.*
t.s.¹ " " *M. transverso-scapularis major.*
t.s.² " " " " *minor.*
v. *A. vesicalis.*
 III. Artery to 3rd spinal nerve.

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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.

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P. CHALMERS MITCHELL, M.A., D.Sc., F.R.S.,
Secretary.

3 Hanover Square, London, W.,
October, 1906.

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OF THE
ZOOLOGICAL SOCIETY OF LONDON
FOR
SCIENTIFIC BUSINESS.
(AT 3 HANOVER SQUARE, W.)

1906.

TUESDAY, NOVEMBER 13 and 27 | TUESDAY, DECEMBER 11

1907.

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OF THE
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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 in them. 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 30s. (which includes cost of delivery), payable on the 1st July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

The following is a complete list of the publications of the Society already issued.

[October, 1906.]

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* In consequence of a re-arrangement of the stock of the 'Transactions,' the Society is now able to offer for sale, at the reduced price of £30, sets from Vol. v.-xvi. inclusive, and separate papers at about one-fourth their published price.

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THE ZOOLOGICAL RECORD.



THE object of the ZOOLOGICAL RECORD is to give, by means of an annual Volume, complete lists of the Works and Publications relating to Zoology in all its branches that have appeared during the year preceding the issue of the Volume, together with full information as to the points they deal with, arranged in such a manner as to serve as an Index to the literature of Zoology in all parts of the globe, and thus to form a repertory that will retain its value for the Student in future years.

The 'Zoological Record' is published by the Society at the price of 40s. per volume. But all Members of the Zoological Society of London have the privilege of receiving it, including the cost of delivery, at a subscription price of 30s. per annum. This Subscription is due on the 1st of July in every year, and the privilege of Subscription is forfeited unless the amount be paid before the 1st of December following.

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P. CHALMERS MITCHELL, M.A., D.Sc., F.R.S.,

Secretary.

October, 1906.

ZOOLOGICAL SOCIETY OF LONDON,
3 HANOVER SQUARE, W.

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*These publications may be obtained at the SOCIETY'S OFFICE
(3 Hanover Square, W.).*

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.

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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.

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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 £30 in lieu thereof; the whole payment, including the Admission Fee, being £35.

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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 admitted with two Children's Tickets.

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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, M.A., D.Sc., F.R.S.,
Secretary.

3 Hanover Square, London, W.,
April, 1907.

MEETINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON
FOR
SCIENTIFIC BUSINESS.
(AT 3 HANOVER SQUARE, W.)

1907.

TUESDAY, JANUARY 15 ,, FEBRUARY 5 and 19 ,, MARCH .. 5 ,, 19		TUESDAY, APRIL .. 9 and 23 ,, MAY 7 and 28 ,, JUNE 18
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The Chair will be taken at half-past Eight o'clock in the Evening precisely.

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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 in them. 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 30s. (which includes cost of delivery), payable on the 1st July in each year; but this privilege is forfeited unless the subscription be paid *before* the 1st of December following.

The following is a complete list of the publications of the Society already issued.

[*April*, 1907.]

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P. CHALMERS MITCHELL, M.A., D.Sc., F.R.S.,

Secretary.

April, 1907.

ZOOLOGICAL SOCIETY OF LONDON,
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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, 18s.; price to the public, 20s.

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ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 1st, 1906.

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

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the month of March 1906, which stated that they were 124 in number.

Mr. OLDFIELD THOMAS, F.R.S., exhibited the skin of a remarkable new Duiker from Nyasaland, which had been presented to the British Museum by Mr. S. W. Frank.

It was (by Mr. Frank's request) named as follows:—

CEPHALOPHUS WALKERI, sp. n.

Size medium. General ground-colour dark greyish brown, darkening almost to black on the back. Under surface scarcely lighter. Whole of forehead deep glossy black, connected by a narrow dark line down the nape with the black of the back. Cheeks and chin pale fawn. Limbs dark throughout.

Hab. Tuchela River, S. Nyasa.

Type. B.M. No. 6.4.21.1.

The Hon. WALTER ROTHSCHILD, M.P., F.Z.S., read a short paper entitled "Further Notes on Anthropoid Apes," and exhibited five mounted specimens, one skeleton, six skulls, and a photograph of the following races:—*Gorilla gorilla* dark-headed race, *G. gorilla* red-headed race, *G. gorilla matschiei*, *G. gorilla diehli*, *Simia vellerosus*, and *S. vellerosus fuliginosus*.

Mr. OLDFIELD THOMAS, F.R.S., read a paper on Mammals collected in South-west Australia for Mr. W. E. Balston.

* 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. Balston had been good enough to defray the expenses of a collector, Mr. G. C. Shortridge, for the exploration of South-west Australia, in the interests of the National Museum, and the present paper gave an account of the Mammals thus obtained.

Thirty-two species and subspecies were enumerated, of which the following were described as new :—

SCOTEINUS BALSTONI, sp. n.

Allied to *S. greyi*; but the fur bicolor, smoky brown basally, pale brown terminally.

Forearm 36 mm.

Hab. Laverton, West Australia.

Type. Female. Original number 170.

TACHYGLOSSUS ACULEATUS INEPTUS, subsp. n.

Very spinous, the spines with dark tips. Snout unusually short, the rostral index 77–80.

Greatest length of typical skull 104 mm.; greatest breadth 47·8; rostrum 43·5.

Hab. Parker's Range, Southern Cross.

Type. Male. Original number 123.

A series of papers was read on the Lepidoptera collected in South Tibet by the officers during the recent expedition to that country under Col. Sir Frank Younghusband. Mr. H. J. ELWES, F.R.S., gave an account of the Butterflies contained in the collection, which comprised 33 species and varieties, four of which were described as new. The Moths, exclusive of the *Tineidæ*, had been worked out by Sir GEORGE HAMPSON, Bt., who enumerated the 63 species of which specimens were obtained. Of these, examples of 36 species were taken at moderate elevations in Sikkim, and belonged to the Indian fauna, two being described as new; 27 species belonged to the Palearctic fauna, of which 9 were widespread and 18 Tibetan; 10 of these were described as new. An account of the *Tineidæ* was supplied by Mr. J. HARTLEY DURRANT: they were referred to 4 species, two of which were new.

