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OF THE

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OF LONDON.

1918, pp. 1-196,

WITH 1 PLATE and 32 TEXT-FIGURES.



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

1918.

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# PROCEEDINGS

OF THE

## GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

# ZOOLOGICAL SOCIETY OF LONDON.

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### PAPERS.

1. Skull of *Rana tigrina* \* Daud. By B. L. BHATIA, M.Sc.,  
and BAINI PRASHAD, M.Sc. (Assistant Professors of  
Zoology, Government College, Lahore)†.

[Received August 8, 1917: Read February 5, 1918.]

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In a recent paper Nicholls (2) pointed out that *Rana tigrina* Daud., which is generally used as a laboratory type throughout India, differs markedly in several skeletal and other characters from the common European forms (*R. temporaria* and *R. esculenta*), of which a detailed description is generally given in the ordinary English text-books. Nicholls had previously (1) published a Note on the urostyle of *R. tigrina* and several other anurous Amphibia, and in the first-mentioned paper he deals with the vertebral column, the shoulder-girdle and sternum, and the tenth spinal nerve; the skull of *R. tigrina*, which presents no less marked differences, however, has not received consideration.

As far back as 1881, Parker (4), whilst working out the morphology of the batrachian skull, published short descriptions of

\* [Dr. G. A. Boulenger, F.R.S., informs me that the Lahore Frog has been identified by him as belonging to the typical form.—Ed. P. Z. S.]

† Communicated by Lieut.-Colonel J. STEPHENSON, D.Sc., I.M.S., F.Z.S.

the skulls of several Indian species including *R. tigrina*, but the account of the latter is incomplete and suffers through having been drawn up from the study of a single specimen. Both the published description and the plate are inaccurate in several important respects, and therefore it was considered desirable to work out in detail the anatomy of the skull of this common Indian frog, and to correct the errors which have crept into the otherwise excellent account given by him. For this purpose the authors have prepared a large series of fresh skulls, and examined them both in the wet and the dry condition. This has been supplemented by an examination of the large number of skulls of this type which are used for study by the students working in the Government College laboratory.

#### *The Cranium.*

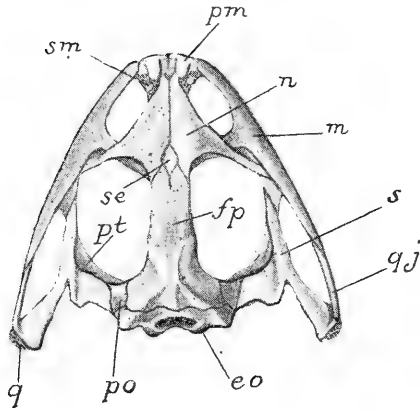
The skull in this frog is very much larger than in the two common European species. An average-sized adult skull measured 40 mm. in the antero-posterior and 37 mm. in the transverse direction, while one of the largest measured 45 mm. in the longitudinal and 48 mm. in the transverse direction. The cranium, which is wide behind, narrows somewhat anteriorly. The superior surface is markedly arched, its most prominent point being a little in front of the occipital region. All the bones associated with the cranium, both investing and replacing, show a marked development; thus the original cartilaginous structure has been considerably reduced. As remarked by Parker (4), *R. tigrina* presents one of the most perfect examples of Batrachian cranial architecture.

#### *The Bones of the Cranium.*

The *Exoccipital bones* (text-figs. 1-4, *eo.*) bounding the foramen magnum meet each other in the middle line ventrally, and leave only a very small V-shaped area of unossified original cartilage between their dorsal ends (all that is left uncovered of the original *tectum synoticum*). The *tectum synoticum* never reaches the superior border of the foramen magnum, and in the skull of older specimens this little area also becomes ossified. The two bones are seen meeting each other and the slight median projection on the posterior border of the fronto-parietals. In conformity with the great strength and massive proportions of this frog, the occipital condyles are large and are well seen in both dorsal and ventral views of the skull (text-figs. 1-4). Laterally, where the exoccipital meets the prootic it presents a prominent bony ridge (*processus mastoideus*), there being a thin strip of cartilage between the two bones in the young specimen only.

The *Prootic bones* (text-figs. 1 & 7, *po.*) form a considerable portion of the roof and anterior wall of the auditory capsule, and extend forwards to form a portion of the inner wall of the orbit. Dorsally each presents a quadrilateral area (*vide* text-fig. 1)

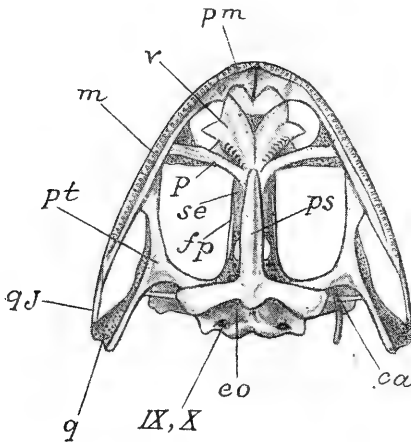
Text-figure 1.



*Rana tigrina*; dorsal view of skull.

*a.l.*, alinasal process; *c.a.*, columella auris; *eo.*, exoccipital; *f.*, anterior fontanelle; *f.o.*, fenestra ovalis; *fp*, fronto-parietal; *m.*, maxilla; *n.*, nasal; *p.*, palatine; *p.c.*, palatal cartilage; *pm.*, premaxilla; *pn.*, prenasal process; *po.*, prootic; *p.r.*, rostral process; *p.rh.*, rhinal process; *ps.*, parasphenoid; *pt.*, pterygoid; *q.*, quadrate cartilage; *qj.*, quadrato-jugal; *s.*, squamosal; *se.*, sphenethmoid; *sm.*, septo-maxillary; *s.n.*, septum nasi; *sp.*, septum dividing the anterior part of the sphenethmoid; *st.*, stapes; *v.*, vomer. *I, II, III, IV, V, VII, IX, X*, refer to the foramina for the exit of the cranial nerves.

Text-figure 2.

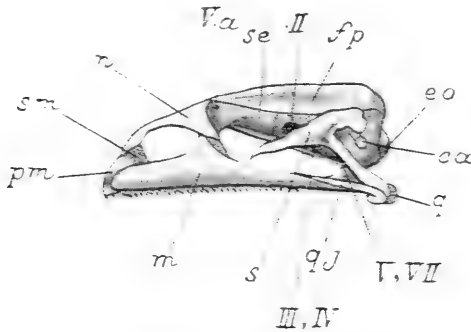


*R. tigrina*; ventral view of skull.

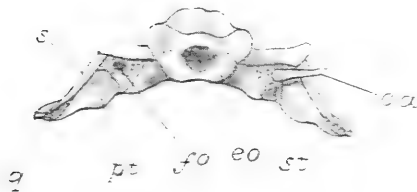
For explanation of the letters see text-fig. 1.

between the fronto-parietal and exoccipital on the inner side and the inwardly directed horizontal flange of the squamosal, which partly overlaps it, on the outer. Anteriorly the prootic bone forms nearly the whole of the anterior wall of the auditory capsule: a small area on the outer side of this anterior wall remains cartilaginous. On the inner side this anterior portion curves forwards to form the posterior part of the inner wall of the orbit. In this angle is situated the foramen for the exit of cranial nerves v. to vii. The foramen is completely surrounded

Text-figure 3.

*R. tigrina*: lateral view of skull.

Text-figure 4.

*R. tigrina*: posterior aspect of skull.

For explanation of the letters see text-fig. 1.

by the prootic bone, and is not merely a notch completed below by cartilage. The ventral and the posterior walls of the auditory capsule are cartilaginous. Postero-laterally the prootic extends to meet the exoccipitals: at the junction of the two is a curved irregular depression, the fossa tympanica, which lodges the auditory ossicles and in which the foramen ovale is situated. The suspensorium of the lower jaw is attached more externally to the side of the auditory capsule. The styloid cartilage is attached to the outer side of the cartilaginous portion of the capsule.

The *Parasphenoid* (text-figs. 2 & 6, *ps.*) is of the typical form, but unusually strong. The transverse limb lies under the occipito-auditory masses. Its posterior border is deeply concave and the ends of the transverse limb are considerably wider than the portion near the middle line. The posterior median process of the longitudinal arm is short and often elegantly pointed. The anterior longer longitudinal arm, besides forming the floor, rises up on each side to form a portion of the lateral wall of the cranium. About the middle it is broader than at the ends. The outer edges articulate with the prootics, the cartilaginous portion of the cranium, and the sphenethmoid. The cartilaginous portion of the side-wall of the cranium is relatively much smaller than the anterior sphenoidal portion.

Text-figure 5.

*R. tigrina*; separated bones from the skull.

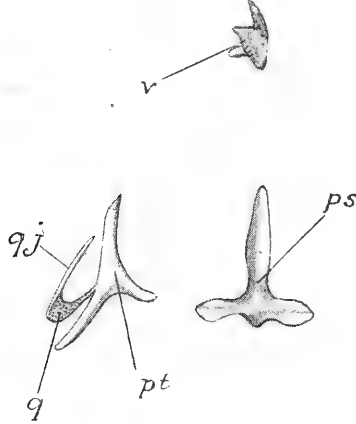
*pm.*, premaxilla; *m.*, maxilla; *n.*, nasal; *fp.*, fronto-parietal; *s.*, squamosal.

The *Fronto-parietals* (text-figs. 1, 3, and 5, *fp.*) are adequately described by Parker (4) in the following words:—

“Above, the fronto-parietals form a strong roof with a notch in front, the remains of the frontal suture, but are wholly coalesced beyond this; they end behind in two broad wings which spread over the hinder region of the cranium almost to the end. At first hollow in the middle, in the posterior region they develop a sagittal crest, which opens out into two temporal wings. The temporal part dips into the orbit and then rises over the ear-masses moulding on to their sinuosities. The sides are notched, and the end has a concave margin.”

On removing the fronto-parietal it is seen that there is only one anterior fontanelle (*vide* text-fig. 7, *f.*), bounded anteriorly by a deep notch in the posterior margin of the sphenethmoid and posteriorly by the cartilaginous cranium. The posterior

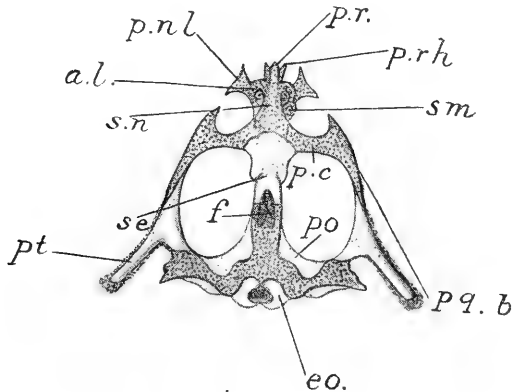
Text-figure 6.



*R. tigrina*; separated bones from the skull.

*v.*, vomer; *ps.*, parasphenoid; *qj.*, quadrato-jugal; *q.*, quadrate; *pt.*, pterygoid.

Text-figure 7.



*R. tigrina*; dorsal aspect of skull after removal of investing bones.

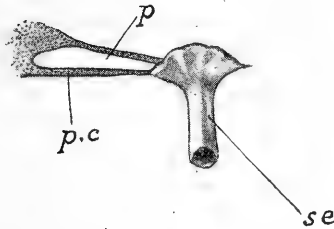
For explanation of the letters see text-fig. 1.

fontanelles usually found in other forms are absent. Parker, in his description, stated "that the fontanelles are presumably like those of the lesser kinds," but this is not the case.

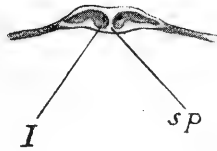


The *Sphenethmoid* (text-figs. 1, 2, 3, 7, 8, and 9, *se.*) is more strongly developed than in the European species, and extends posteriorly almost to the region of the optic foramen. Anteriorly it extends on either side so as to form a part of the anterior boundary of the orbit (*vide* text-fig. 8); this feature is much better marked in the adult specimens. In the average adult specimen its front portion forms more than half the extent of the nasal roof, floor, and the middle wall. In a dorsal view a lozenge or diamond-shaped area of this bone (*vide* text-fig. 1) is left between the nasals anteriorly and the anterior median notch of the fronto-parietals behind.

Text-figure 8.



Text-figure 9.



*R. tigrina.*

Text-fig. 8.—Sphenethmoid, dorsal aspect after removal of investing bones.  
*se.*, sphenethmoid; *p.*, palatine; *p.c.*, palatal cartilage.

Text-fig. 9.—Sphenethmoid, anterior aspect.  
*I.*, aperture for olfactory nerve; *sp.*, septum.

The cartilaginous skeleton of the nose does not call for any special remarks, except that in addition to the rhinal process (text-fig. 7, *p.rh.*) there is a median prenasal rostrum (*p.r.*) in continuation of the septum nasi (*s.n.*). A definite *septo-maxillary* (*sm.*) is present on either side, extending horizontally from the anterior wall into the nasal cavity, though Parker (4) regarded them as mere ossifications in the nasal cartilage.

#### *The Bones of the Face.*

The *Nasals* (text-figs. 1, 3, & 5, *n.*) are large broad-based triangular bones, meeting each other in the middle line and diverging posteriorly to enclose the diamond-shaped area of the sphenethmoid referred to above, and to meet the anterior ends of the fronto-parietals. Anteriorly also they extend as far forwards as nearly to reach the nasal processes of the premaxillæ. The apex or external angle of the triangular bone is drawn out and extends outwards to meet the ascending process of the maxilla.

The *Vomers* (text-figs. 2 & 6, *v.*) meet each other in the middle line posteriorly, but diverge anteriorly leaving a portion of the

floor of the nasal capsule uncovered. The outer border presents two notches, the posterior one bounding the posterior nares. The vomerine teeth are situated in an oblique line along the posterior border.

The *Squamosals* (text-figs. 1, 3, 4, & 5, s.) are strongly developed. From the posterior half of the cross-bar is given off a horizontal shelf-like process covering the *tegmen tympani* and extending inwards along its posterior border as far as the junction of the prootic and the exoccipital.

The *Pterygoids* (*pt.*), *Palatines* (*p.*), *Quadrato-jugals* (*qj.*), *Maxille* (*m.*), bones of the lower jaw and the hyoid apparatus are of the usual type. An interesting feature, however, is the presence of three well-marked depressions on the ventral side of the upper jaw in its anterior portion (*vide* text-fig. 2). The middle one of these depressions is between the two premaxillæ; it receives a corresponding median projection from the mento-meckelians. The two lateral depressions are at the junction of the premaxilla with the maxilla of each side; each accommodates a strongly developed projection of the dentary of each side.

*Literature cited.*

1. NICHOLLS, GEORGE E.—A Note on the Urostyle (*os coccygeum*) of the Anurous Amphibia. Proceedings of the Zoological Society of London, 1915, p. 239.
2. NICHOLLS, GEORGE E.—Some Notes upon the Anatomy of *Rana tigrina*. Proceedings of the Zoological Society of London, 1915, p. 603.
3. PARKER, W. K.—On the Structure and Development of the Skull of the Common Frog (*Rana temporaria* L.). Philosophical Transactions of the Royal Society of London, 1871, vol. 161, p. 137.
4. PARKER, W. K.—On the Structure and Development of the Skull in the Batrachia.—Part III. Philosophical Transactions of the Royal Society of London, 1881, vol. 172, p. 1.

2. Description of a new Snake of the Genus *Oligodon* from Upper Burma. By G. A. BOULENGER, F.R.S., F.Z.S.

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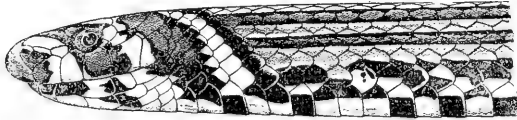
[Received January 1, 1918 : Read February 5, 1918.]

(Text-figure 1.)

OLIGODON HAMPTONI.

In 1905 I described a new *Oligodon*\* occupying an isolated position in the genus, of which two specimens had been obtained

Text-figure 1.



*Oligodon hamptoni*, sp. n.  $\times 1\frac{1}{2}$ .

at Mogok, Upper Burma, by the late Mr. Herbert Hampton.

\* *Oligodon herberti* Boulenger, Journ. Bombay N. H. Soc. xvi. 1905, p. 235, pl. fig. 1.—The species has been rediscovered in Tonkin and noticed as *O. herberti*, var. *eberhardti*, by Pellegrin, Bull. Soc. Zool. France, xxxv. 1910, p. 30.

Three years later the British Museum received another specimen found at the same place by the same collector and which pertains to the same aberrant group, although unquestionably of a distinct species. I had put aside the specimen in the hope of obtaining others; but as the hope must now be given up, I propose to give a description of this handsome and very remarkable Snake.