Mr. F. E. BEDDARD, F.R.S., read a paper entitled "Contributions to the Knowledge of the Vascular and Respiratory Systems in the Ophidia and to the Anatomy of the Genera *Boa* and *Coralbus*."

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 15th May, 1906, at half-past Eight o'clock P.M., when the following communications will be made :—

1. Mr. J. N. HALBERT.—Zoological Results of the Third Tanganyika Expedition conducted by Mr. W. A. Cunnington, 1904–05. Report on the *Hydrachnidae*.

2. Mr. OLDFIELD THOMAS, F.R.S.—On Mammals from Northern Australia presented to the National Museum by Sir William Ingram and the Hon. John Forrest.

3. Prof. W. B. BENHAM, D.Sc., and Mr. W. J. DUNBAR.—On the Skull of a young Specimen of the Ribbon Fish (*Regalecus*).

The following Paper has been received :—

Dr. VON LINSTOW.—Gordiiden aus Korea.

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.

8th May, 1906.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 15th, 1906.

Dr. J. ROSE BRADFORD, F.R.S., Vice-President, in the Chair.

The SECRETARY read a report on the additions that had been made to the Society's Menagerie during the month of April 1906, which stated that they were 171 in number.

Mr. F. E. BEDDARD, F.R.S., exhibited a nearly full-time fœtus of *Lemur rufifrons*, and called attention to the carpal vibrissæ, which were extremely conspicuous, though the rest of the ventral surface of the arm was devoid of hair.

Mr. BEDDARD also exhibited, on behalf of Dr. C. G. SELIGMANN, a cock of mixed breed which had been caponised for commercial purposes whilst young. The bird, which had been under observation for over a year, at no time showed any evidence of sexual attraction for or towards either sex. On dissection, there was no trace of testicular tissue. The head was hen-like, but the bird possessed well-marked and rather stout but short spurs, whilst the tail, which contained sickle-feathers, was "over-furnished."

Mr. R. I. Pocock, F.Z.S., Superintendent of the Gardens, exhibited and made remarks upon a specimen of a Leaf-insect (*Phyllium*) from the Seychelles, which had been brought to the Gardens by Mr. E. G. B. Meade-Waldo, F.Z.S.

Mr. HENRY MUNT, F.Z.S., exhibited, on behalf of Mr. BUSSELL, a skin of the Spotted-necked Otter (*Lutra maculicollis*) obtained

* 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.

at Fort Johnston, Uganda. The skull and carcase had been extracted through the mouth, thus leaving the skin intact.

A communication from Mr. J. N. HALBERT contained descriptions of the two species of Water-Mites (*Hydrachnidæ*) collected by Mr. W. A. Cunnington in Lake Nyasa during the Third Tanganyika Expedition 1904-05.

Mr. OLDFIELD THOMAS, F.R.S., read a paper on a collection of Mammals made by Mr. W. Stalker in the Northern Territory of South Australia, and presented to the National Museum by Sir William Ingram, Bart., and the Hon. John Forrest. The collection included 16 species, of which the two following were of special interest:—

MUS FORRESTI, sp. n.

Size medium. Colour drab-grey above, white below. Teeth with their laminae peculiarly twisted, the first molars with large cingular ledges.

Head and body 104 mm.; tail 72; hind foot 19.

Type. B.M. No. 6.3.9.39.

PHASCOGALE INGRAMI, sp. n.

Size minute; the teeth and feet smaller than in any known Australian Marsupial. Head peculiarly flattened.

Head and body 80 mm.; tail 60; hind foot 10.

Type. B.M. No. 6.3.9.77.

Mr. F. E. BEDDARD, F.R.S., communicated a paper by Prof. W. B. BENHAM and Mr. W. J. DUNBAR dealing with the skull of a young Ribbon-Fish (*Regalecus*).

A communication from Dr. VON LINSTOW contained descriptions of two species—one of them new—of Hair-Worms of the family *Gordiidae*. The specimens had been obtained in Korea by Mr. Malcolm Anderson, who was making collections of the fauna of Eastern Asia for the Duke of Bedford.

A communication from Mr. G. A. BOULENGER contained descriptions of a new Lizard, a new Snake, and a new Toad collected in Uganda by Mr. E. Degen, F.Z.S.

Mr. R. I. POCOCK read a paper on the gestation and parturition of certain Monkeys that had bred in the Society's Menagerie in the spring of the present year.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 29th May, 1906, at half-past Eight o'clock P.M., when the following communications will be made:—

1. MESSRS. OLDFIELD THOMAS and HAROLD SCHWANN.—The Rudd Exploration of South Africa.—V. List of Mammals obtained by Mr. Grant in N.E. Transvaal.

2. MR. F. E. BEDDARD, F.R.S.—On the Vascular System of *Heloderma*, with Notes on that of the Monitors and Crocodiles.

The following papers have been received:—

1. DR. R. BROOM, C.M.Z.S.—On the South African Diaprosaurian Reptile *Howesia*.

2. DR. G. STEWARDSON BRADY, F.R.S.—On the Entomostracan Fauna of the New Zealand Lakes.

3. DR. CHARLES CHILTON.—Note on some Crustacea from the Freshwater Lakes of New Zealand.

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.
22nd May, 1906.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

May 29th, 1906.

FREDERICK GILLETT, Esq., Vice-President, in the Chair.

Mr. R. H. BURNE, F.Z.S., exhibited, on behalf of Prof. STEWART, some dissections prepared for the Museum of the Royal College of Surgeons from material derived from the Society's Gardens. The specimens included the head of a Ki-wi (*Apteryx mantelli*) in sagittal section, showing the relatively large size of the olfactory parts of the brain and the complexity of the olfactory chamber; the head of a Crowned Crane (*Balearica regulorum*), showing the dilatable pharynx, which by its inflation when the bird crows causes a sudden distension of the gular wattle, and apparently acts as a resonating-chamber; preparations of the cheek-pouches of a Spotted Cavy (*Coelogenys paca*); and the stomach of a foetal Giraffe (*Giraffa camelopardalis antiquorum* ♂ × *G. c. wardi* ♀).

Mr. R. E. HOLDING exhibited, and made remarks upon, the skull and horns of a male, so-called "Wild" Irish Goat, also the skull of a Domestic Cat in which the posterior border of the orbit was complete.

Dr. L. W. SAMBON exhibited a series of diagrams illustrating the transmission of diseases by Insects and Ticks.

Prof. ROBERT T. JACKSON exhibited a photograph of the Champley collection of eggs of the Great Auk taken before the collection was dispersed, and made remarks on specimens of the bird that had lately come under his notice. He also exhibited a long-focus lens for museum work and dissections.

* 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 SECRETARY exhibited the skull of a Wild Boar that had lately been dug up during building operations in James Street, Oxford Street, W.

Mr. HAROLD SCHWANN, F.Z.S., read a paper prepared by Mr. OLDFIELD THOMAS, F.R.S., and himself, on Mammals collected by Mr. C. H. B. Grant in the Zoutpansberg district of the Transvaal, and presented to the National Museum by Mr. C. D. Rudd.

The collection had been obtained at two localities—Klein Letaba at 1000' altitude and Woodbush at 4500', and so gave a good general idea of the fauna of the region. In all it consisted of about 250 specimens belonging to 51 species and subspecies, of which several were described as new. In addition, the old genus *Macroscelides* was broken up into three, the new name *ELEPHANTULUS* being given to the group of which *M. rupestris* was the type, and *NASILIO* to that typified by *M. brachyrhynchus*.

Of the species the following was specially noteworthy :—

HELOGALE BRUNNULA, sp. n.

Allied to *H. parvula*, but with the head paler than the body, a suffusion of buffy in the general colour and with the limbs not darkening terminally.

Hab. Klein Letaba.

Type. Male. B.M. 5.12.9.22. Eight specimens examined.

Mr. F. E. BEDDARD, F.R.S., read a paper entitled "On the Vascular System of *Heloderma*, with Notes on that of the Monitors and Crocodiles."

Mr. BEDDARD also read a paper containing a description of the external characters of an unborn fœtus of a Giraffe (*Giraffa camelopardalis antiquorum* ♂ × *G. c. wardi* ♀).

Dr. A. SMITH WOODWARD, F.R.S., communicated a paper by Dr. ROBERT BROOM, C.M.Z.S., on the South African Diaptsaurian Reptile *Hovesia*.

The next Meeting of the Society for Scientific Business (closing the Session 1905-06) will be held on Tuesday, the 19th June, 1906, at half-past Eight o'clock P.M., when the following communications will be made :—

1. Sir CHARLES ELIOT, K.C.M.G.—The Nudibranchs of South India and Ceylon.

2. The Hon. WALTER ROTHSCHILD, F.Z.S.—Description of a new Species of Zebra.
 3. Dr. G. STEWARDSON BRADY, F.R.S.—On the Entomostracan Fauna of the New Zealand Lakes.
 4. Dr. CHARLES CHILTON.—Note on some Crustacea from the Freshwater Lakes of New Zealand.
 5. Mr. C. TATE REGAN, F.Z.S.—A Classification of the Selachian Fishes.
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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.
5th June, 1906.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

June 19th, 1906.

Sir EDMUND G. LODER, Bart., Vice-President, in the Chair.

The SECRETARY read a Report on the additions that had been made to the Society's Menagerie during the month of May 1906.

Dr. W. T. CALMAN, F.Z.S., exhibited, on behalf of Dr. A. DUGÈS, C.M.Z.S., a specimen of the Crustacean *Palæmon jamaicensis* Herbst, from the Atoyac River, Vera Cruz, Mexico.

Dr. CALMAN also exhibited a photograph of a Lobster with abnormal chelæ.

Dr. C. G. SELIGMANN, F.Z.S., the Society's Pathologist, exhibited and made remarks upon the heart of a Tiger that had died in the Society's Menagerie.

Dr. SELIGMANN also exhibited some feathers from the tail of a cock Pheasant which were gradually assuming the pattern of the feathers of the hen bird.

Mr. W. SAVILLE KENT, F.Z.S., exhibited a series of lantern-slides, taken from photographs in natural colours, illustrating the Fish and associated fauna of the Polynesian Coral Reefs.

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Sir CHARLES ELIOT, K.C.M.G., F.Z.S., communicated a paper entitled "On the Nudibranchs of Southern India and Ceylon, with Special Reference to the Collections and Drawings preserved in the Hancock Museum at Newcastle-on-Tyne." This paper was an attempt to settle the synonymy of various Nudibranchiata of the Indo-Pacific with the help of Kelaart's drawings and the collections made by him and Walter Elliot, and now preserved at Newcastle. It also contained some new information as to the anatomy of several species (particularly *Platydoris formosa*, *P. papillata*, *Doriopsilla miniata*, *Kalinga ornata*, and several Pleurophyllidiidae).