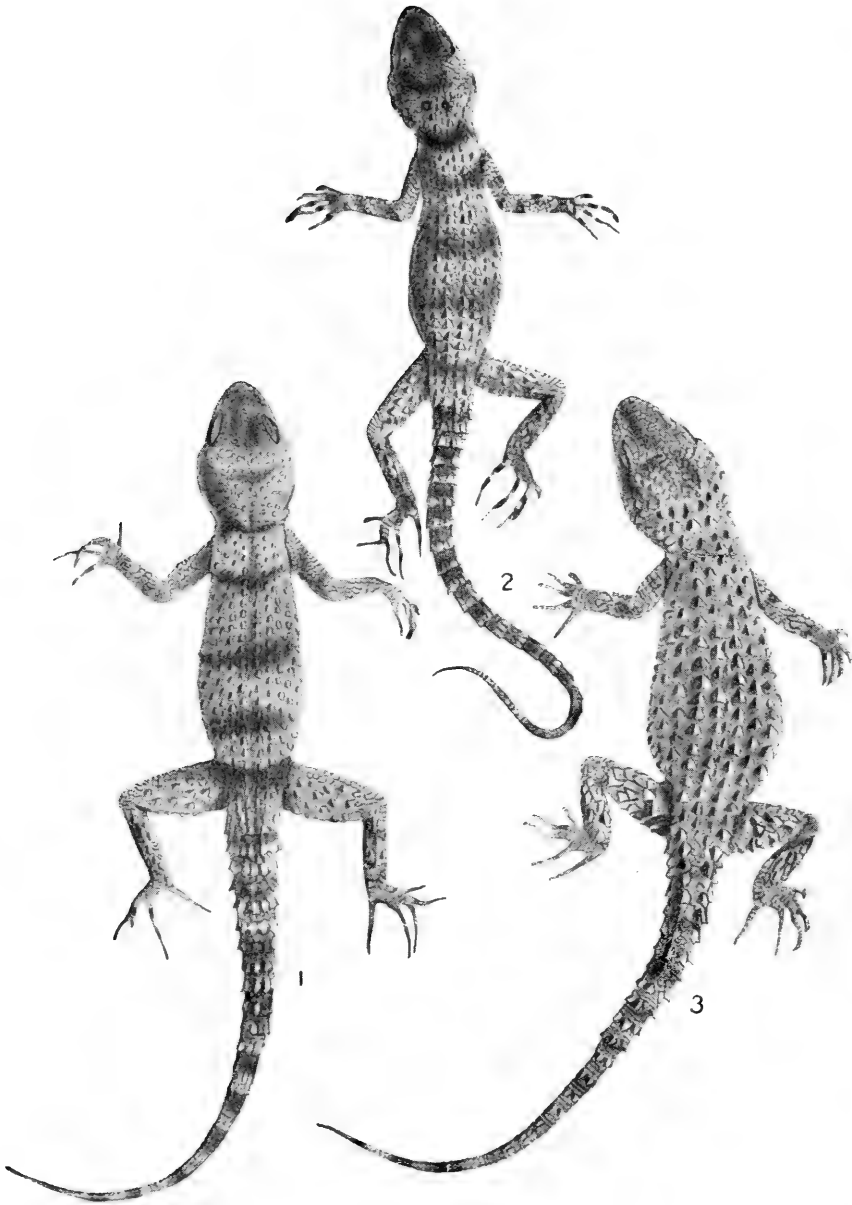
Nasal undivided; portion of rostral seen from above a little longer than its distance from the frontal, penetrating rather far between the præfrontals; no internasals; frontal longer than its distance from the end of the snout, shorter than the parietals; loreal small, longer than deep; one præ- and one postocular; temporals 1+1; five upper labials, second and third entering the eye; three or four lower labials in contact with the anterior chin-shields, which are longer than the posterior. Scales in 15 rows. Ventrals 160; anal divided; subcaudals 32. A broad yellow vertebral band, from the nape to the end of the tail, between a pair of reddish brown, black-edged dorsal bands of about the same width; sides bluish grey, with two narrower dark brown bands, the lower interrupted; head yellow with dark brown markings: a spot capping the tip of the snout, a crescentic band from lip to lip through the eyes and across the snout, an elongate spot on the frontal and on the suture between the parietals, connected with a large occipital bifid spot which is continued as bands along the body, and an oblique band from the parietal to the commissure of the mouth and below. Belly red, with black bars occupying a whole shield or interrupted and alternating; lower surface of tail uniform red.

Total length 540 millim.; tail 70.

A single male specimen.

Although not longer than *O. herberti*, this is a much heavier Snake, which must be regarded for the present as the largest and handsomest of all the Oligodons.





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LIZARDS FROM TRANSCASPIA.

## 3. Reptiles from the River Tajan (Transcaspia).

By L. A. LANTZ\*.

[Received February 5, 1918: Read February 19, 1918.]

(Plate I.)

The small collection of reptiles which I am about to describe was made from April to September 1914 by Mr. N. V. Meriakri, who presented it to the Zoological Museum of the Moscow University. Prof. G. A. Kojevnikof was kind enough to entrust me with its study.

This material, although consisting of only 35 specimens, contains 16 species, one of which appears to be new. It thus affords interesting information on the herpetological fauna of the region of the river Tajan, situated at the meeting of the Persian, Afghan, and Transcaspian frontiers.

1. *GYMNODACTYLUS MICROLEPIS*, sp. n. (Pl. I. fig. 1.)

3 ♂. Length of head and body (from snout to vent) 61, 60, and 40 mm.

Head oviform, rather depressed. Snout much longer than the diameter of the eye. Forehead slightly concave. Ear-opening small, elliptical. Proportion:  $\frac{\text{length of head}}{\text{length of head and body}} = 0.27$  to 0.30; average 0.28.

Body moderate, depressed. A well-marked lateral fold.

Limbs rather long. Proportion:  $\frac{\text{length of fore limb}}{\text{length of head and body}} = 0.42$  to 0.43; average 0.43. Proportion:  $\frac{\text{length of hind limb}}{\text{length of head and body}} = 0.61$  to 0.64; average 0.63.

Tail cyclotetragonal and slightly depressed at the base, becoming cylindrical towards the end. Proportion:  $\frac{\text{length of tail}}{\text{length of head and body}} = 1.33$  (1 spec.).

Rostral broader than deep, with median cleft above. Nostril pierced between the rostral, the first supralabial, and 3 feebly swollen nasals. 10 or 11 supralabials. Scales of snout, forehead, and supraocular region polygonal, slightly convex, small in the postnasal depression, enlarged in front of the eye. One enlarged superciliary. Parietal and occipital regions covered with small, roundish, feebly convex scales, intermixed with larger, more convex, or slightly conical ones. On the temple a few large, moderately conical, but not keeled tubercles; the other temporal scales small, granular; in front of the ear-opening 2 or 3 small tubercles.

Mental large, sub-triangular. 7 to 9 infralabials. 3 pairs of chin-shields, the first *not* forming a suture behind the apex

\* Communicated by G. A. BOULENGER, F.R.S., F.Z.S.

of the mental. Gular scales extremely small, roundish, scarcely imbricate.

Neck with very small, juxtaposed, granular scales and longitudinal rows of large, slightly conical, but not keeled scales, changing gradually along the back into 12 or 14 longitudinal rows of moderate, elongated, trihedral tubercles; between the median rows a row of small tubercles. The other scales of the back larger than those of the neck, flat, feebly imbricate; across the middle of the body 62 to 65 dorsal scales (in a transverse line passing between the tubercles).

Ventral scales small, cycloid, smooth, 35 to 38 in a transverse row in the middle of the belly, 136 to 144 in the median line from the mental to the vent.

Suprahumeral scales rather small, imbricate, more or less rounded, smooth, or indistinctly keeled. Forearm covered with scales like the dorsals, and with a few moderately keeled tubercles. Infracapital scales granular, juxtaposed. Infracapital scales like the ventrals.

Suprafemoral scales imbricated, pointed, smooth, or indistinctly keeled on the inner side of the thigh; the other parts of the thigh and leg covered with scales like the dorsals, intermixed with large, moderately prominent trihedral tubercles. Infracapital scales large, roundish, imbricate. Male with a continuous series of 34 to 39 femoral and præanal pores. Infracapital scales similar to the ventrals, but a little larger.

Tail covered above with transverse rows of very large, moderately keeled spinose scales, decreasing in size towards the end of the tail; between these rows of large scales about two rows of small, imbricate, more or less distinctly keeled ones. On the lower side of the tail, except at its base, a single row of enlarged transverse plates.

Coloration grey above, with more or less distinct darker transverse bands, which are disposed as follows:—one on the occipital region, one on the neck, 4 to 7 on the back, about 12 on each limb, 12 on the tail. Lower parts white.

#### *Comparative Notes.*

The presence of a series of numerous femoral and præanal pores show *G. microlepis* to belong to the group of *G. caspius* Eichw. It is especially closely allied to *G. fedtschenkoi* Str. and *G. longipes* Nik., agreeing with the former in proportions and with the latter in most characters of scaling. I am greatly indebted to Mr. W. A. Lindholm, who was so kind as to examine the types and other material of *G. longipes*, which are preserved in the Museum of the Petrograd Academy of Science\*. Owing to his notes, which complete the description given by Nikolski †, I am able to state that these two species are quite distinct.

\* Nos. 8809 (3 ♂), 8810 (1 ♂, 2 ♀), 8811 (1 ♀), from Neh in Eastern Persia, 18. v. 1896, leg. N. A. Zarudny (types); Nos. 9191 (1 ♀), 9193 (1 ♂, 4 ♀), 9194 (1 ♂) from the country Zirkuh in Eastern Persia, 21. iv. to 6. v. 1898, leg. N. A. Zarudny.

† Ann. Mus. Zool. Acad. St. Petersburg, 1897, p. 313.



Mr. Lindholm measured specimens of *G. longipes* and obtained the following data:—

Length of fore limb	♂	♀
Length of head and body	0.48 to 0.51; average 0.50	0.49 to 0.51; average 0.50
Length of hind limb		
Length of head and body	0.69 to 0.73; average 0.71	0.65 to 0.70; average 0.68

The comparison with the corresponding data of *G. microlepis* shows the difference in the length of limbs\*. Besides *G. longipes* has 12 to 15 supralabials, and the first pair of chin-shields almost always forming a suture behind the mental; on one specimen only out of 14 these plates are separated by two small scales. As to the size of the tubercles of the head, neck, and back, the scaling of the throat and belly, the number of femoral and præanal pores, the two species seem to agree.

There is a very interesting gradation in the characters of scaling between the three species *G. microlepis*, *G. fedtschenkoi*, and *G. caspius*. *G. microlepis* has the smallest and the most numerous scales, its tubercles are relatively feebly developed; *G. fedtschenkoi* forms the link between the foregoing and *G. caspius*, which has the largest and the least numerous scales, and very strongly developed tubercles. The following table contains the most important distinctive characters of these three species:—

	<i>G. microlepis</i> .	<i>G. fedtschenkoi</i> †.	<i>G. caspius</i> ‡.
Tubercles of the temple	moderately conical.	conical.	triangular.
Before the ear-opening	2 or 3 small tubercles.	2 or 3 small tubercles.	1 large tubercle.
On the neck	slightly conical scales.	moderately prominent triangular tubercles.	very prominent large-triangular tubercles.
Tubercles of the back	moderate, prominent, not spinose.	large, prominent, not spinose.	very large, very prominent, often spinose.
Gular scales	extremely small.	very small.	small.
Number of scales in a line between the apex of the mental or the suture of the chin-shields and the anal cleft	136 to 144.	123 to 131.	100 to 114.
Number of ventral scales across the middle of the belly	35 to 38.	30 to 33§.	24 to 29.
Suprafemorals on the inner side of the thigh	small, smooth, or distinctly keeled.	moderate, distinctly keeled.	large, strongly keeled.
Number of femoral and præanal pores	34 to 39.	26 §.	27 to 29   .

\* Nikolski attributes as a distinctive character to *G. longipes* the greater diameter of the eye, which he supposes to be longer than the distance from eye to nostril; with this statement Mr. Lindholm does not agree.

† Material: 2 ♂ from Samarkand.

‡ Material: 2 ♀ from Shemakha (Caucasus); 5 spec. (2 ♂, 1 ♀, 2 juv.) from Sangatshaly near Baku (Caucasus); 3 spec. (1 ♂, 2 ♀) from Askhabad (Transcaspia), 1 ♂ from Anau (Transcaspia), and the ♀ described here from the river Tajan.

§ 24 to 34 ventral scales and 30 to 37 pores, according to Nikolski, Fauna of Russia. Reptiles I., Petrograd 1915, p. 78.

|| The maximum is 30, according to Nikolski, *loc. cit.* p. 74.

2. *GYMNODACTYLUS CASPIUS* Eichw. (Pl. I, fig. 3.)

1 ♀. Length of head and body 65 mm. 9/10 supralabials, 7/8 infralabials. 14 longitudinal rows of dorsal tubercles. 65 dorsal scales in a transverse row across the middle of the body. 101 scales in a line between the suture of the chin-shields and the vent. 28 ventral scales across the middle of the belly.

3. *AGAMA SANGUIOLENTA* Pall.

4 specimens, agreeing in every respect with others from Transcaspia (Askhabad, Anaú, Bairam-Ali). Length of head and body 83 mm. (♂), 81 mm. (♂), 78 mm. (♀), and 36 mm. (juv.). 14 to 17 supralabials, 15 to 17 infralabials. 43 to 47 gular scales and 73 to 76 ventral scales in a line from mental to vent. 58 to 64 dorsal and ventral scales round the middle of the body. The young differs from the adults in having no spinose scales.

4. *EREMIAS VELOX VELOX* Pall.

2 specimens, entirely agreeing with other material from Transcaspia (Askhabad, Bairam-Ali). Length of head and body 65 mm. (♂) and 34 mm. (juv.). 6 to 9 superciliaries. The large supraocular shields completely or almost completely separated by a row of granules from the frontal and the postfrontal. Infranasal not reaching the rostral. 6 anterior and 3 posterior supralabials, 6 to 8 infralabials. 5 or 6 chin-shields in the young, the first 3 or 4 forming a suture. 22 or 23 gular scales in a line between the suture of the chin-shields and the collar. 10 plates in the collar. 50 to 53 dorsal scales across the middle of the body. 30 transverse rows of ventral plates, the longest of which consists of 13 to 15 plates. 20/21 femoral pores. Supracaudal scales strongly keeled.

5. *EREMIAS INTERMEDIA* Str.

3 typical specimens. Length of head and body 55 mm. (♀), 37 and 38.5 mm. (juv.). In the ♀ a granule between the prefrontals. 6 to 8 superciliaries. The large supraocular shields entirely separated by a row of granules from the frontal and the postfrontal\*. 6+1+2 to 4 supralabials; 7 or 8 infralabials. 26 or 27 gular scales in a line between the suture of chin-shields and the collar. 11 or 12 plates in the collar. 47 to 50 dorsal scales across the middle of the body. 29 or 30 transverse rows of ventral plates, the longest of them consisting of 16 to 18 plates. 13 or 14 femoral pores on each side.

\* I shall show in a more detailed publication that the subspecies *transcaspica* Nik., which, according to the author, may be distinguished by this character, is identical with the typical *E. intermedia*.

6. *EREMIAS (MESALINA) GUTTULATA* Licht.

1 ♀. Length of head and body 49 mm. 5 superciliaries. Row of superciliary granules beginning behind the 7th superciliary only. Occipital as large as the interparietal. 4 anterior and 3 posterior supralabials. 7 infralabials. 22 gular scales in a line between the suture of the chin-shields and the collar. Collar free, consisting of 9 plates. 40 dorsal scales across the middle of the body. 28 transverse rows of ventral plates. 10 femoral pores on each side.

7. *EUMECES SCHNEIDERI* Daud.

1 spec. Length of head and body 109 mm. (♂) and 63 mm. (hgr.). 6+1+3 supralabials in the ♂, 5+1+2 only in the half-grown specimen, the middle one being fused with the following by forming a very large subocular. 8 infralabials. 4/5 or 5/6 nuchal plates. 25 or 26 dorsal and ventral scales round the middle of the body. 68 scales in a line between the suture of the chin-shields and the anal plates.

8. *EUMECES SCUTATUS* Theob.

3 spec. Length of head and body 122 mm. (♂), 124 and 116 mm. (both ♀). The head-shields offer many anomalies. In one ♀ the right supranasal is divided; the other ♀ has both præfrontals divided into two unequal parts, and two loreals on the left side. In the ♂ the parietals form a long suture behind the interparietal.—4 to 6 superciliaries. 4 or 5+1+3 supralabials, the last being very small. 7 infralabials. 3/4 or 4/4 nuchal plates. 21 dorsal and ventral scales round the middle of the body. 78 to 80 scales in a line between the suture of the chin-shields and the anal plates.

9. *MABUIA SEPTEMTENIATA* Reuss.

2 spec. Length of head and body 82 mm. (♂) and 90 mm. (♀). Supranasals meeting in a point (♂) or separated (♀). Præfrontals separated from each other, the internasal forming a short suture with the frontal. 4 anterior and 2 posterior supralabials. 8 infralabials. 34 or 35 dorsal and ventral scales round the middle of the body. 70 or 71 scales in a line between the suture of the chin-shields and the vent.

10. *VIPERA LEBETINA* L.

1 spec.\* Length of head and body 520 mm. Tail incomplete. 10 supralabials, 13/14 infralabials. 25 longitudinal rows of dorsal scales. 121 ventral plates.

\* It was impossible to ascertain the sex of the snakes, the viscera having been removed.

11. *BOIGA TRIGONATUM* Schneid.

2 specimens:—

Length of head and body.....	510	480 mm.
Length of tail .....	115	108 "
Number of supralabials .....	8, 9, the 3rd, 4th, and 5th entering	
Number of infralabials .....	11/12	[the orbit.
Temporal shields .....	2+3	$\frac{2+1+3}{1+3+3}$
Number of rows of dorsal scales.....	21	
Number of ventral plates .....	222	221
Number of pairs of infracaudals ...	86	84

12. *TAPHROMETOPON LINEOLATUM* Brandt.

1 specimen. Length of head and body 790 mm. Length of tail 375 mm. 8 supralabials; the 4th and 5th entering the orbit. 11 infralabials.  $2+1\frac{1}{2}+3$  temporal shields. 12 rows of dorsal scales. 181 ventral plates. 121 pairs of infracaudals.

13. *ZAMENIS RHODORHACHIS* Jan.

2 specimens:—

Length of head and body.....	715	630 mm.
Length of tail .....	265	230 "
Number of supralabials .....	9, the 5th and 6th entering the	
Number of infralabials.....	10	[orbit.
Temporal shields .....	2+5 to 8 irregular ones.	
Number of rows of dorsal scales.....	19	
Number of ventral plates.....	227	226
Number of pairs of infracaudals ...	121	117

These specimens have no red stripe along the back.

14. *ZAMENIS DIADEMA* Schleg.

4 specimens:—

Length of head and body .....	870	830	825	770 mm.
Length of tail .....	215	190	215	(140) "
Number of supralabials .....	11/12	12/13	10/11	12/13
Number of infralabials .....	11/13	12	13/14	12
Number of rows of dorsal scales ...	27	29	27	27
Number of ventral plates .....	225	244	217	234
Number of pairs of infracaudals ...	76	83	83	—

Behind the praefrontals a row of 3 accessory shields; in one specimen the median one is fused with the right internasal.  $3\left(\frac{1}{1+1}\right)$  exceptionally  $4\left(\frac{1}{1+1+1}\right)$  frenals. 2 praeculars. Supralabials more or less separated from the loreals and entirely separated from the orbit by a row of small shields, the first of which may reach the postnasal; there are 2 or 3 shields between the supralabials and the loreals, 3 to 5 between the former and the orbit, and, following them, 2 or 3 postoculars. Temple covered with small irregular shields.

15. *NATRIX TESSELLATA* Laur.

3 specimens:—

Length of head and body .....	580	530	470 mm.
Length of tail .....	155	155	125 ..
Number of supralabials .....	8		
Number of infralabials .....	10/11		
Number of præoculars .....	4	2/3	2
Number of postoculars .....	4	4	3
Temporal shields .....	1 + 2 + 2 or 3		
Number of rows of dorsal scales .....	19		
Number of ventral plates .....	176	170	176
Number of pairs of infracaudals .....	70	73	69

In the specimen having 2 præoculars and 3 postoculars the 4th and 5th supralabials enter the orbit.

16. *ERYX MILIARIS* Pall.

1 specimen. Length of head and body 355 mm. Length of tail 30 mm. Internasals separated by the point of the rostral. 4 scales between the postnasals. Round the eye a circle of 13 small shields, the lowest of them much enlarged and reaching the 6th supralabial, the two anterior ones a little enlarged (præoculars), the others (supraoculars and postoculars) about equal in size. Between the supraoculars 5 scales across the head. Between the postnasals and the præoculars  $8 \left( \frac{1}{1} + \frac{1}{1} + \frac{1}{1} \right)$  small loreal shields. 13 supralabials, the 3rd one being the highest. 20 infralabials, the first 3 or 4 enlarged, the others very small, with larger shields below them.

EXPLANATION OF PLATE I.

- Fig. 1. *Gymnodactylus microlepis*, sp. n., ♂, River Tajan.
- Fig. 2. *G. fedtschenkoi* Str., ♂, Samarkand.
- Fig. 3. *G. caspius* Eichw., ♀, River Tajan.



4. On the External Characters of the Lemurs and of  
*Tarsius*. By R. I. Pocock, F.R.S.

[Received March 5, 1918; Read March 5, 1918.]

(Text-figures 1-16.)

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*Introduction.*

The materials upon which this paper is based are mainly the lemuroid Primates which have died in the Zoological Gardens during the past ten years or so. Representatives of practically all the commonly imported menagerie species of the group have passed through my hands in that time, namely, species belonging to the genera *Chiromys*, *Chirogaleus*, *Lemur*, *Galago*, *Perodicticus*, and *Nycticebus*. For the loan of examples of *Hemigalago* and *Tarsius* I am indebted to Prof. Wood-Jones, the Society's Prosector. I am also indebted to Mr. Oldfield Thomas and to Prof. J. P. Hill for the chance to examine other specimens of *Tarsius*. I have not, however, been able in all cases to see representatives of both sexes of the species; and of many admitted genera, notably *Microcebus*, *Mixocebus*, *Lepilemur*, and *Loris*, no specimens have come to hand. This applies also to the three genera of Indrididæ (*Indris*, *Propithecus*, *Lichanotus*), which, like *Tarsius*, seem to be intolerant of captivity even in their own countries. The external characters of the Indrididæ, however, have been tolerably fully described and illustrated in Milne-Edwards and Grandidier's great work on the Fauna of Madagascar. From this I have freely borrowed. Unfortunately no text accompanies the numerous plates on the various species of Lemuridæ published in that work. Of other treatises dealing with the Lemurs on a comprehensive scale the most important is the paper by Mivart and Murie (Tr. Zool. Soc. vii. 1872), in which some of the external characters of a few diverse types are dealt with from the comparative point of view. The rest of the bibliography consulted consists mostly of special memoirs on particular species, like Owen's paper on *Chiromys*, Burmeister's

on *Tarsius*, Van der Hoeven's on *Perodicticus*, Huxley's on *Arctocebus*, Beddard's on *Hapalemur*, and so forth.

Many of the facts dealt with in the following pages are of course well known. Some characters, however, are here described, I believe, for the first time; and I trust that the collation of the facts and their comparative treatment may prove useful to future students of this group.

In the matter of names I have followed the conservative course of using *Lemur* for the species to which it has been by common consent assigned in all recent literature, although by the rules of nomenclature, it has no right to a place in the Primates at all, but belongs by Storr's very definite selection to the Dermoptera, *Galeopithecus volans* being its type-species. Even if that selection be set aside, it appears to me that the "indications" of the 10th edition of the 'Systema' show that the species known as *Loris tardigradus* is its type. This is clearly a case for the "Fiat" Committee on Mammalian generic names; and it is my confidence that the Committee will see the wisdom of allowing *Lemur catta* to stand as the type of *Lemur*, that induces me to retain this generic name in its commonly accepted sense. Similarly I have employed *Chiromys* for the Aye-Aye (*madagascariensis*), although *Daubentonia* is the correct title for that species. The Fiat Committee, I believe, has these names now under consideration.

#### *The Muzzle and the Rhinarium.*

The bestial aspect of the face of the Lemuroid as compared with the Pithecoïd Primates is not due to the general elongation of the jaws. In this character the Lemurs are surpassed by *Papio* amongst the Pithecoïds. It is due to two correlated features, namely, the retention of the primitive moist glandular rhinarium and the projection of the upper jaw supporting it beyond the level of the chin.

The rhinarium is naked to a varying extent on its dorsal side and also beneath the nostrils laterally and in front. It is continued downwards in front as a strip of grooved naked skin cleaving the upper lip to its inferior edge. At this point the lip is adherent to the gum covering the premaxillæ, so that it is incapable of protrusion.

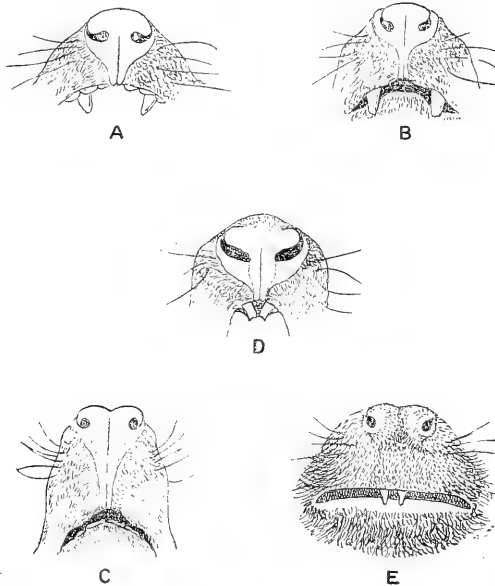
Although the rhinarium is tolerably similar throughout the group, one or two variations may be pointed out. In the typical Mascarene Lemurs, including *Chirogaleus* (text-fig. 1, A), the labial extension of the rhinarium is comparatively short and the laterally extended infranarial portions shallow. In *Perodicticus* the infranarial portion is deeper; but in *Nycticebus* it is not so. In *Galago crassicaudatus* (text-fig. 1, B) the labial extension of the rhinarium is a little longer and thinner than in *Chirogaleus* and *Lemur*. In *Hemigalago demidoffi* it is remarkably long and gradually widens above where it passes into the infranarial portion



of the rhinarium ; but in the length and shape of the rhinarium *G. senegalensis* is intermediate between *G. crassicaudatus* and *H. demidoffi* (text-figs. 1, C ; 2, B).

In *Chiromys* the rhinarium is not so prominent ; the nostrils are longer, more slit-like, and separated in front by a narrower septum. The infranarial portion is very deep towards the middle line, reaching almost to the edge of the upper lip and making the labial extension of the rhinarium appear very short. In this genus also the frenum which ties the lip to the gum between the

Text-figure 1.



- A. Rhinarium of *Chirogaleus major*.  
 B. Rhinarium of *Galago crassicaudatus*.  
 C. Rhinarium of *Hemigalago demidoffi*.  
 D. Rhinarium of *Chiromys*.  
 E. Nose of *Tarsius*.

points of insertion of the incisor teeth is somewhat longer than in typical Lemurs, so that the lip is capable of being protruded to a slightly greater extent in the middle line. It is probable that the variations of the rhinarium and upper lip, like many of the structural characters in *Chiromys*, are correlated with the rodent dentition and peculiar method of feeding of this Lemur ; but our knowledge of the function of the rhinarium is too imperfect to warrant more than a suggestion on this point (text-fig. 1, D).

I have not been able to examine in a fresh state the rhinarium of any species of *Indrididæ*.

The muzzle of *Tarsius* is very different from that of all Lemurs. The only trace of the rhinarium, if such it can be called, that remains is a narrow rim of naked skin surrounding the nostrils, which are widely separated as in the Platyrrhine Pithecoïd Primates. The nose scarcely projects at all, and the muzzle is squarely truncated and deep, and the upper jaw hardly overhangs the lower, so that in profile view the muzzle has a decidedly feline appearance, contrasting markedly with the generally canine appearance of that of the true Lemurs. The long upper lip is undivided and continuously hairy from side to side across the middle line, and its frenum is set higher above the incisor teeth, suggesting that the lip is susceptible of partial protrusion after the manner of the lip of the pithecoïd Primates, but to a lesser degree (text-figs. 1, E; 2, A).

The primitive muzzle of the lemuroïd Primates, with its rhinarium and adherent upper lip, is associated with the habit of drinking by means of lapping. The specialised muzzle of the pithecoïd Primates with aborted rhinarium and protrusible upper lip is associated with the habit of drinking by means of suction. But *Tarsius*, although more resembling the pithecoïds in the structure of the muzzle, drinks, it is said, by the lapping method\*. This fact is full of interest in connection with the view, supported by other considerations, that *Tarsius* links the Lemuroïds and Pithecoïds together.

#### *The Ear* †.

In the species referred to *Lemur* the pinna of the ear is tolerably uniform in shape and structure. It is small and concealed to a greater or less extent by its own hairs and those of the surrounding area of the head. Its superior posterior edge is not folded; but the anterior edge of the upper half forms a strong ridge overlapping the anterior end of the simple shelf-like supratragus (*plica principalis*) and descending below it and vanishing in the capsule of the pinna above and within the small lobate tragus. The antitragus is somewhat larger than the tragus, sometimes much larger (*Lemur catta*); and the deep notch between them is approximately on a level with the external auditory meatus. The flap of the ear behind the antitragus is marked with a depression, the anterior and posterior margins of which are respectively the ridge running upwards from the antitragus and the adjoining postero-inferior edge of the pinna. The supratragus, forming the upper boundary of the capsule of

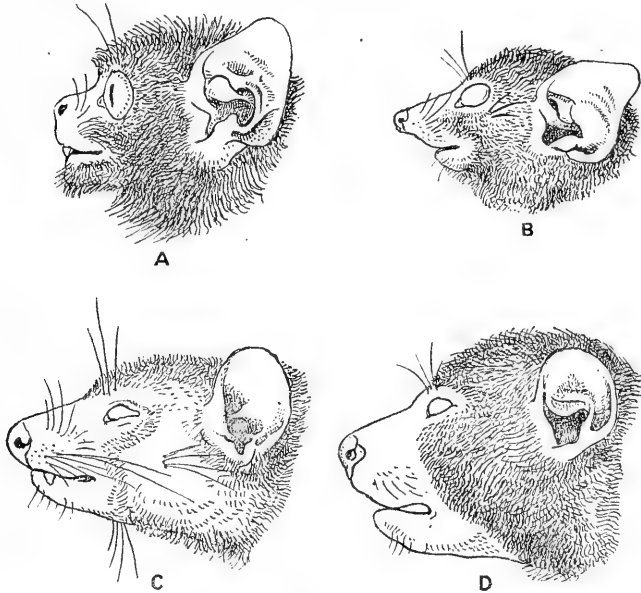
\* H. Cuming, P. Z. S. 1838, p. 67. Mr. Cuming also makes the interesting remark that when any object is put near a *Tarsius*, the animal "draws up the muscles of the face similar to a Monkey and show its . . . teeth." I have never seen Lemurs behave in this way.

† Described in several types by Mivart and Murie, Tr. Zool. Soc. 1872.

the pinna, is set comparatively high up, approximately halfway between the tragal notch and the upper edge of the pinna.

In *Chirogaleus* (text-fig. 2, C) the ear is similar to that of *Lemur*, but the ear of *Microcebus* is provided with a much larger pinna which, judging from a living example, is ribbed above the capsule and capable of being folded as in the Galagos. In the latter, as is well known, the pinna is of great size. The portion of it just above the capsule is ribbed and grooved and susceptible of folding. The supratragus is more expanded and more flap-like

Text-figure 2.



- A. Head of *Tarsius*.  
 B. Head of *Hemigalago demidoffi*.  
 C. Head of *Chirogaleus major*.  
 D. Head of *Perodicticus*.

Figures drawn from spirit specimens. All  $\times \frac{2}{3}$ .

than in *Lemur* and the pouch, probably the homologue of the *bursa* of the ear of the Carnivora, is set higher up than in the Lemurs. *Nycticebus* and *Perodicticus* have the pinna no larger relatively than in *Lemur*, and it is simplified by the almost total suppression of the tragal and antitragal thickenings; but, as in *Galago*, the pouch is set high up and the supratragus is flap-like and valvular (text-fig. 2, D). As Mivart and Murie pointed out, there is a small fold of the integument above the supratragus in *Nycticebus*, and a similar but better developed fold is developed

in *Arctocebus*. Huxley cites the presence of this fold as one of the features distinguishing this genus from *Perodicticus*.

Although the ear of *Chiromys* is relatively as large as in the Galagos, it is not ribbed and grooved above the capsule. The supratragus is a thickened ridge as in *Lemur*; but the tragus is not an angular projection as in that genus but a simple ridge, and the notch between it and the well-developed antitragus is comparatively deep and wide. Its lower rim, however, does not extend downwards so low as the external auditory meatus, the portion of the pinna just beyond this meatus being elevated as in Carnivora, Ruminants, and many other Mammals.

The ear of *Tarsius* is similar in all essential details to that of the Galagos, except that the supratragus and the antitragus are somewhat larger and more valvular (text-fig. 2, A).

The simplest type of ear in this group, and I suspect the most primitive, is that of *Lemur* and *Chirogaleus*, ears with a greatly expanded and ribbed pinna and valvular supratragus being derivative and specialised structures. According to this view the ear of *Tarsius* is the least primitive of all. It is gradationally linked with the ear of *Chirogaleus* by the ears of *Galago* and *Microcebus*.