Of the identifications suggested, the following were regarded as more or less certain:—(1) *Hexabranchnus marginatus* (Q. & G.) = *Doris gloriosa* Kel.; (2) *Chromodoris diardii* (Kel.) = *C. semperi* Bgh.; (3) *Casella maccarthyi* (Kel.) = *C. cincta* Bgh.; (4) *Kentrodoris maculosa* (Cuv.) = *K. annuligera* Bgh.; (5) *Discodoris concinna* (A. & H.) = *D. concinniformis* Bgh.; (6) *Archidoris violacea* Bgh. = *A. africana* Eliot; (7) *Thordisa villosa* A. & H. = *T. maculigera* Bgh.; (8) *Trippa luteola* (Kel.) = *Thordisa* ? *caudata* Farran; (9) *Trevelyana ceylonica* Kel. = *T. rubromaculata* Bgh.; (10) *Bornella digitata* Ad. & Reeve = *B. hancockana* Kel.; (11) *Samla bicolor* (Kel.) = *S. annuligera* Bgh.; (12) *Elysia caerulea* Kel. = *E. lineolata* Bgh.; (13) *E. punctata* Kel. = *E. nigropunctata* (Pse.).

The following were regarded as probable, but not certain until further specimens could be examined:—(1) *Chromodoris fidelis* (Kel.) = *C. flammulata* Bgh.; (2) *Hoplodoris desmoparypha* Bgh. = *Platydoris papillata* Eliot; (3) *Asteronotus hemprichi* Ehrenb. = *Doris exanthemata* Kél.; (4) *Thordisa crosslandi* Eliot, 1904 = *Diarulula* ? *gigantea* Bgh., 1905; (5) *Doris intecta* Kel. = *Trippa ornata* Bgh.; (6) *Doris leoparda* Kel. = *Trippa monsoni* Eliot; (7) *Doridopsis tuberculosa* (Q. & G.) var. = *Doris carbunculosa* Kel.; (8) *Diphyllidia marmorata* Kel. = *Linguella cinerea* Farran; (9) *Phyllobranchnus orientalis* (Kel.) = *P. prasinus* and *P. rubicundus* Bgh. In both these lists the first specific name had priority, if established.

The following references to genera were certain or probable:—*Chromodoris gleniei* (Kel.); *C. amabilis* (Kel.); *C. tennantana* (Kel.); *Platydoris* (not *Discodoris*) *elliotti* (A. & H.); *Halgerda* ? *apiculata* (A. & H.); *Staurodoris rusticata* (A. & H.); *Doriopsilla miniata* (A. & H.); *Stiliger* ? *viridis* (Kel.).

The Hon. WALTER ROTHSCHILD, M.P., F.Z.S., exhibited specimens of, and described, a new species of Zebra, intermediate between *Equus zebra* and *E. burchelli*, from N.E. Rhodesia, and a new Bush-buck from Portuguese East Africa.

Mr ROTHSCHILD also exhibited specimens of the Forest-Pigs, *Hylochoærus meinertzhageni*, *Potamochoærus johnstoni*, and *P. chceropotamus daemonis*, and described certain distinctive features.

A paper was read from Dr. G. STEWARDSON BRADY, F.R.S., C.M.Z.S., which contained an account of the Entomostraca taken during a bathymetrical survey of the New Zealand Lakes, and a comparison of this fauna with that of the English Lakes, which appeared to present very similar physical conditions.

A paper by Prof. CHARLES CHILTON, F.L.S., dealing with the higher Crustacea obtained during the same survey, was also read.

Mr. C. TATE REGAN, B.A., F.Z.S., read a paper entitled "A Classification of the Selachian Fishes." The author stated that the Selachii were regarded as entitled to rank, at least, as a well-marked subclass, and he divided them into two principal groups, viz. Trematopnea and Chasmatopnea, the latter including the single order Holocephali. The Trematopnea were arranged as follows :—

Order.	Suborder.	Division.	Family.	Subfamily.
PLEUROPTERYGII			{ <i>Cladoselachidæ.</i>	
			{ <i>Cladodontidæ.</i>	
ACANTHODII			{ <i>Diplacanthidæ.</i>	
			{ <i>Acanthodidæ.</i>	
ICHTHYOTOMI			{ <i>Pleuracanthidæ.</i>	
			{ <i>Chlamydoselachidæ.</i>	
		HEXANCHOIDEI.	{ <i>Hexanchidæ.</i>	
			{ <i>Odontaspididæ.</i>	
			{ <i>Lannidæ.</i>	
			{ <i>Oretotobidæ.</i>	
			{ <i>Scyliorhinidæ.</i>	
	PLEUROTREMATA	GALEOIDEI	{ <i>Carchariidæ.</i>	{ Carchariinæ.
			{ <i>Cochliodontidæ.</i>	{ Sphyrninæ.
			{ <i>Hybodontidæ.</i>	{ Hybodontinæ.
			{ <i>Palæospinacidæ.</i>	{ Palæospinacinae.
		SQUALOIDEI	{ <i>Cestraciontidæ.</i>	
			{ <i>Squalidæ.</i>	{ Squalinæ.
			{ <i>Squatimidæ.</i>	{ Pristiophorinæ.
EUSELACHII ...			{ <i>Narcobatidæ.</i>	
	HYPOTREMATA	NARCOBATOIDEI.	{ <i>Rhinobatidæ.</i>	{ Rhinobatinae.
		BATOIDEI	{ <i>Raiidæ.</i>	{ Pristinæ.
			{ <i>Dasybatidæ.</i>	

A paper by Mr. F. F. LAIDLAW gave an account of the Polyclad Turbellaria from the Cape Verde Islands collected by Mr. C. Crossland, F.Z.S. The collection showed that, on the whole, the fauna of this region of the Atlantic agreed closely with that of the Mediterranean so far as the Polyclads were concerned. The most interesting of the 16 or 17 species represented in the collection were, perhaps, a species of *Anonymus* (of which several specimens were taken) and *Traunfelsia elongata*, gen. et sp. nov. The latter was an elongated form remarkable for the possession of marginal tentacles, which were not usually associated with a long narrow body in this class. A unique feature in this genus was the presence

of a pair of alveolar glands, each with a long duct opening on either side of antrum masculinum. The genus was referred to the *Diposthiidae* of Woodworth.