#### *The Facial and Carpal Vibrissæ.*

In the development of the facial vibrissæ\* the most generalised type I have examined is *Chirogaleus major*, where the mystacial, superciliary, genal, and interramal tufts are all well developed (text-fig. 2, C). There is a single genal tuft on each side set low down behind the corner of the mouth. Most of the species referred to *Lemur* resemble *Chirogaleus* except that the interramal tuft is absent; but in *L. variegatus* it is usually, if not always, retained, although of small size. The full complement of tufts is present in *Chiromys*, but the vibrissæ composing them are generally shorter than in the typical Lemurs, and in two cases the interramal tuft was reduced to a single vibrissa.

In the Galagos (*Galago crassicaudatus*, *G. senegalensis*, and *Hemigalago demidoffi*) the vibrissæ are poorly developed as compared with those of the typical Mascarene Lemurs, more particularly *Chirogaleus major*, with which the Galagos were at one time associated. The interramal tuft appears to be invariably absent, and the genal tuft is set high up on the cheek a little below and behind the posterior angle of the eye (text-fig. 2, B). It resembles in position the upper genal tuft of the typical Carnivora, whereas in *Chirogaleus* and *Lemur* the genal tuft resembles in position the lower of the two tufts in that order. In *Nycticebus* and *Perodicticus* the vibrissæ are even less well developed than in the Galagos, the genal tuft being suppressed in the specimens examined (text-fig. 2, D). The genal and interramal tufts are also absent apparently in *Tarsius*, although

\* P. Z. S. 1914, pp. 889-912.

Burmeister figures some vibrissæ in front of the ear. These do not, however, correspond in position to the genal tuft of the Galagos (text-fig. 2, A).

The prevalence in most orders of Mammalia of the complement of tufts described above as occurring in *Chirogaleus* suggests that the absence of one or more of the tufts is a derivative and not a primitive feature. In this respect the Lorises, Pottos, and *Tarsius* are more specialised than the Mascarene Lemurs.

The Carpal vibrissæ in Lemurs have been studied by Beddard and Bland-Sutton. Confirming and extending their observations, I may add that I have found these tufts of tactile bristles in *Chirogaleus major*, *Hapalemur griseus*, and in examples of the following species of *Lemur*, namely, *catta*, *variegatus*, *macaco*, *mongoz*, *coronatus*, *rufiventer*, *albifrons*, and many of the species, subspecies or varieties grouped round the last. They are not always easy to detect in the thick fur, and sometimes appear to be wanting; but in such cases I suspect their absence is due to moulting or to artificial removal by rubbing. I have not found them in *Chiromys*, *Nycticebus*, *Perodicticus*, or *Tarsius*; and, since Bland-Sutton also noticed their absence in *Perodicticus*, it may be inferred that their absence is characteristic of the Asiatic and African lemuroids\*.

The prevalence of these vibrissæ in many orders of Mammals suggests that they are a primitive Metatherian and Eutherian character, a suggestion which involves the conclusion that their absence in the above-mentioned Lemuroid genera is due to suppression and is a derivative feature.

#### *The Glands of the Fore Limb.*

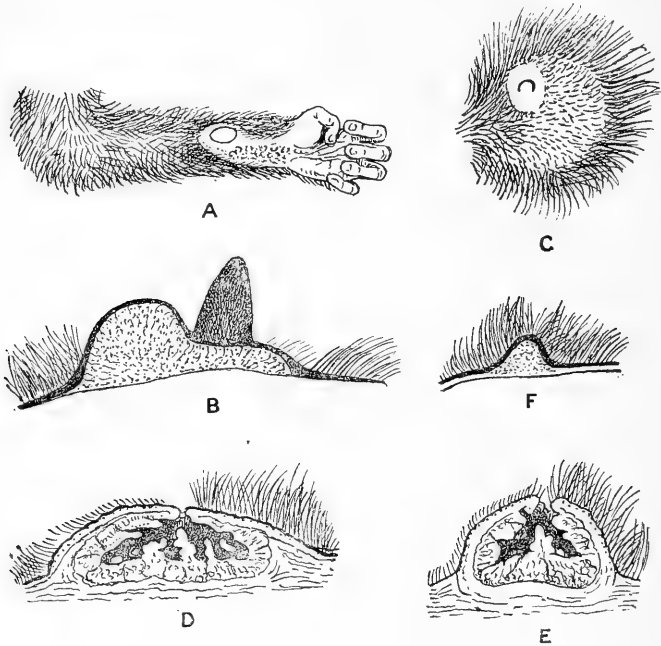
In *Lemur catta*, but in no other species referred to the genus *Lemur*, there is a peculiar gland on the fore-leg, which was figured and described by Bland-Sutton† and also figured by Milne-Edwards and Grandidier. A strip of black naked skin extends from the palm of the hand over the wrist up the distal third of the corresponding surface of the fore-leg. It ends proximally in a smooth elliptical area, which is present even in the newly-born young (text-fig. 3, A). In adult males the elliptical area is raised into a swollen cushion-like pad composed of white tissue, fatty in appearance and consistency and covered with black skin. On the ulnar side of the pad a large, erect, solid horny excrescence is developed (text-fig. 3, B). This varies in size apparently with age; its apex is sometimes bifid, but generally simple, and it is sometimes present on one limb and

\* I have failed to detect the carpal vibrissæ on dried skins of *Indris* and *Propithecus*; and in both these genera the interramial tuft appears to be absent. Also in the one skin of *Indris* available for examination the genal tufts are wanting, whereas in a skin of *Propithecus diadema* these tufts are well developed and set low down on the cheek as in Lemuridae.

† Proc. Zool. Soc. 1887, pp. 369-372. In 1863 Gray pointed out the presence of this structure in *L. catta* and its absence in other species.

absent on the other. In females the excrescence is generally absent or quite small. Only in rare cases of probably aged individuals is it comparable in size to that of the males; and the elliptical area is generally flat in the females.

Text-figure 3.



- A. Fore-arm of *Lemur catta*, newly born, showing the extension of the naked skin from the palm of the hand and the elliptical glandular area above the wrist.
- B. Section through the glandular area and the horny spur of the fore-arm of an adult male *Lemur catta*.
- C. Superficial view of the shoulder-gland of an adult male *Lemur catta*.
- D. Vertical longitudinal section through the same.
- E. Vertical transverse section through the same.
- F. Section through the shoulder-gland of adult female *Lemur catta*.

According to Bland-Sutton the ducts of numerous sweat-glands open upon the surface of the skin of the elliptical area. Secretion, no doubt, exudes through the pores; but I have never succeeded in squeezing any visible secretion to the surface by pressure.

The only use I have seen the Lemur make of this structure is to apply it to the tail by drawing simultaneously the applied wrists along that organ from near the base to the point. Possibly by this means the secretion is wiped on the long hairs.

to scent them. But so far as my observations go, this action is restricted to the male when stimulated to anger at the time of rut.

Also in *Lemur catta*, but in no other species referred to the genus, there is a large gland in the male on the inner side of the upper arm near the top of the biceps muscle just below the shoulder (text-fig. 3, C). It is a circular or elliptical mound-like elevation covered with short hair, except in the centre of the summit where there is a small naked area carrying the orifice of the gland which is usually shaped like a strongly curved crescent. In section the gland is seen to be composed of a thick-walled sac, the cavity of which is subdivided by ridges and outgrowths of the walls, making, in a sense, a multilocular gland. It is the partial blocking of the rounded orifice of the gland by one of these outgrowths that gives the orifice its crescentic shape. The cavity of the gland is filled with strong-smelling brown sticky secretion which under pressure can be squeezed, like a worm, from the orifice (text-fig. 3, D, E).

In the female this gland is not always developed, and when present it consists of a small elevation covered with normally long hair and having no cavity or trace of orifice (text-fig. 3, F).

The suggestion that these glands are modified mammary glands is, I think, erroneous. At all events they coexist with the normal pectoral mammary glands.

It is interesting to recall that *Hapalemur* also has a similar gland on the shoulder and a somewhat similar gland above the wrist. I have, however, seen these only on dried skins, and have nothing to add to the descriptions published by Beddard \* and Bland-Sutton †.

But there are two points worth attention arising out of the facts just mentioned. Despite the development of these glands in *Lemur catta* and *Hapalemur griseus*, and in no other species, these two Lemurs do not appear to be nearly related. Judging from cranial and dental characters, the relationship of *Hapalemur griseus* is with *Prolemur simus*, and of *Lemur catta* with the other species usually assigned to the genus *Lemur*.

The second point is the coexistence in two otherwise dissimilar genera of two sets of glands, one below the shoulder, the other above the wrist. This raises the very important question of possible correlation in development between two or more structures, a question which opens a very wide field for research in zoology.

#### *The Hands and Feet.*

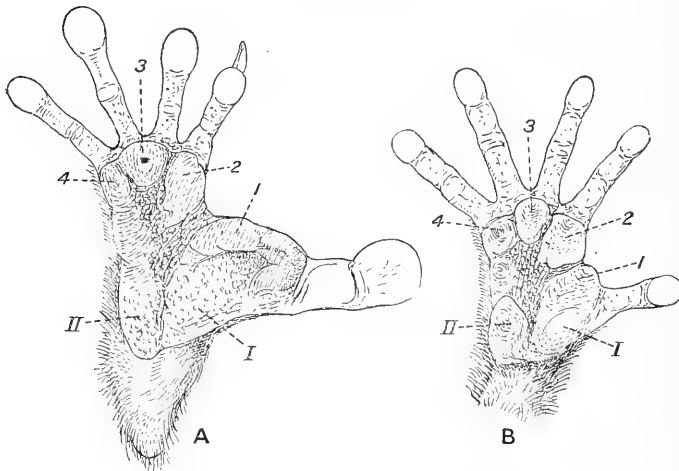
In the species of *Lemur* the digits of the hand are longish and slender, and free from webbing to approximately the same extent as in Man. The pollex is the shortest of the series and is separated by a wide space from the second, the base of which it

\* Proc. Zool. Soc. 1884, p. 393; and 1891, p. 450.

† Proc. Zool. Soc. 1887, p. 369.

slightly overlaps when laid forwards. It can be extended at right angles to the long axis of the palm, but is not truly opposable since the large composite palmar pad—the “ball” of the thumb—at its base is almost stationary. The succession of the digits in length is 4, 3, 5, 2, but the fourth only exceeds the third slightly, and the second and fifth are approximately equal. The palm is longish, longer than wide, and passes proximally beyond the base of the pollex. Of the four interdigital pads, the first or pollical is confluent with the inner proximal (thenar), constituting the “ball” of the thumb. The remaining three interdigitals form a transverse trilobed cushion-like pad. Behind the fourth or external interdigital, the external portion of the palm is occupied

Text-figure 4.

A. Foot and B. Hand of *Lemur macaco*;  $\times \frac{2}{3}$ .

1, 2, 3, 4, the intermediate pads; I, II, the proximal pads.

by the elongated external proximal (hypothenar) pad, which is subdivided, the posterior expanded portion lying alongside the posterior portion of the “ball” of the pollex, from which it is separated by a groove (text-fig. 4, B).

In its main features the hand only varies in minor particulars in the different species examined, namely, *L. catta*, *macaco*, *albifrons*, *mongoz*, *variegatus*, and *coronatus*, except that in *L. variegatus* the palm is a little wider as compared with its length.

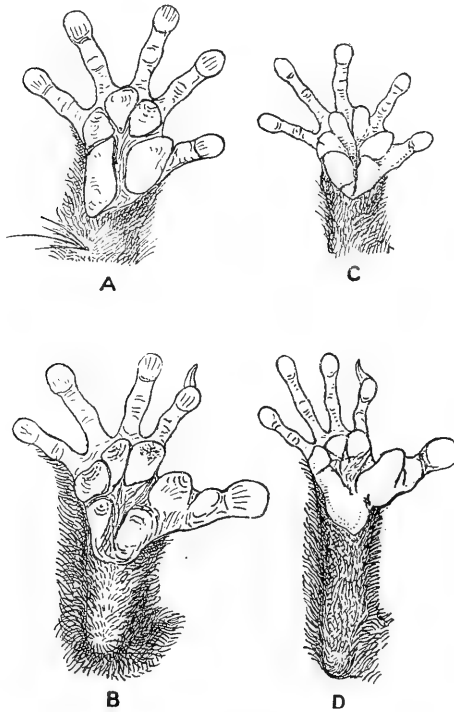
In the foot the hallux is of great length and thickness, is capable of being extended at right angles to the sole, and is opposable, the “ball” of the hallux, consisting mainly of the large, projecting first or hallucal interdigital pad, being movable



and capable of being pressed against the second interdigital pad and the elongated external proximal pad, closing up the depression in the middle of the lower surface of the foot. For the rest, the digits and the pads of the foot resemble in a general way those of the hand (text-fig. 4, A).

A point to notice is that in *Lemur catta* the naked sole is extended proximally to the tip of the calcaneum or heel. In the other species the heel is covered with hair, the hairy area being about one-third the length of the naked area, or a little more.

Text-figure 5.



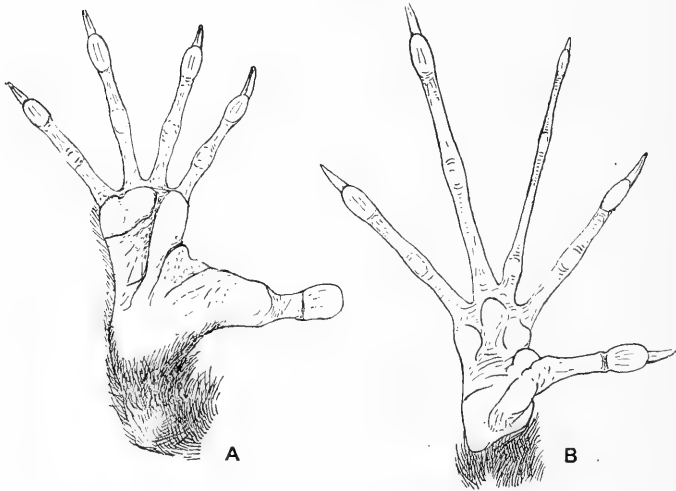
A. Hand and B. Foot of *Chirogaleus major*; nat. size.‡  
 C. Hand and D. Foot of *Galago senegalensis*; nat. size.

In *Chirogaleus major* the hands and feet are substantially similar to those of *Lemur*, but the naked palmar and plantar surfaces are broader as compared with their length, and the individual pads are more sharply differentiated, and, judging by their papillary ridges, endowed with greater tactile sensibility. In the foot the hairy area of the heel is relatively longer, being

about two-thirds the length of the naked portion. In the specimen examined the third and fourth digits were approximately equal both on the hands and feet (text-fig. 5, A, B).

The hands and feet of the Indrisidae, as figured and described by Milne-Edwards and Grandidier, show some interesting peculiarities suggesting more complete adaptation to arboreal life than in the Lemuridae. In *Propithecus* the digits of the hand are hardly more webbed than in *Lemur*, but the palm is narrower, especially posteriorly, where the pollex arises. The pads appear to be very little differentiated, and the absence of the "ball" of the thumb indicates a feeble grip for that digit. In *Lichanotus* (*Avahis*) the ball of the thumb is better developed, but the palm of the hand is apparently longer than in *Propithecus*, the second

Text-figure 6.



A. Foot and B. Hand of *Chiromys*;  $\times \frac{2}{3}$ .

digit, which is very short, being widely separated from the pollex. The third, fourth, and fifth are long and united by narrow webbing approximately to the ends of the first phalanges. In *Indris* also the hand is long and slender, with a wide space between the long weak pollex and the second digit. The latter, however, is not so short as in *Lichanotus*, and is united to the third, as the third is to the fourth and the fourth to the fifth, by integument permitting but slight divarication of these digits and increasing in appearance the elongation of the palm.

In the feet there is less variation. The hallux is normally elongated, but is slender from base to apex without the muscular development seen in other Lemuroidea, and the digits are webbed

approximately to the distal ends of the first phalanges. In *Indris* the interdigital webbing is somewhat deeper than in the others and extends to an equal distance along all the digits, but in *Propithecus* and *Lichanotus* it is deeper between the third and fourth than between the second and third and the fourth and fifth.

Some of the peculiarities of the hand of *Chiromys*, such as the presence of claws and the modification of the third digit, are well known (text-fig. 6, B). The palm is narrower than in the true Lemurs. The pollex is not truly opposable, but it is so long that when turned forwards it overlaps the palm, as in Man. All the other digits are long, even the second and fifth, which are subequal, exceeding the length of the palm. The third is very long and slender; the metacarpal that supports it projects beyond the palm, a unique modification which confers exceptional mobility on the digit. Nevertheless this digit is shorter than the fourth, which is nearly twice as long as the palm. Although a shallow web joins these two digits at the base, the hand may be described as unwebbed. In correlation with the grasping capacity of the large claws, the digital pads are comparatively slightly expanded.