Messrs. E. G. B. MEADE-WALDO, F.Z.S., and MICHAEL J. NICOLL gave an account of a large unknown marine animal they had observed off the coast of Brazil during their cruise in the Earl of Crawford's yacht the 'Valhalla.'

This Meeting closes the Session 1905-06. The next Session (1906-07) will commence in November next.

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.

26th June, 1906.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

November 13th, 1906.

HOWARD SAUNDERS, Esq., Vice-President, in the Chair.

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, 1906.

Mr. A. DICKSEE exhibited a living specimen of the Golden Pheasant (*Thaumalea picta*) in abnormal plumage.

Mr. H. C. BECK, F.Z.S., exhibited a skull of the Capybara (*Hydrochaerus capybara*) showing an elongation of the first pre-molar in the lower jaw.

Prof. E. A. MINCHIN, F.Z.S., exhibited some diagrams of Trypanosomes from Tsetse-flies and made remarks on the dissemination of diseases by these insects.

A communication was read from Prof. R. BURCKHART, C.M.Z.S., containing a short account of a very young embryo of the Okapi (*Okapia johnstoni*) obtained by his correspondent Dr. T. David from a specimen which had been shot in the Semliki Forest. The object not being well preserved and in an early stage, it could only be stated that all the particulars ascertainable were specially Ungulate in character.

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Dr. P. L. SCLATER, F.R.S., made some remarks on the letter from Capt. P. H. G. Powell-Cotton, published in the 'Times' of Sept. 27th, 1906, on the Okapi.

A communication was read from Mr. F. F. LAIDLAW which contained a description of a new species of Turbellarian obtained during Dr. W. A. Cunningham's expedition to Lake Tanganyika.

A communication from Mr. OLDFIELD THOMAS, F.R.S., contained a list of a second collection of Mammals made in Western Australia for Mr. W. E. Balston, with Field-notes by the collector, Mr. G. C. Shortridge.

This second collection had been made in the Avon watershed, and consisted of about 350 specimens, of which a fine series had been presented to the National Museum by Mr. Balston.

In all 42 species were enumerated, and of these Mr. Shortridge had given notes on the distribution and comparative rarity at the present time, such notes being of particular value in the case of a disappearing fauna like that of Australia.

An appendix dealt with a small series obtained on Bunier Island, Shark's Bay, on the N.W. coast of Australia.

The sixth instalment of the results of the Rudd Exploration of South Africa, prepared by Messrs. OLDFIELD THOMAS, F.R.S., and HAROLD SCHWANN, F.Z.S., was read. It contained an account of the Mammals obtained by Mr. C. H. B. Grant in the Eastern Transvaal. Twenty-one species were represented in the collection, of which one was new.

Mr. J. COSMO MELVILL, F.Z.S., read a paper prepared by himself and Mr. ROBERT STANDEN of the Manchester Museum, entitled "The Mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea, as evidenced mainly through the Collections of Mr. F. W. Townsend, 1903-1905, with descriptions of new Species.—Part II. Pelecypoda."

It was a continuation of the enumeration of the Mollusca of the above-named seas published in the Proc. Zool. Soc. vol. ii. 1901, and completing the Catalogue, the total number embraced being nearly sixteen hundred species, many of these being found to be new to science. Amongst the Pelecypoda, *Tellina* held the premier place; most orders and families were, however, represented, and the result was a very refined and varied molluscan fauna. Some interesting forms occurred amongst the *Lardiaceae*; while the *Pectinidæ* showed alliance and, in some cases, specific identity with the Erythræan fauna, lately so ably monographed by Dr. Sturany.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 27th November, 1906, at half-past Eight o'clock P.M., when the following communications will be made:—

1. Mr. T. A. COWARD, F.Z.S.—On some Habits of *Rhinolophus hipposiderus*.

2. Messrs. EDGAR A. SMITH, I.S.O., F.Z.S., and H. H. BLOOMER.—The Marine Fauna of Zanzibar and British East Africa, from Collections made by Cyril Crossland in the Years 1901 and 1902. On some Species of *Solenidae*.

3. Mr. W. WOODLAND, F.Z.S.—Suggestions concerning the Origin and Significance of the “Renal-portal System,” with an Appendix on the Production of Subdominal Veins.

4. Mr. W. WOODLAND, F.Z.S.—On the Anatomy of *Centrophorus calceus* (*crepidalbus* Bocage and Capello) Günther.

The following Papers have been received:—

1. Mr. OLDFIELD THOMAS, F.R.S.—The Duke of Bedford's Zoological Exploration in Eastern Asia.—II. List of small Mammals from Korea and Quelpart.

2. Messrs. JOHN RENNIE, D.Sc., and HARRY WISEMAN, M.A.—On Collections of the Cape Verde Island Marine Fauna made by Cyril Crossland from July to September 1904. Ascidiarians.

3. Mr. LIONEL K. CRAWSHAY, M.A.—On Variations in the Arterial System of certain Species of Anura.

4. Mr. GUY A. K. MARSHALL, F.Z.S.—On new Species of African *Curculionidae*.

5. Dr. R. W. SHUFELDT, C.M.Z.S.—On the Osteology of the Tubinares.

6. Mr. O. A. MERRITT HAWKES.—The Cranial and Spinal Nerves of *Chlamydoselachus anguineus*.

7. Mr. R. LYDEKKER.—Descriptions of two Mammals from the Ituri Forest.

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.

20th November, 1906.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.*

November 27th, 1906.

HOWARD SAUNDERS, Esq., Vice-President, in the Chair.

The SECRETARY read a Report on the additions that had been made to the Society's Menagerie during the month of October 1906.

Mr. E. T. NEWTON, F.R.S., exhibited the leg-bones of two Foxes that had been caught in snares. The wire in each case had cut through the skin and was drawn tight round the bone, which in course of development had grown over the wire and enveloped it.