The feet are less modified than the hands and conform to those of the Lemur-type, except that the digits are thinner, the hallux is a little shorter and weaker, the second, third, fourth, and fifth are a little longer and armed with claws correlated with narrower pads. The heel is covered with hair as in all Lemurs except *L. catta* (text-fig. 6, A).

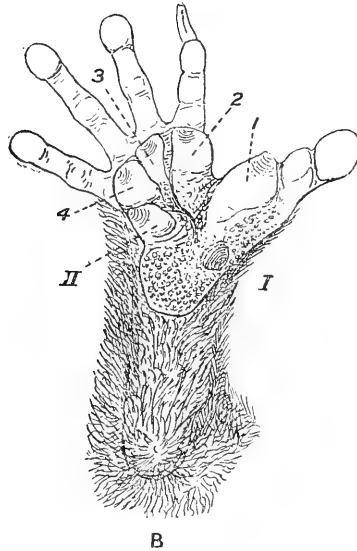
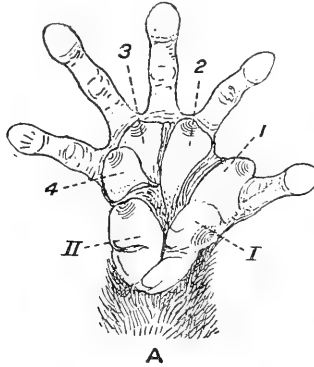
In this genus the unique elongation of the metacarpal of the third digit of the hand and the slenderness of the digit are adaptations to feeding.

In *Galago* of the *crassicaudatus* and *senegalensis* types the hand is wider than in *Chirogaleus* and its pads still better differentiated and more prominent, especially the first, or pollical, intermediate. All the normal six pads are distinguishable. The internal proximal is a small pad situated near the base of the outer border of the thumb, and the external proximal is a rounded pad in contact with the internal intermediate and not extending backwards to the wrist as in *Chirogaleus* and the true Lemurs. A wide space separates it from the internal proximal, which is also set nearer the wrist. Similar differences obtain in the feet, where all the six pads are clearly defined. In *G. crassicaudatus*, *monteiri* and their allies the posterior part of the naked portion of the foot, as Beddard pointed out, is covered with coarse close-set papillae, and the hairy area of the heel is longer than in *Chirogaleus major*, being about as long as the naked portion. In *G. senegalensis* it is considerably longer (text-figs. 5, C, D; 7, A, B).

In *Hemigalago* the pads show some interesting differences from those of *Galago*. In the hand the six pads are even more sharply defined, and are arranged so as almost to encircle a large naked submedian area of wrinkled skin. The two proximal pads

are almost in contact in the middle line, the external being elongated and extending practically from the wrist up to the internal intermediate. Behind the two proximal pads there is a short

Text-figure 7.

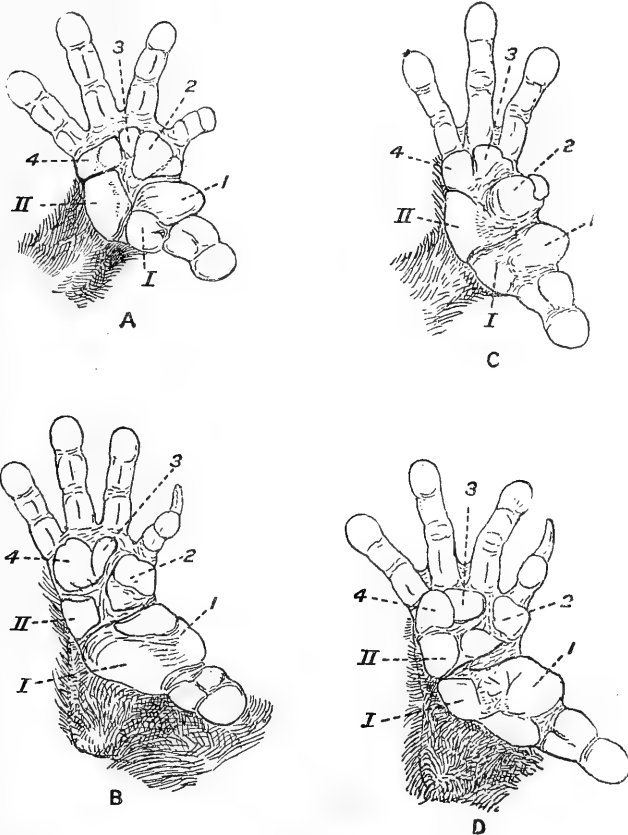


A. Hand and B. Foot of *Galago crassicaudatus*.  
1-4, the intermediate pads; I, II, the proximal pads.

area of naked wrinkled skin. The pollex is longer and more prehensile than in *Galago*. The arrangement of pads on the foot is similar, but the two proximal pads are relatively much smaller than in the hand, and the internal is set farther from the

hallucal intermediate and is widely separated from the external. In this genus there is no definite heel-like area behind the pads as in *Galago*, the skin round the proximal pads being merely soft and creased. The hairy area of the foot back to the tip of the calcaneum is nearly twice as long as the naked area (text-fig. 9, A, B).

Text-figure 8.



A. Hand and B. Foot of *Nycticebus*;  $\times \frac{2}{3}$ .

C. Hand and D. Foot of *Perodicticus*;  $\times \frac{2}{3}$ .

1-4, the intermediate pads; I, II, the proximal pads.

The arrangement and distribution of the pads give a primitive stamp to the hands and feet of *Hemigalago* in the sense that they recall very forcibly the pad-development seen in the extremities of many Rodents, Insectivores, and Marsupials.

The hand of *Nycticebus* and *Perodicticus* differs in some

remarkable particulars from that of the other genera hitherto noticed. It is capable of being turned at right angles to the axis of the forearm. The palm is short and broad, and the powerful pollex can be set so far backwards that its long axis is practically in the same line as that of the palm and of the fourth and longest digit, thus giving the widest possible span to the extremity, and when the pollex is in this position the internal proximal pad, constituting the proximal portion of the "ball" of the thumb, lies nearly in a line behind the external proximal pad. The pollex, moreover, is incomparably more strongly opposable than in any other genus of Lemuroid Primates, and surpasses even the thumb of Man in that respect. When brought into opposition, the composite ball of the thumb is pressed against the second intermediate pad and the external proximal pad. Except that the hallux is a little longer and stronger than the pollex, the feet conform to the hands in type. In all other genera of Primates the two extremities are dissimilar.

As is well known, the second digit of the hand in *Nycticebus* is dwarfed and in *Perodicticus* is represented by an excrescence upon the second intermediate pad. For the rest the hand of *Perodicticus* is narrower with reference to its span, and the third and fifth digits are tied basally by a shallow web to the fourth, so that the three cannot be so widely separated as in *Nycticebus*. In the feet of both genera the heel is hairy and shorter than the naked part of the sole, the second digit is dwarfed, and the third and fifth are basally webbed to the fourth in *Perodicticus*, free in *Nycticebus*. The nails on both extremities are larger in the former than in the latter genus (text-fig. 8, A, B, C, D).

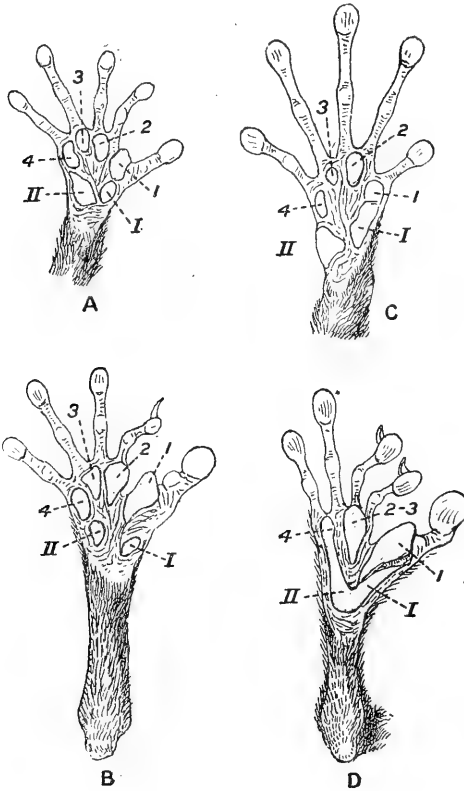
The published descriptions of the extremities of *Arctocebus* suggest that they differ from those of *Perodicticus* in having the third, fourth, and fifth digits more completely webbed (see P. Z. S. 1864, pp. 316-317, 319-320). Huxley, however, states that the calcaneal tuberosity of the foot is naked and separated from the padded portion by a narrow band of hair. But since the heel is without exception covered with hair in all the remaining species of arboreal\* lemuroid Primates, I suspect that the nakedness mentioned by Huxley was due to artificial rubbing in the specimen he examined. It is not uncommon for the hair to be worn off the heels in captive examples of common lemurs (*L. albifrons*, etc.).

In the distinctness and separation of the pads and their encircling arrangement round a central palmar area, the hand of *Tarsius* recalls that of *Hemigalago*; but there are certain differences. The hand and fingers of *Tarsius* are relatively longer, the pollex is smaller, closer to the second digit and not opposable, the third digit is the longest of the series, slightly surpassing the second and fourth, which are subequal. The first, or pollical,

\* *Lemur catta*, which has the heels naked along the middle line, lives in rocky hills.

intermediate pad is small and rounded, smaller than and in contact with the internal proximal, which is elongated and surpasses the external proximal in length. The second intermediate pad is markedly larger than the others of that series. Finally, the nails are sharply pointed, compressed and convex from base to tip, simulating claws, nearly the distal half being free from the pad though normally resting upon it (text-fig. 9, C).

Text-figure 9.

A. Hand and B. Foot of *Hemigalago demidoffi*; nat. size.C. Hand and D. Foot of *Tarsius*; nat. size.

1-4, intermediate pads; I-II, proximal pads.

In the feet the hairy area back to the heel is shorter than in *Hemigalago*, and the naked padded area and digits longer. The plantar pads are peculiar. The hallucal, or first, intermediate is large and prominent, and is fused to the internal proximal to

form a single long pad which sometimes fuses proximally in the middle line with the external proximal, which is itself united to the external intermediate, forming a long pad extending along the outer edge of the sole of the foot. The second and third intermediates are united to form a single large elongated pad, broad distally, narrowed proximally, where it terminates in the middle of the membranous area of the sole. Of digits two to five the fourth is the longest as in Lemuroid Primates; but the third has an erect claw like the second—a characteristic not found in any Lemuroids, but probably primitive and forcibly recalling the corresponding “syndactyle” digits of many Marsupials (text-figure 9, D).

#### *The Sublingua.*

There are one or two points to be recorded in connection with the *sublingua*, an organ which is especially well developed in the Lemuroid Primates. Typically it is a thin flat fibrous plate, lyrate or leaf-like in form with free apex and free lateral margins. It covers a considerable area of the lower surface of the tongue, the frenum of which arises from an angular notch in the middle of its posterior border. The pointed or truncated apex is serrated or denticulated to a varying extent, and the underside is strengthened by a fine median longitudinal ridge, with frequently a smaller ridge close to it on each side, making three in all.

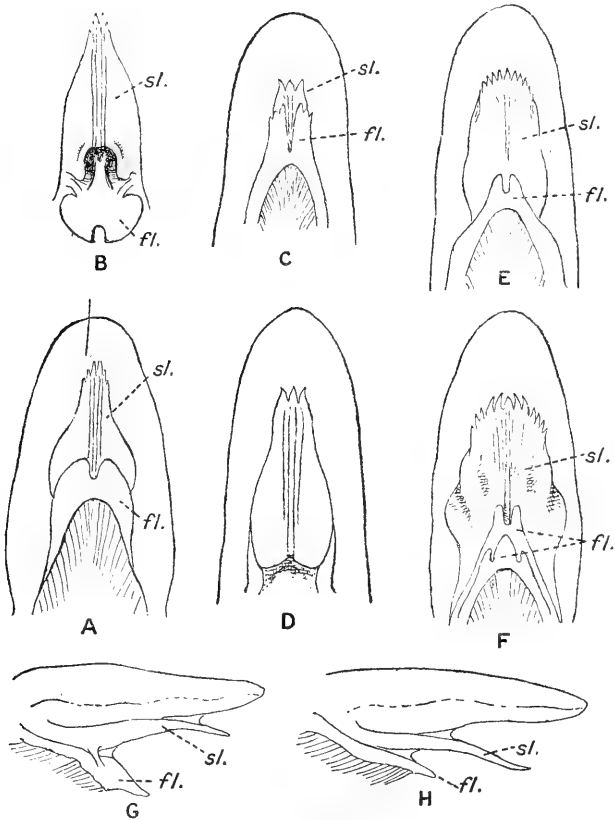
Beneath the sublingua the floor of the mouth is provided in front with a pair of small soft flaps, the *frenal lamellæ*, arising at the bottom of the lingual frenum and continued backwards to a varying extent as a free narrow edge towards the base of the tongue. A similar and homologous structure is present in some other Mammals—e. g., *Canis*, *Pteropus*, where, as in the Primates, it overlies the orifices of the sublingual and submaxillary salivary glands.

In the species usually referred to *Lemur* the sublingua exhibits certain structural differences, which examination of a larger number of individuals than I have seen may show to have systematic value. For instance, in *L. variegatus* there are three comparatively strong denticles at the tip and three correspondingly strong keels below. In other species the tip is rather serrulate and the keels weaker. On the other hand, I have noticed differences in the shape of the sublingua within specific limits. In a male of *L. coronatus*, for example, it was lyrate with bulging postero-lateral margins; in a female it was evenly attenuated, the two margins gradually converging from near the base to the tip. In the male again the frenal lamellæ formed together a broad semicircular flap; in the female they were narrower, forming a nearly parallel-sided flap. In a male specimen of *L. albifrons albifrons* and in a female of *L. a. nigrifrons* the frenal lamellæ were of the same shape as in the male *L. coronatus*; but in examples of *L. variegatus*, *macaco*, *catta*, and *mongoz* the lamellæ were narrow and resembled more or less closely those



of the female *L. coronatus* mentioned above (text-fig. 10, A-D, G). In *Chirogaleus major* the narrowed sublingua is apically serrulate and the frenal lamellæ are narrow as in most Lemurs. The sublingua of *Hapalemur* was briefly described by Beddard.

Text-figure 10.



- A. Lower side of tongue of *Lemur coronatus*.
- B. Sublingua of another specimen of the same species raised from the frenal lamellæ.
- C. Lower side of distal end of tongue of *Lemur variegatus* with the tip of the sublingua showing beyond the frenal lamellæ.
- D. Lower side of tongue of the same without the frenal lamellæ.
- E. Lower side of tongue of *Galago crassicaudatus*.
- F. The same of *Nycticebus* with supplementary frenal lamellæ.
- G. Side view of tongue of *Lemur coronatus*.
- H. The same of *Galago crassicaudatus*.

*sl.*, sublingua; *fl.*, frenal lamellæ.

The sublingua is also present, as Milne-Edwards and Grandidier have shown, in the Indrisidæ.\* It has a single median inferior crest and three apical denticles. In *Propithecus* it hardly differs in form from that of the Lemuridæ, being broad at the base posteriorly, nearly parallel-sided, and attenuated at the apex. In *Indris* its lateral edges are rather strongly convex, the base being narrowed like the apex. In *Lichanotus* it is very short, its free lateral edge being apparently only about half as long relatively as in *Propithecus* and *Indris*.

In *Galago*, *Nycticebus*, and *Perodicticus* the sublingua is broader than in the Lemuridæ, especially at the apex, which is almost truncated and armed with many denticles—*i. e.* 9 in a *Galago monteiri*—and its attachment to the tongue in the middle line is set farther back so that a greater extent of its apex is free. I also noticed 9 denticles at the tip in a specimen of *Perodicticus ibeanus*. But in both *Perodicticus* and *Galago* these denticles form a continuous series, whereas in an example of *Nycticebus*, with 7 denticles, the outer on each side was larger than the rest and separated from them (text-fig. 10, E, F, H).

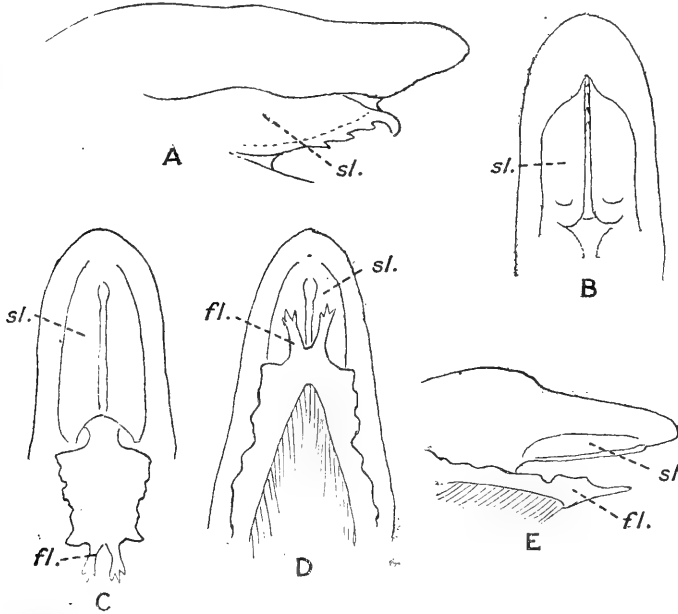
In *Chironomys* the sublingua is of a different type. It has a free lateral margin, but towards its abruptly attenuated tip it is closely adherent to the tongue. It is not denticulated, but ends in front in a firm, deflected hook which is the anterior termination of a thick median keel or ridge, itself carrying two or three teeth, and traversing the whole of the underside of the sublingua back to the upper end of the lingual frenum. Just in front of the point there is on each side of the sublingua a small, probably glandular pouch, like a watch-pocket, with its orifice looking forwards. The frenal lamellæ are present and narrow; but I could not be sure of their exact form. In the example of this genus I examined the sublingua is less cordate and the tongue less rounded than depicted by Owen, who, moreover, did not mention the small teeth on the carina or the pocket-like glands near the base of the sublingua (text-fig. 11, A, B).

The sublingua of *Tarsius*, described and figured by Burmeister, is different from that of Lemurs. It is not so well developed, is softer in consistency, and is defined from the tongue laterally by a groove. In the middle it is provided with a rod-like thickening which has a knob-like expansion at the apex. This rod, corresponding to the median carina of the sublingua seen in *Chironomys* and other Lemurs, was compared to the lytta of the tongue of *Canis* by Burmeister. But the bifurcation of this rod and some other structures at the tip of the sublingua described by that author I was unable to detect in the single example of the tongue of *Tarsius* I examined. In this specimen the frenal lamellæ consist of a pair of longish slender processes, each tipped with a few small projections. At the proximal end of these processes on the outer side the edge expands abruptly to form a flap with a lobulate margin which extends far backwards along the sides of the tongue. Burmeister described the frenal lamellæ as the

“Unterzunge.” His figure represents this structure as an undivided semielliptical lamina with evenly denticulated margin. This does not agree with my observations (text-fig. 11, C-E).

It has been suggested that the sublingua of the Lemurs acts as a tooth-brush to clean the porrect, close-set, and comb-like series of anterior mandibular teeth. Lemurs certainly use these teeth to comb their own fur and that of their companions. I have never seen them employ these teeth for any other purpose, and

Text-figure 11.



- A. Side view of the tongue of *Chironomys*.  
 B. Lower view of the same.  
 C. Lower view of the tongue of *Tarsius* raised from the floor of the mouth.  
 D. The same extracted with the frenal lamellæ and the fringe attached.  
 E. Side view of the tongue of *Tarsius*, showing the comparatively slight differentiation of the sublingua and the well-developed frenal lamellæ with backwardly extending lobulated fringe.

since there is frequently a rapid movement of the tongue after the combing action, I do not doubt that the suggestion as to the function of the sublingua is correct; and the suggestion is strengthened by the structure of the sublingua in *Chironomys*, where the median keel ends in a firm hook well adapted to all appearance for removing particles lodged between the two rodent incisor teeth of the lower jaw.

In connection with the fur-combing use of the pectiniform mandibular teeth in the true Lemurs, it must be remembered that the spatulate finger-tips and short nails of these animals deprive the digits of the scratching power they possess in ordinary mammals with narrow finger-tips and comparatively long claws or nails. Only one digit in the Lemurs is functional as a scratcher, namely, the second of the hind-foot, which is short with small terminal pad and long semi-erect claw. Thus is established a most interesting correlation of characters in the Lemurs:—namely, the uselessness of the fingers for scratching the fur, the modification of the anterior mandibular teeth to subserve that end, and the differentiation of the sublingua to keep these teeth clean from scurf and hair. Now in *Tarsius* the lower mandibular teeth are not modified to form a comb. Possibly they are employed for cleaning the coat, but their structure makes them less liable to be clogged, and at the same time less efficient instruments for the purpose than the corresponding teeth of the typical Lemurs. Possibly, perhaps probably, for these reasons, the sublingua is less differentiated and two of the digits of the hind-foot, the second and third, are set apart as scratchers and are capable of acting in unison, almost like the corresponding united digits of the syndactylous Marsupials.

The sublingua of *Chiromys* probably serves mainly the purpose of keeping the gnawing-teeth free from woody fibre; and, for anything I know to the contrary, it may also cleanse them of hair and scurf. But I am not aware whether these teeth are used as a comb or not. At all events, in the case of this genus it is interesting to note that the absence of the typical lemurine dental comb is accompanied by well-developed claws and by fur of a very different texture from that of ordinary Lemurs, since it consists of a light underwool covered by long coarse hairs. Possibly the usefulness of the claws in combing this fur has been one of the principal guiding factors in their evolution from nails.

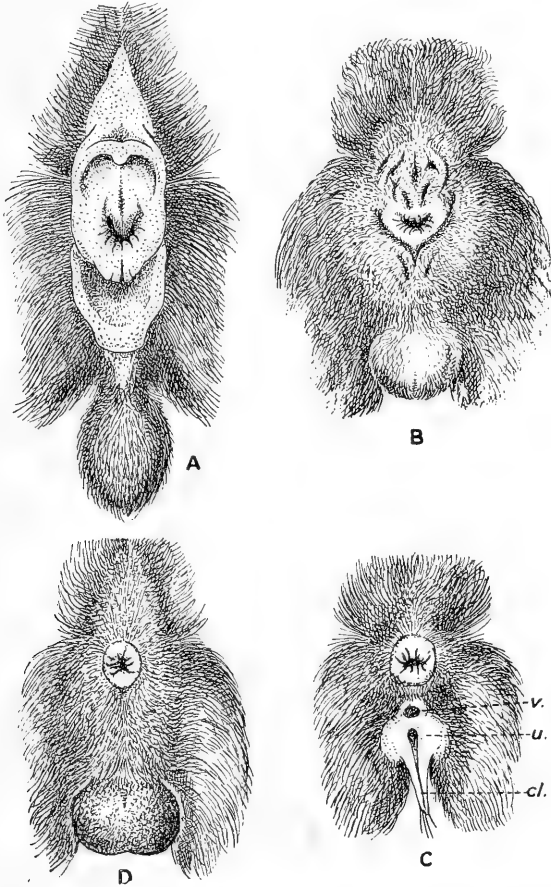
#### *The Anus and its Glands.*

In all the Lemuroids examined, with one exception, the anus is situated in the normal position below the joint of the tail so that the base of that organ, when depressed, closes over it. But in *Chirogaleus major* it is placed below, or on the distal side of the joint of the tail, so that when that organ is raised the anus is carried up on its base (text-fig. 16, A).

Normally in this group, that is to say in *Nycticebus*, *Perodicticus*, *Galago*, *Chiromys*, the Indrisidæ apparently, and in *Lemur catta*, *variegatus*, and *coronatus*, the perineal and circumanal areas are covered with hair; but in *L. macaco*, *L. albifrons*, and the various forms such as *nigrifrons*, *rufus*, *fulvus*, *cinereiceps*, associated with *albifrons*, these regions are covered in both sexes with nearly naked, folded, wrinkled, and glandular skin, and similar naked skin extends for an inch or so along the root of

the tail (text-figs. 12, A ; 15, E). In other species referred to this genus, i. e. *L. mongoz* and *L. rubriventer*, the glandular area is much less differentiated, the skin being more closely covered with fine, short hair and less distinctly folded and wrinkled.

Text-figure 12.



- A. Anal and genital area of male *Lemur albifrons*, showing the nearly naked glandular skin stretching from the root of the tail to the scrotum.
- B. The same of *Lemur mongoz*, showing the hairy but partially wrinkled skin round the anus.
- C. The same of female *Lemur mongoz*, showing the absence of wrinkled skin round the anus, the long grooved clitoris (*cl.*), and the orifice of the urethra (*u.*) below that of the vagina (*v.*).
- D. The same of male *Lemur catta*, showing the hairy unwrinkled skin round the anus and the naked scrotum.

The only example of *L. rubriventer* examined, namely a female, had the skin of the circumanal area distinctly but not strongly wrinkled. On the other hand, some females of *L. mongoz* show no sign of wrinkling, others show traces of it, and in some males the wrinkling is rather strongly pronounced. A complete gradation therefore in the development of the glandular area can be traced from *L. coronatus* through *L. mongoz* to *L. macaco* and *L. albifrons* (text-fig. 12, A-C).

The paired anal glands, so well known in some orders of Mammals, *e. g.* the Rodentia and Carnivora, appear to be absent in almost all Lemurs. The only genus in which I have found a trace of them is *Chiromys*, where they are represented by a pair of small, shallow invaginations, one on each side of the anal orifice.

### *The External Genitalia of the Male.*

According to Milne-Edwards and Grandidier each of the three genera of Indrididæ may be characterised by the structure of the penis and baculum. The penis appears to be short, subcylindrical, and apically truncated, and the baculum is distally biramous in all cases.

In *Lichanotus* the epithelium is striated, and there are on each side of the organ near the middle of its length two strong recurved spines set one above the other. The baculum is greatly expanded at its proximal end and gradually narrows from the thickening to the middle of its length. From that point the two sides diverge gradually to the apices of the two branches, which themselves diverge evenly at about an angle of sixty degrees, each branch being rather less than one-third of the length of the whole bone.

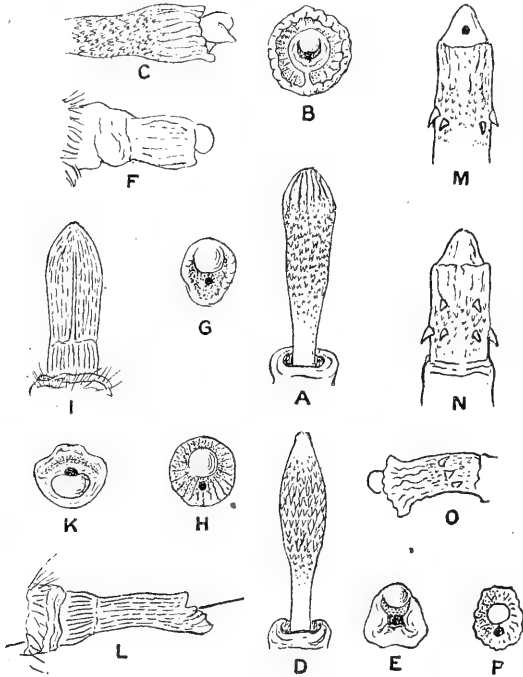
In *Indris* the epithelium of the penis is irregularly reticulated, and on each side of the organ there is a patch of rather small spines set in three irregularly vertical rows which extend also to the underside. The baculum differs from that of *Lichanotus* in being thicker in the middle of its length, without any proximal (or basal) expansion, and in having the two branches much less divergent and a little longer, each slightly exceeding one-third the length of the entire bone (text-fig. 14, C).

In *Propithecus* the epithelium of the penis is grooved and beset with minute spicules. The baculum differs from that of *Indris* in having the branches very long, each being more than half the length of the entire bone, longer, that is to say, than the stalk instead of shorter as in *Indris* and *Lichanotus*.

The penis of *Chirogaleus major* (text-fig. 13, I, K, L) is rather short and broad, nearly parallel-sided, with an ovate extremity giving it a somewhat linguiform appearance from the lower or upper view. It is longitudinally grooved and closely punctured, the punctures possibly marking the position of minute spicules

rubbed off. The orifice of the urethra is situated *above* the pad covering the tip of the baculum, a character in which the penis

Text-figure 13.



- A. Penis of *Galago crassicaudatus* from below with the frill folded over the tip of the glans.  
 B. Tip of the glans of the same with the frill spread.  
 C. End of the penis of the same from the side with the tip protruding from the frill.  
 D. Penis of *Galago senegalensis* from below.  
 E. Tip of the glans of the same showing the absence of the frill.  
 F. Penis of *Nycticebus* from the side.  
 G. Tip of the glans of the same to compare with B and E.  
 H. The same of *Perodicticus*.  
 I. Penis of *Chirogaleus major* from below.  
 K. Tip of penis of the same showing the orifice of the urethra above the tip of the baculum.  
 L. Penis of the same from the side with a probe passed down the urethra.  
 M. End of penis of *Lemur macaco* from below.  
 N. The same from above.  
 O. Penis of *Lemur albifrons* from the side.  
 P. Tip of penis of the same.

differs from that of all the Lemuroid Primates examined by me. Above the orifice there is a transverse glandular depression overlapped by a thick flap of epithelium. A somewhat similar crescentic flap half encircles the bacular pad laterally and below. The baculum (text-fig. 14, A, B) itself is a little longer than that of an adult example of *Lemur albifrons* more than twice the size of *Chirogaleus major*. Seen from the side the baculum shows a slight sinuous curvature, the distal half being depressed. Seen from above or below, the main part of the shaft is straight and subcylindrical, but its apical fourth is divided into two curved branches, a right and left, which diverge at first, then converge so as almost to meet apically in the middle line, circumscribing an ovate space. The urethra, which runs along the underside of the main portion of the baculum, passes through this space at the point of bifurcation of the baculum. Hence it comes about that the orifice of the urethra lies above the pad which covers the juxtaposed tips of the two branches.

In being distally biramous the baculum of *Chirogaleus* resembles that of the Indrisine Lemurs, a point of great interest. It is most like that of *Lichanotus*, but has the base less expanded and the branches curved and convergent apically instead of widely divaricated. According to Beddard *Hapalemur* also has a bifid baculum. I do not know the course of the urethra with regard to the baculum in the Indrisidæ, nor is Beddard quite clear on this point in his description of the penis of *Hapalemur*, but since he states that the urethra opens at the posterior end of a groove marking on the glans penis the forking of the baculum, it may be inferred that the orifice of the urethra is beneath the tip of the baculum as in typical Lemurs and not above it as in *Chirogaleus*.

On one of the plates of his unfinished work Milne-Edwards illustrates the male genitalia of a Lemur which, although unnamed in the legend, is clearly shown to be *L. catta* by the naked scrotum. Four bacula are figured on the same plate. They may have been taken from specimens representing four distinct species or from four examples of *L. catta*. If the latter, the figures attest a certain amount of individual variation in this bone, particularly in width at the base and expansion and curvature at the tip. There the matter must rest.

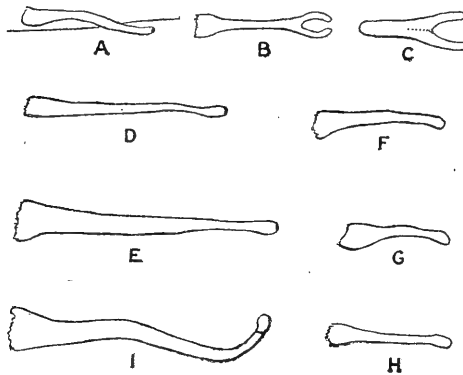
In the species I have examined, namely *L. catta*, *macaco*, *albifrons*, and *coronata*, there is very little variation in the penis and baculum. The penis (text-fig. 13, M-P) is subcylindrical and armed in the middle of its length with many reversed spines which are mostly of small size; two or more pairs, however, on each side are much larger than the others, but these large spikes are not always either symmetrically placed or numerically identical on the two sides. The orifice of the urethra is terminal and opens just beneath the tip of the baculum. The baculum is a comparatively short and slender rod with a larger proximal and



a smaller, sometimes incipiently bilobed distal expansion. As compared with the size of the animals, the baculum in the species referred to *Lemur* is smaller than in any other genus (text-fig. 14, H).

In *Galago senegalensis* the penis is long (text-fig. 13, D, E). Its narrow and cylindrical, proximal portion gradually expands distally to a considerable extent, and its terminal portion is attenuated. The orifice of the urethra, opening beneath and behind the hardened rounded pad covering the tip of the baculum, is provided with a small inferior and two small lateral labia. Except at the distal and proximal ends the epithelium of the penis is thickly beset with comparatively coarse reversed spines

Text-figure 14.



- A. Baculum of *Chirogaleus major* from the side, the line indicating the course of the urethra.  
 B. The same from above showing the apical bifurcation.  
 C. Baculum of *Iudris* from above (copied from Milne-Edwards).  
 D. The same of *Galago senegalensis* from the side.  
 E. The same of *Galago crassicaudatus*.  
 F. The same of *Nycticebus*.  
 G. The same of *Perodicticus*.  
 H. The same of *Lemur albifrons*.  
 I. The same of *Chiromys*.

(All the figures twice nat. size.)

approximately equal in size. The baculum (text-fig. 14, D) is long and slender, being actually nearly twice as long as that of an adult male *Lemur albifrons*. It is practically straight and gradually attenuated from its broad base, but there is a slight sinuosity in its distal third and a slight and gradual thickening at the apex which is blunt.