Mr. T. A. COWARD, F.Z.S., read some notes on the habits of the Lesser Horseshoe Bat, *Rhinolophus hipposiderus*, in the course of which it was stated that this Bat usually occupied different retreats in summer and winter, and that during the earlier period of occupation of the winter retreat sleep was not profound. The Bats fed probably in the caves or retreats, and the food was at times, if not always, consumed when the animal was at rest and not on the wing. When feeding it did not—probably could not—make use of the interfemoral membrane, after the manner of the *Vespertilionidae*, but, as a substitute, the interbrachial membrane was employed. These facts suggested that the hibernation of this species, and probably of other cave-haunting Bats, was not really a profound winter sleep.

A communication from Messrs. EDGAR A. SMITH, I.S.O., and H. H. BLOOMER contained an account of four species of *Solenidae* contained in the collections made by Mr. Cyril Crossland in Zanzibar and British East Africa in 1901-02.

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Mr. W. WOODLAND, F.Z.S., read a paper in which an attempt was made to explain the existence of the so-called "renal-portal" system. Arguments and facts were adduced to prove that the venous blood supplied to the "portal" kidney was not used for excretory purposes. On the other hand, it was suggested that the "renal-portal" system was solely due to the fact that the lumen of the venous sinus offered a convenient space for the kidney-substance to intrude upon, the kidney developing under conditions in which space was extremely limited, and consequently under pressure. This view, which was justified by all known morphological and physiological facts, implied that all kidney-elements in the Vertebrata had a similar vascular supply.

Mr. WOODLAND also read a paper on the anatomy of *Centrophorus calceus*, the Author describing in particular the anatomy of the alimentary tract, which differed in several respects from that of most Selachians and, as regards the length of the bile-duct, from most Vertebrates.

Mr. OLDFIELD THOMAS, F.R.S., read a paper on mammals collected in Korea and Quelpart Island by Mr. Malcolm P. Anderson for the Duke of Bedford's Exploration of Eastern Asia, and presented by His Grace to the National Museum.

The collection consisted of about 130 specimens, belonging to nine species, of which four were described as new.

Quelpart Island proved to contain a very poor mammal-fauna, and the only specimens obtained there were a *Putorius* and a *Micromys*, both identical with forms found on the Korean Peninsula.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 11th December, 1906, at half-past Eight o'clock P.M., when the following communications will be made:—

1. MESSRS. JOHN RENNIE, D.Sc., and HARRY WISEMAN, M.A.—On Collections of the Cape Verde Island Marine Fauna made by Cyril Crossland from July to September 1904. Ascidians.

2. Mr. LIONEL K. CRAWSHAY, M.A.—On Variations in the Arterial System of certain Species of Anura.

3. Mr. GUY A. K. MARSHALL, F.Z.S.—On new Species of African *Curculionidæ*.

4. MRS. O. A. MERRITT HAWKES.—The Cranial and Spinal Nerves of *Chlamydoselachus anguineus*.

5. Mr. R. LYDEKKER.—Descriptions of two Mammals from the Ituri Forest.

The following Papers have been received :—

1. MR. J. LEWIS BONHOTE, F.Z.S.—On a Collection of Mammals made by Dr. Vassal in Annam.
 2. MR. P. H. BAHR, F.Z.S.—On the “Bleating” or “Drumming” of the Snipe (*Gallinago caelestis*).
 3. DR. E. A. GOELDI, C.M.Z.S.—Some new and insufficiently-known Species of Marmoset Monkeys from the Amazonian Region.
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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 4th, 1906.

ABSTRACT OF THE PROCEEDINGS
OF THE
ZOOLOGICAL SOCIETY OF LONDON.*

December 11th, 1906.

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

The SECRETARY exhibited a drawing, by Mr. CARTON MOORE-PARK, F.Z.S., of "Martha," the young Gorilla that had recently died in the Society's Menagerie.

Mr. H. B. FANTHAM, B.Sc., F.Z.S., exhibited original drawings of "*Trypanosoma balbianii* (Certes), showing apparent cilia, which might, however, be only threads of the sheath or undulating membrane which had become ruptured. These were first seen in this organism by M. Fred Vlès and himself at Roscoff this summer. This parasite, which occurs in the crystalline style of the Oyster, was compared with various Spirilla and Spirochaetes, and its systematic position among the Protista was discussed.

The SECRETARY exhibited, on behalf of Dr. C. G. SELIGMANN, two skulls of the Domestic Sheep, one of which was of a normal male and the other of a male castrated in youth, and called attention to the differences in the bones apart from those directly associated with the absence of the horns in the castrated specimen.

Mr. F. E. BEDDARD, F.R.S., exhibited some examples of the Earthworm (*Benhamia johnstoni*) from Mt. Ruwenzori, which had been entrusted to him for study by Mr. W. R. Ogilvie-Grant.

Mr. J. L. BONHOTE, F.Z.S., exhibited one of the innermost secondaries of the Knot (*Tringa canutus*) taken from a bird in his aviaries. The feather was remarkable from the fact that the summer feather instead of being cast at the autumn moult was continuous with the new autumn feather; it did not merely adhere to the tip of this latter, but the shaft was continuous and

* 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 barbs forming at the proximal extremity, the white tip of the winter feather formed also the light base of the summer feather. The summer feather was rather shorter than the normal, and possibly was not fully grown when the autumn moult intervened.

Mr. R. I. POCKOCK, the Superintendent of the Gardens, exhibited the tail of a Crested Porcupine to show the peculiar structure of the quills which constituted the animal's so-called "rattle."

A communication was read from Messrs. JOHN RENNIE, D.Sc., and HARRY WISEMAN, B.Sc., of the University of Aberdeen. It contained an account of the Ascidians of the Cape Verde Marine Fauna collected by Mr. Cyril Crossland, B.A., B.Sc., F.Z.S., and recorded the occurrence of ten species of Ascidia Simplicis, of which three were described as new.