In *Galago crassicaudatus* and *monteiri* (text-fig. 13, A-C) the penis differs considerably from that of *G. senegalensis*. It is clavate in form, being gradually incrassate from the base to the blunted tip. The orifice is just below the apex of the baculum, and the two are encircled by a frill of grooved, wrinkled epithelium, forming a sort of secondary prepuce, which is attached by a frenum to the lower lip of the orifice and encloses a glandular space. The spines covering the penis are bidentate or tridentate, and much smaller than in *G. senegalensis*. The baculum (text-fig. 14, E), although actually longer than in *G. senegalensis*, is approximately the same shape and relatively about the same size.

In *Nycticebus* the penis (text-fig. 13, F, G) is much shorter than in *Galago* and smooth and of tolerably even thickness throughout. The callous pad at the tip of the baculum is large, rounded and prominent, and overhangs the orifice of the urethra, which lies in a glandular space bounded laterally and below by a pair of labia practically as in *G. senegalensis*. The baculum (text-fig. 14, F) is a nearly straight rod, only about two-thirds the length of that of *G. senegalensis*, although the animal itself is much bigger.

In *Perodicticus* the penis (text-fig. 13, H) is short and smooth and like that of *Nycticebus* except that the tip of the baculum and the orifice of the urethra are surrounded by a complete hood or frill of wrinkled epithelium enclosing a circular glandular space. The baculum (text-fig. 14, G) in the specimen examined is shorter than that of the example of *Nycticebus*, but decidedly thicker at the base inferiorly and with its upper edge a little more sinuous.

According to Huxley's description (P. Z. S. 1864, p. 334) the extremity of the glans penis in *Arctocebus* closely resembles that of *Perodicticus* except that the encircling hood is bifid in the middle line below. He states, however, that the baculum is .75 of an inch in length, about twice as long, that is to say, as in my example of *Perodicticus*, although, judging from the dimensions of the limbs, his animal was considerably the smaller of the two.

In *Chiromys* the penis is rugulose, wrinkled, and very slightly narrowed distally for three-fourths of its length, then somewhat abruptly attenuated to the apex, where the upturned tip of the baculum terminates; but just below this point there is a little soft, curved, subcylindrical process upon which it seems probable the orifice of the urethra opens. When the prepuce is reflected to its fullest extent, the basal fourth of the exposed portion of the penis is seen to be provided with five probably glandular, longitudinal grooves, one in the middle line above and two on each side, one above the other, the ventral middle line being occupied by the frenum. The baculum (text-fig. 14, I) is tolerably stout and longer than in any genus of Lemuroid known to me. Allowing for its curvature, it is as long relatively as in *Galago crassicaudatus*. When seen from the side it is markedly sinuous, its upper edge

being concave close to the base, then convex, then strongly concave owing to the upcurling of the distal fourth of its length. The ventral side is curved in correspondence. No other Lemuroid known to me has a strongly upcurled tip to this bone.

In connection with the scrotum there is one fact to be recorded. In *Lemur catta* this sac is always naked (text-fig. 12, D). In all other species of Lemuroid Primates it is clothed with hair normally (text-figs. 12, A, B; 16, A). Occasionally the postero-inferior portion is naked, as I have noticed in one or two specimens of *Galago*; but I have no doubt that in these cases the absence of the hair was due to rubbing.

#### *The External Genitalia of the Female.*

In the standard text-books of Mammals published even as recently as Max Weber's in 1904, it is stated that the urethra traverses the clitoris in the Lemuroidea. This is not true of any Madagascar Lemur I have examined, and applies only to the Asiatic and African forms. In the Madagascar species the urinary orifice opens at a varying distance between the vaginal aperture and the apex of the clitoris, generally much closer to that orifice and only in one case, *Lemur catta*, a little nearer the tip of the clitoris.

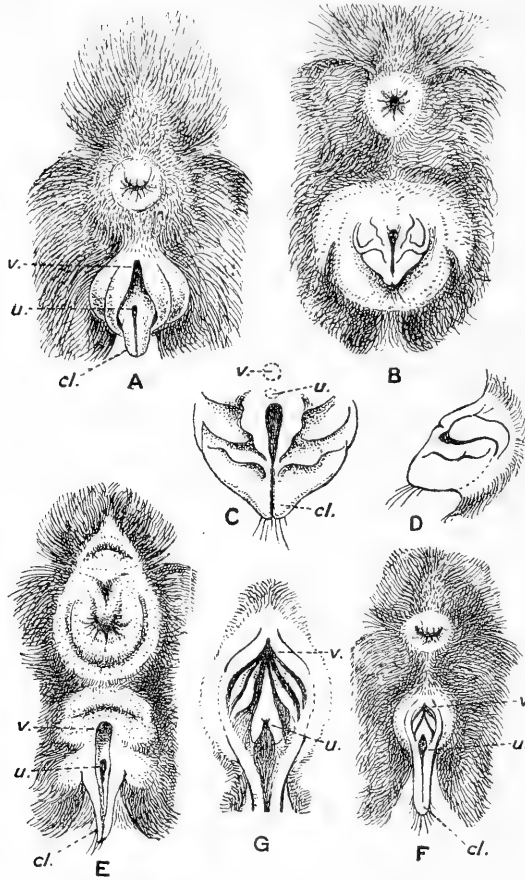
Milne-Edwards and Grandidier have shown that the clitoris varies considerably in form in the three genera of Indrididæ. In *Lichanotus* (*Avahis*) it is long, pendulous, and narrow, and parallel-sided in its distal two-thirds, but expanding proximally towards the orifice of the vulva. From the orifice of the urethra, situated a little below the vulva, a groove extends towards the tip of the clitoris, and at the extreme tip of the latter is placed the aperture of a glandular depression.

In *Propithecus* the clitoris is much shorter and thicker, with a broadly rounded distal end carrying a glandular orifice. The aperture of the urethra lies approximately midway between the orifice of this gland below and of the vagina above. In *Indris* the distal end of the clitoris is gradually and widely expanded laterally and extended considerably beyond the orifice of the gland, but the orifice of the urethra is situated even nearer to the vulva than in *Lichanotus*.

In the species usually referred to the genus *Lemur* there is considerable variation in the structure of the genital area of the female.

In *Lemur varius* the clitoris is a short, thick, fleshy excrecence with a blunt apex and somewhat cordate in shape, rising from the centre of a tolerably large area of naked skin. Its free posterior surface is marked by a median groove or rima defined laterally by a pair of thick labia. When the latter are separated the urinary channel, a gutter with thin elevated margins, is displayed. In a mated female this gutter is seen to lead from

## Text-figure 15.



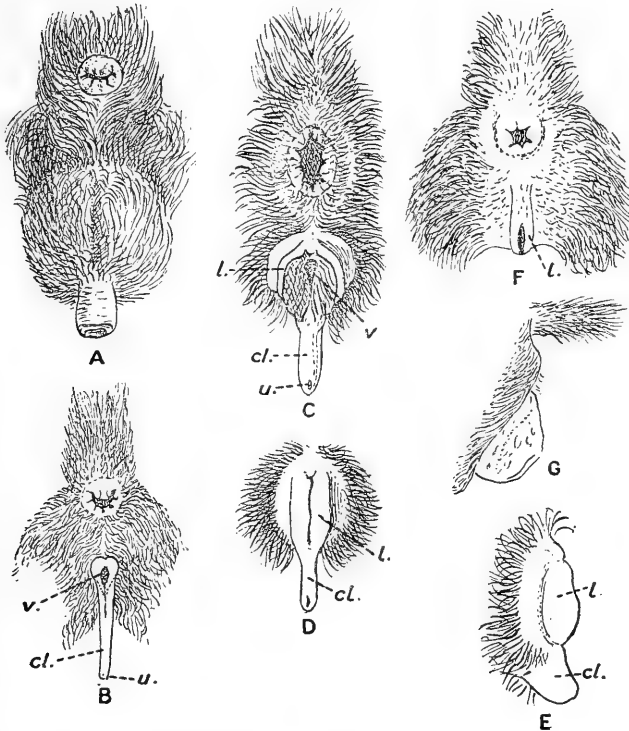
- A. Anal and genital area of female *Lemur catta*, showing the thick clitoris protruding between the labia of the vulva.
- B. The same of female *Lemur variegatus*, showing the short cordate vulva arising from a naked area of skin.
- C. Vulva of the same enlarged, showing the lateral grooves and the orifices of the urethra and vagina covered by membrane (hymen) in the virgin female.
- D. Side view of the same vulva.
- E. Anal and genital area of female *Lemur albifrons*, showing the circumanal glands and the long attenuated clitoris.
- F. The same of *Lemur coronatus*, showing the long clitoris and the absence of circumanal glands.
- G. Vulva of the same on larger scale, showing the supplementary labia beneath the orifice of the vagina.

cl., clitoris; u., orifice of urethra; v., orifice of vagina.

the orifice of the urethra, which is just below that of the vulva; but in a virgin female the two orifices are concealed by a flap of membrane (*hymen*), below the edge of which the open channel extends, narrowing in its course to the apex of the clitoris. The sides of the clitoris are marked by a couple of deep, probably glandular, grooves (text-fig. 15, B, C, D).

In *Lemur catta* the clitoris is a thick elongated excrescence

Text-figure 16.



- A. Anal and genital area of male *Chirogaleus major*, showing the position of the anus on the root of the tail.
- B. The same of female *Hemigalago demidoffi*, showing the long pendulous clitoris below the vulva.
- C. The same of female *Galago crassicaudatus* with the labia of the vulva spread open.
- D. Vulva of the same with the labia closed.
- E. Vulva of the same from the side.
- F. Anal and genital area of female *Tarsius*, showing the labia of the vulva partially spread open.
- G. The same from the side with the labia closed.

*cl.*, clitoris; *l.*, labium of vulva; *u.*, orifice of urethra; *v.*, orifice of vagina.

with the orifice of the vulva at its base and that of the urethra about one-third of the distance from the tip—much lower, that is to say, than in *L. varius*. The urinary channel runs from the urethral orifice to the apex of the clitoris. The orifice of the vulva is bounded on each side by a pair of thick labia, which, when separated, diverge from above that orifice and inferiorly disappear in the area of naked integument from which the clitoris rises (text-fig. 15, A).

In *L. macaco*, *albifrons*, *fulvus*, *mongoz*, *rufiventer*, and *coronatus*, the clitoris is narrow, elongated, attenuated towards the apex, and arises from an area of naked or nearly naked skin. It is channelled to the apex from the orifice of the urethra, which opens a short distance below that of the vagina. It varies to a certain extent in length within specific limits, e. g. *L. albifrons*, and is rather exceptionally long, less attenuated and narrower at the base in *L. coronatus* than in the others. Moreover, in the single example of this species examined, two pairs of elongated laminae, constituting labia, diverged obliquely just below the orifice of the vagina (text-figs. 12, C; 15, E, F, G).

In the Asiatic Lemuroids the clitoris differs from that of the Madagascar forms in being traversed by the urethra which opens at its tip.

In *Galago crassicaudatus* the clitoris is elongated, thick from before backwards in profile view, and parallel-sided and compressed from the posterior aspect: at its tip there is a depression, probably glandular, almost encircling the urethral orifice, and comparable to the similarly situated gland in the Indrididae. The vulva consists of two turgid labia, of which the opposed surfaces are provided with several small fine laminae, running from the edges of the labia inwards towards the orifice of the vagina (text-fig. 16, C, D, E).

In *Hemigalago* the clitoris is relatively much longer and thinner than in *G. crassicaudata*. The distal portion appears to be strengthened by a baculum and the tip is provided with a glandular depression encircling the end of the bone. The two labia at the sides of the orifice of the vagina are relatively smaller than in *G. crassicaudatus* (text-fig. 16, B).

In *Nycticebus* the clitoris is short and thick, resembling the prepuce of a penis. There is a glandular depression at the tip. The orifice of the vagina is a wide transverse rima just at the base of the clitoris. The general appearance of the external genitalia is very different from that of *Galago* and *Hemigalago*. Possibly the specimen examined was a virgin female.

The female external genitalia of *Tarsius* are unlike those of the Asiatic and Mascarene Lemurs, but in the single example examined recall rather those of the Old World pithecoïd Primates. The vulva is a laterally compressed, elongated excrescence, without pendulous apex. The rima is short and bounded by a pair of labia concealing the small clitoris and the orifices of the

urethra and vagina, which are comparatively close together. It is significant that the vulva of this genus as a whole is less like the vulva of the Galagos than that of the true Lemurs. It approaches most nearly the vulva of *L. varius* (text-fig. 16, F, G).

### *General Conclusions.*

The conclusions of general interest which have suggested themselves in the course of the investigations above detailed are subjoined in the order of their importance:—

1. In the case of *Tarsius* the structure of the upper lip and of the nose severs the genus completely from the Lemurs and brings it into line with the Pithecoid Primates. Taking this character in conjunction with the nature of the placenta, the presence of the postorbital partition, and other well-known features, it seems that Hubrecht was quite right in removing *Tarsius* from the Lemurs and placing it in the higher grade of Primates. I propose to give practical expression to this view by dividing the Primates into two great series. For the first, comprising the Lemurs, the old name STREPSIRHINI is available. For the second, comprising *Tarsius* and the Pithecoidea, I suggest the title HAPLORHINI. The Haplorhini will contain two divisions, the Tarsiodea and the Pithecoidea\*.

2. With *Tarsius* eliminated from the Lemurs, the Strepsirhini may be divided into the Chiromyoidea and the Lemuroidea. It has been the fashion of late years to depreciate the characters of *Chiromys*. Dr. Standing indeed gave the genus merely subfamily rank under the Indridiæ, the latter being equivalent to the Lemuridæ. But that classification sacrificed the characters of *Chiromys* to the hypothesis that the genus is a specialised offshoot of the Indridoid stock. That may be true. Nevertheless, the specialisation has proceeded so far, and in so many directions, that it appears to me impossible to dispute the claim that the Lemuridæ and the Indridiæ are much more nearly akin to each other than either is to the Chiromyidæ. In the description of *Chiromys* the peculiarities of the teeth generally distract attention from the curious cranial modifications correlated with the rodent dentition, such as the immense size of the premaxillæ, which reach the lachrymals and exclude the reduced maxillæ from contact with the nasals; also the absence of the bony ridge closing the glenoid behind and the longitudinal extension of the mandibular condyle, two correlated characters subservient to the back and forth movement of the mandible well known in the

\* I prefer this name to Anthropeidea because in ordinary terminology the title "anthropoid," reasonably according to its meaning, has become restricted to the man-like Apes. A marmozet can hardly be called "anthropoid," with any approach to the real meaning of the word. But a marmozet and a man are alike "pithecoïd."

Rodentia. These cranial features distinguish *Chiromys* from all Lemurs; and when taken in conjunction with the teeth, with the peculiarities of the hands and feet, and of the sublingua, they outweigh, in my opinion, the known differences between the true Mascarene Lemurs (Lemuridæ and Indrisidæ) and the Asiatic and African Galagos, Pottos, and Lorises.

3. With regard to the Galagos, Pottos, and Lorises, I am only acquainted with one invariable cranial character distinguishing them from the Lemuridæ and Indrisidæ. This was pointed out by Forsyth Major and has been briefly expressed by Mr. Gregory\* as follows:—In the Asiatic forms the ectotympanic is enlarged and external to the bulla of which it forms the outer wall. In the Mascarene forms the ectotympanic is inclosed within the bulla, forming a ring or horseshoe. To this difference may be added the one pointed out above in connection with the clitoris, which in the Asiatic genera is traversed by the urethra, whereas in the Mascarene forms the urethra opens above the tip of the clitoris.

In view of these facts, I should divide the Lemuroidea into two series, for which Mr. Gregory's names Lemuriformes for the Lemuridæ and Indrisidæ, and Lorisiformes for the Lorisidæ (or Nycticebidæ) and the Galagidæ may be adopted. Similarly for the subdivision of the Lemuridæ I follow Mr. Gregory in relegating the genera to two subfamilies, the Lemurinae and Chirogaleinae; but I cannot agree with him that *Hapalemur* belongs to the Chirogaleinae. That genus appears to me to be essentially a Lemurine, its inclusion in the Chirogaleinae spoiling the definition of the subfamily.

4. As a matter of minor interest it is quite clear that the genus *Lemur* as generally admitted and as recognised in this paper is susceptible of division into two or three genera. *L. catta*, for instance, differs from the other species in having the glands on the fore-limb and the naked heel and scrotum, and also in the structure of the vulva. *L. variegatus* is also peculiar in the structure of the vulva. Furthermore, the Galagos of the *G. senegalensis*-type may be distinguished by the structure of the penis from that of the *crassicaudatus*-type. Generic names appear to be available for these subdivisions of *Lemur* and *Galago*; but I do not propose to enter into that question now.