Mr. F. E. BEDDARD, F.R.S., communicated a paper, on behalf of Mr. LIONEL K. CRAWSHAY, on variations in the Arterial System of certain species of Anura.

A communication was read from Mr. GUY A. K. MARSHALL, F.Z.S., containing descriptions of fifty-three new species of African Coleoptera of the family Curculionidæ.

A paper by Mrs. O. A. MERRITT HAWKES, B.Sc. (Lond.), on the Cranial and Spinal Nerves of *Chlamydoselachus anguineus*, was read. It contained a description of these nerves and discussions of them from the point of view of the nerve-component theory, and showed that the nervous as well as the other systems of *Chlamydoselachus* combined specialized and primitive features; that the nervous system was intermediate in position between that of *Scyllium* and of *Chimæra*; that the trigemino-facial complex exhibited but few signs of the primitive; that the true facialis was interesting owing to the presence of pre- and post-trematic rami apart from the truncus hyomandibularis; that there was a chorda tympani; that the glossopharyngeus probably supplied two neuromasts; that the vagus was disappointing in that its ganglia were mostly indistinguishable, but this was probably due indirectly to the marked backward swing of the jaws. On the other hand, it showed that there was a sixth ramus branchialis vagi to the remnants of a seventh arch; that a hypoglossal nerve was present; that the acoustico-lateralis rami were closely related to one another, their distribution showing the close functional relationship of neuromasts and ampullæ of Lorenzini; and that both the lateral line system and ampullæ were primitive and remarkably unstable.

In a communication regarding two mammals obtained by Major Powell-Cotton in the Ituri Forest, Mr. R. LYDEKKEK, F.Z.S., referred a dark-coloured Cat's skin to a race of *Felis chrysothrix*, and also described a giant Elephant-Shrew as new.

In a second paper MR. LYDEKKER described the skull of a Bruang, or Malay Bear, from Tibet, which he proposed to regard as representing a distinct race.

In continuation of his paper on South-Indian Nudibranchs (Proc. Zool. Soc. 1906, pp. 636-691), Sir CHARLES ELIOT, K.C.M.G., presented a supplementary account of the radulæ of various species based on microscopic slides prepared by Alder and Hancock, which had just been discovered in the Hancock Museum at Newcastle on-Tyne. These slides confirmed many of the identifications suggested in the first paper, and in particular showed that *Doris glenei* was a *Chromodoris*, and that *Doris villosa* was *Thordisa maculigera* Bgh.

The next Meeting of the Society for Scientific Business will be held on Tuesday, the 15th January, 1907, at half-past Eight o'clock P.M., when the following communications will be made:—

1. MR. J. LEWIS BONHOTE, F.Z.S.—On a Collection of Mammals made by Dr. Vassal in Annam.

2. MR. P. H. BAHR, F.Z.S.—On the “Bleating” or “Drumming” of the Snipe (*Gallinago caelestis*). (Illustrated with lantern-slides.)

3. DR. E. A. GOELDI, C.M.Z.S.—Some new and insufficiently-known Species of Marmoset Monkeys from the Amazonian Region.

4. MR. F. E. BEDDARD, F.R.S.—Contributions to the Knowledge of the Systematic Arrangement and Anatomy of certain Genera and Species of Squamata.

The following Papers have been received:—

1. DR. W. T. CALMAN, F.Z.S.—On new or rare Cumacea from the Collection of the Copenhagen Museum. Part I.

2. MR. G. H. KENRICK, F.Z.S.—A List of the *Pyralidæ*, with Descriptions of new Species, collected by A. E. Pratt in British New Guinea in 1902-03.

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 18th, 1906.

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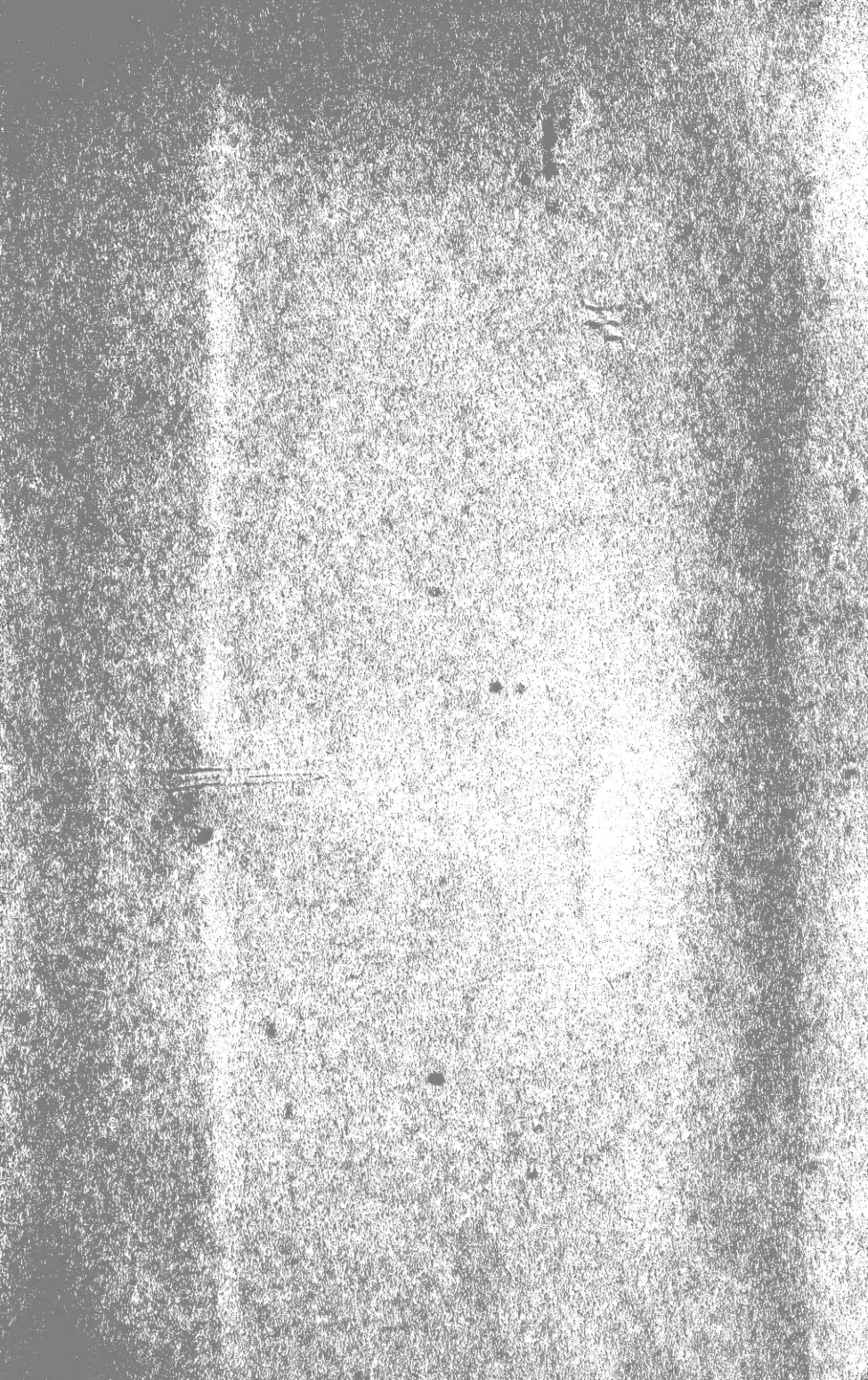
The 'Proceedings' for the year are issued in *four* parts, forming two volumes: as follows:—

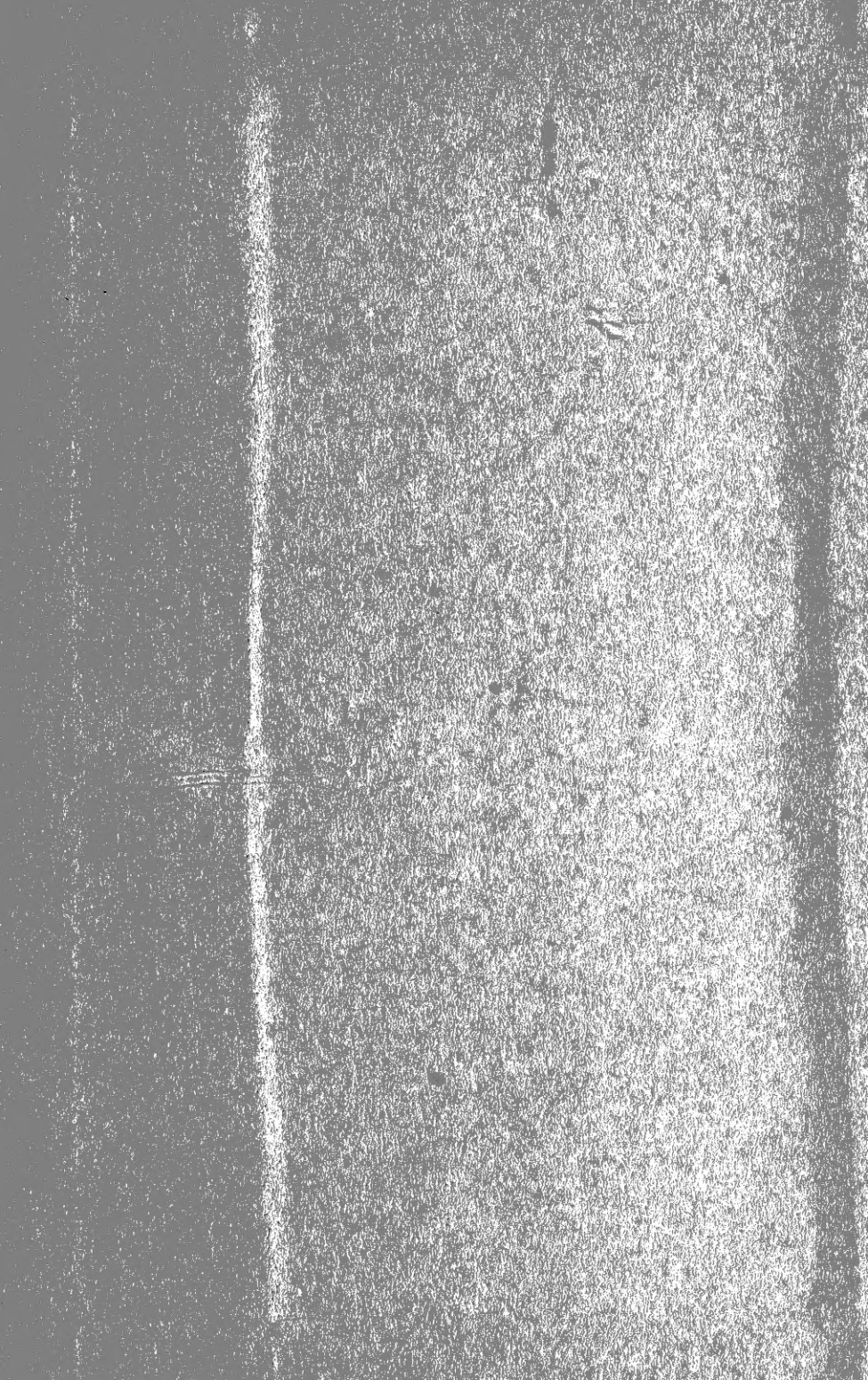
- Papers read in January and February, in June.
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'Proceedings,' 1906, pp. 463-758, were published on October 10th, 1906.

The Abstracts of the papers read at the Scientific Meetings in November and December are contained in this Part.

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