My views above set forth differ in so many particulars from those of Mr. Gregory that it may be interesting to tabulate our classifications side by side, omitting those he adopts based upon extinct genera, which, so far as I am aware, do not materially affect the arrangement of recent forms.

\* Bull. Geol. Soc. Amer. 26, pp. 432-436, 1915. See also Bull. Amer. Mus. Nat. Hist. 35, pp. 266-267, 1916.



Gregory, 1915-1916.

Order PRIMATES.

Subord. LEMUROIDEA.

Series LEMURIFORMES.

Fam. LEMURIDÆ.

Subfam. *Lemurinae*.

    " *Chirogaleinae*.

Fam. INDRISIDÆ.

    " CHIROMYIDÆ.

Series LORISIFORMES.

Fam. LORISIDÆ.

Subfam. *Lorisinae*.

    " *Galaginae*.

Series TARSIFORMES.

Fam. TARSIDÆ.

Subord. ANTHROPOIDEA.

Pocock, 1918.

Order PRIMATES.

Grade STREPSIRHINI.

Subord. LEMUROIDEA.

Series LEMURIFORMES.

Fam. LEMURIDÆ.

Subfam. *Lemurinae*.

    " *Chirogaleinae*.

Fam. INDRISIDÆ.

Series LORISIFORMES.

Fam. LORISIDÆ.

    " GALAGIDÆ.

Subord. CHIROMYOIDEA.

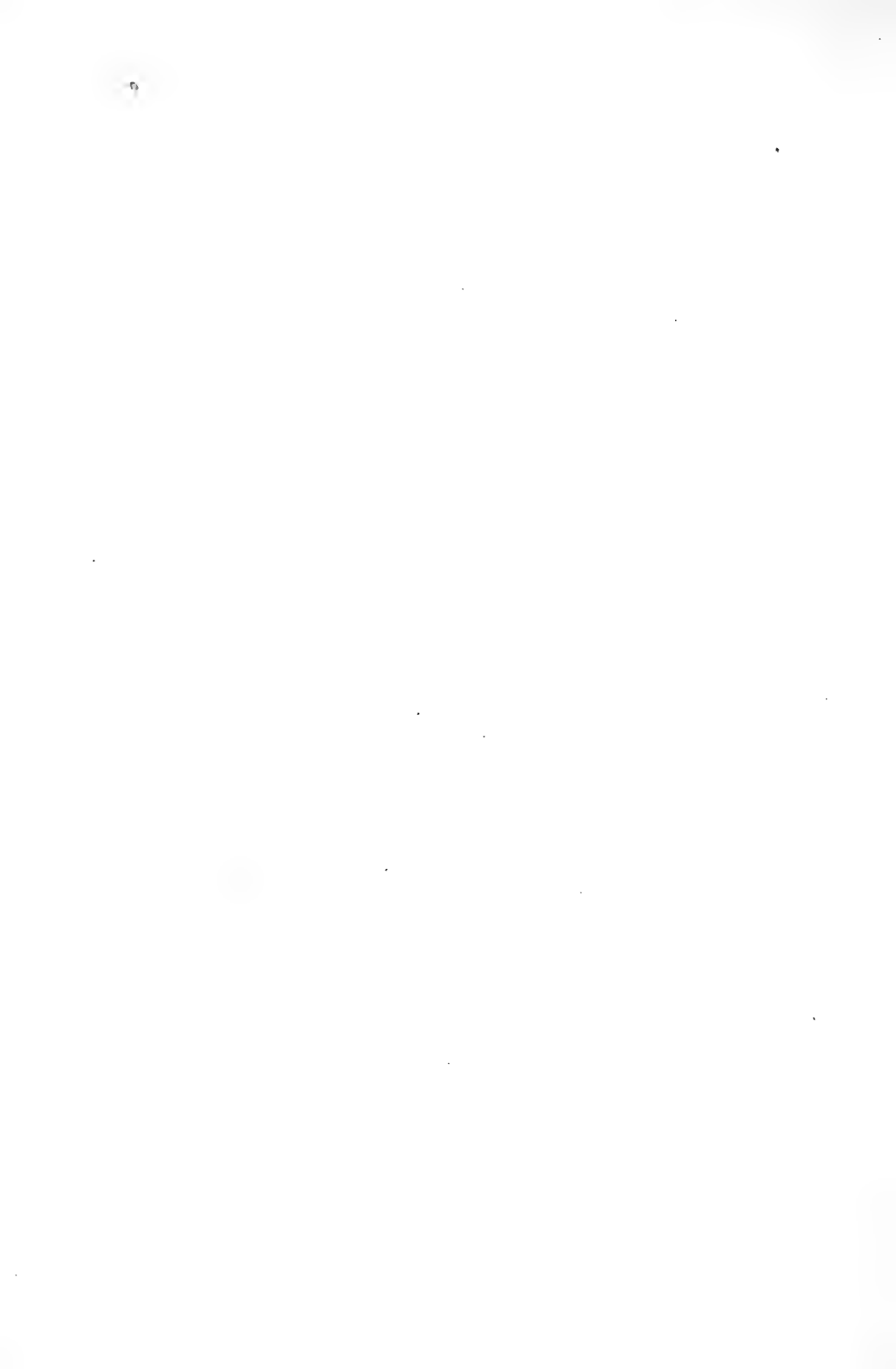
Fam. CHIROMYIDÆ.

Grade HAPLORHINI.

Subord. TARSIOIDEA.

    " PITHECOIDEA.

Apart from the removal of *Tarsius* from the Lemuroidea and the union of the Lorisidæ and Galagidæ in a group equivalent to the Lemuridæ and Indrisidæ combined, my classification agrees in the main with the classification published in Flower and Lydekker's 'Mammals,' and in other works of about that period. Of more recent classifications it appears to me that Gadow's (Class. of the Vertebrata, 1898, pp. 52-53), although brief, expresses the facts with the nearest approach to the truth, especially in the primary division of the Primates into the three suborders Lemures, Tarsii, and Simiæ.



## 5. A Classification of the PYRALIDÆ, subfamily HYPOTROPINÆ. By Sir GEORGE HAMPSON, Bart., F.Z.S.

[Received February 19, 1918 : Read March 5, 1918.]

Proboscis aborted or absent; palpi upturned, oblique or down-curved, the males of the species with the maxillary palpi brush-like and contained in a hollow of the labial palpi usually having the palpi oblique in the male and downcurved in the female; maxillary palpi small and filiform, well developed and more or less dilated with scales at extremity, or brush-like and contained in a hollow of the labial palpi; frons smooth, with tuft of hair, or prominences of various forms; antennæ of male ciliated, laminate, serrate or pectinate with uniseriate branches, the basal joint often dilated and the shaft often downcurved at base with a ridge of scales in its sinus; the build slender; tibiæ with all the spurs present; abdomen smoothly scaled. Fore wing narrow; vein 1 *a* separate from 1 *b*; 1 *c* absent; veins 2, 3 rarely stalked; vein 4 often absent or stalked with 5, 3 and 5 stalked or from the cell; 6 from below upper angle; 7 absent; 8, 9 and often 10 stalked or 9 absent, rarely 10 also absent, 8 given off before or after 10; 11 from cell. Hind wing with the median nervure pectinated on upper side; veins 1 *a*, *b*, *c* present; 2 from near or well before angle of cell; veins 3 and 4 sometimes absent, or 3 and 5 stalked or from the cell, 4 often absent, or 3, 4, 5 all present, 4 stalked with 5 or from cell; 6, 7 stalked or from upper angle of cell; 8 anastomosing with 7 or approximated to it but free.

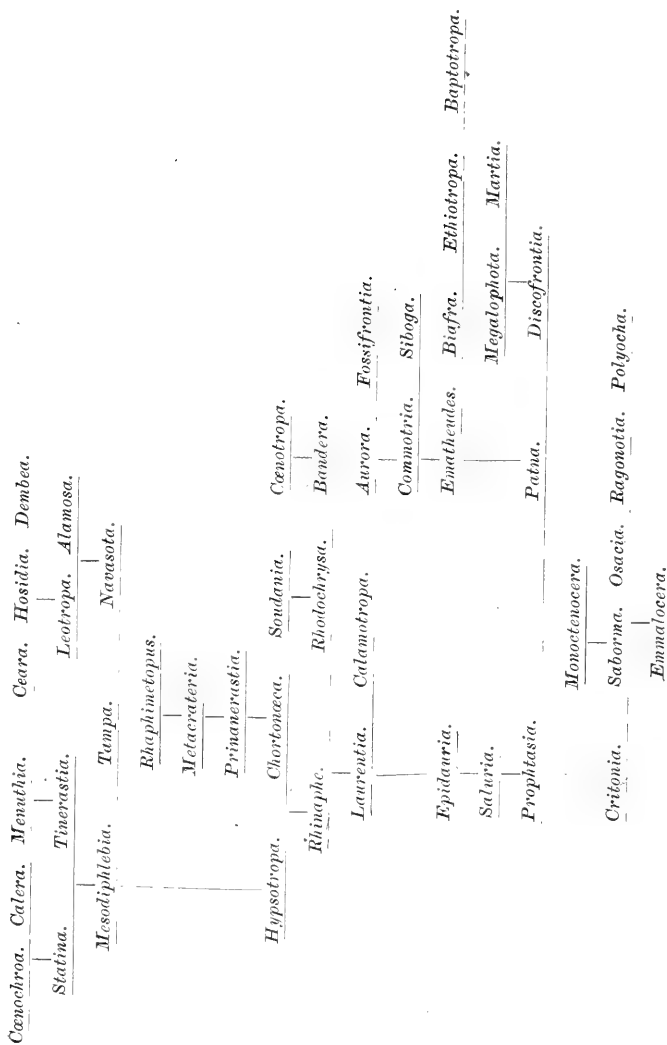
The larvæ of very few species are known; these live on *Graminaceæ* and pupate in the ground in a chamber formed by agglutinated particles of the soil; *Emmalocera depressella*, however, is injurious to sugar-cane, the larva feeding in its roots.

The subfamily is a development from the *Anerastianeæ*—*Anerastia* Hübn. Verz. p. 367 (1827), type *dignella* Hübn.—from which it differs only in the proboscis being absent or aborted and non-functional.

The types of the new species are in the British Museum, the species of which the types are in the collection are marked with a †, and those not in the collection with a \*.

No quotations from German authors published since Aug. 1st, 1914 are inserted. "*Hostes humani generis.*"

PHYLOGENY OF THE HYPOTROPINÆ.



## Key to the Genera.

- A. Hind wing with veins 3 and 4 absent.
- a. Fore wing with vein 8 from 9 before 10, 3 and 5 stalked ..... *Cænochroa*, [p. 58.
- b. Fore wing with vein 8 from 9 after 10.
- a<sup>1</sup>. Fore wing with veins 3 and 5 stalked.
- a<sup>2</sup>. Palpi upturned ..... *Menuthia*, p. 60.
- b<sup>2</sup>. Palpi oblique, straight ..... *Calera*, p. 59.
- c<sup>2</sup>. Palpi downcurved ..... *Statina*, p. 59.
- b<sup>1</sup>. Fore wing with veins 3 and 5 from the cell.
- a<sup>2</sup>. Palpi upturned ..... *Tinerastia*, p. 61.
- b<sup>2</sup>. Palpi porrect.
- a<sup>3</sup>. Fore wing with vein 9 absent, 11 stalked with 8 and 10 ..... *Cænotropia*, p. 89.
- b<sup>3</sup>. Fore wing with vein 9 present, 11 from cell ..... *Mesodiphlebia*, [p. 61.
- c. Fore wing with vein 10 from the cell ..... *Calamotropia*, [p. 91.
- B. Hind wing with vein 3 present, 4 absent.
- a. Fore wing with vein 4 absent.
- a<sup>1</sup>. Fore wing with veins 9 and 10 absent, 8 from cell, 3 and 5 from cell ..... *Tampa*, p. 62.
- b<sup>1</sup>. Fore wing with vein 9 absent, 10 from cell, 3 and 5 from cell ..... *Bandera*, p. 89.
- c<sup>1</sup>. Fore wing with vein 8 from 9 before 10, 3 and 5 stalked... *Hosidia*, p. 63.
- d<sup>1</sup>. Fore wing with vein 8 from 9 after 10.
- a<sup>2</sup>. Fore wing with veins 3 and 5 stalked.
- a<sup>3</sup>. Palpi upturned.
- a<sup>4</sup>. Frons with rounded prominence ..... *Dembea*, p. 64.
- b<sup>4</sup>. Frons without prominence.
- a<sup>5</sup>. Palpi reaching to above vertex of head, the 2nd joint slenderly scaled ..... *Ceara*, p. 63.
- b<sup>5</sup>. Palpi not reaching to above vertex of head, the 2nd joint broadly scaled ..... *Leotropia*, p. 64.
- b<sup>3</sup>. Palpi oblique or downcurved.
- a<sup>4</sup>. Frons with corneous plate produced to two slight points in front ..... *Alamosa*, p. 65.
- b<sup>4</sup>. Frons without corneous plate ..... *Nacasota*, p. 65.
- b<sup>2</sup>. Fore wing with veins 3 and 5 from cell.
- a<sup>3</sup>. Hind wing with veins 3 and 5 stalked ..... *Hypstropa*, [p. 67.
- b<sup>3</sup>. Hind wing with veins 3 and 5 from the cell.
- a<sup>4</sup>. Palpi upturned ..... *Sudania*, p. 88.
- b<sup>4</sup>. Palpi downcurved ..... *Rhodochrysa*, [p. 88.
- c<sup>1</sup>. Fore wing with vein 10 from the cell, 8 and 9 stalked.
- a<sup>2</sup>. Hind wing with veins 3 and 5 stalked.
- a<sup>3</sup>. Frons with flattened corneous plate, rather trifold in front and produced to short lateral points, a corneous plate below the frons ..... *Raphimetopus*, [p. 78.
- b<sup>3</sup>. Frons with pointed conical prominence ..... *Chortonæa*, [p. 80.
- c<sup>3</sup>. Frons with long truncate corneous process with raised rim at extremity ..... *Metacrateria*, [p. 79.
- a<sup>3</sup>. Frons with rounded prominence with raised rim at extremity ..... *Prinanerastia*, [p. 80.
- c<sup>3</sup>. Frons without prominence ..... *Rhinaphæ*, p. 82.
- b<sup>2</sup>. Hind wing with veins 3 and 5 from the cell.
- a<sup>3</sup>. Hind wing with vein 8 anastomosing with 7 ..... *Laurentia*, p. 90.
- b<sup>2</sup>. Hind wing with vein 8 not anastomosing with 7 ..... *Epidauria*, p. 91.
- b. Fore wing with vein 4 present.
- a<sup>1</sup>. Fore wing with vein 10 stalked with 8.
- a<sup>2</sup>. Fore wing with veins 4, 5 stalked or from a point.
- a<sup>3</sup>. Hind wing with vein 2 from or from close to angle of cell.
- a<sup>4</sup>. Frons with conical prominence ..... *Fossifrontia*, [p. 107.
- b<sup>4</sup>. Frons without prominence.
- a<sup>5</sup>. Frons with long pointed tuft of hair ..... *Aurora*, p. 106.
- b<sup>5</sup>. Frons without tuft of hair ..... *Commotria*, [p. 107.

- b*<sup>3</sup>. Hind wing with vein 2 from well before angle of cell.  
*a*<sup>4</sup>. Frons with rounded prominence ..... *Siboga*, p. 112.  
*b*<sup>4</sup>. Frons without prominence.  
*a*<sup>5</sup>. Fore wing with veins 4, 5, hind wing with veins  
 3 and 5 stalked ..... *Ematheudes*,  
 [p. 114.  
*b*<sup>5</sup>. Fore wing with veins 4, 5, hind wing with veins  
 3 and 5 from angle of cell ..... *Baptotropa*,  
 [p. 116.  
*b*<sup>2</sup>. Fore wing with veins 4, 5 separate.  
*a*<sup>3</sup>. Hind wing with vein 2 from near angle of cell ..... *Biafra*, p. 115.  
*b*<sup>3</sup>. Hind wing with vein 2 from well before angle of cell.  
*a*<sup>4</sup>. Hind wing with vein 8 anastomosing with 7 ..... *Ethiotropa*,  
 [p. 116.  
*b*<sup>4</sup>. Hind wing with vein 8 not anastomosing with 7 ... *Patna*, p. 117.  
*b*<sup>1</sup>. Fore wing with vein 10 from the cell.  
*a*<sup>2</sup>. Fore wing with veins 4, 5 stalked.  
*a*<sup>3</sup>. Hind wing with veins 3 and 5 stalked ..... *Saluria*, p. 93.  
*b*<sup>3</sup>. Hind wing with veins 3 and 5 from the cell ..... *Prophtasia*,  
 [p. 104.  
*b*<sup>2</sup>. Fore wing with veins 4, 5 from the cell.  
*a*<sup>3</sup>. Hind wing with veins 3 and 5 stalked; frons with  
 truncate conical prominence ..... *Megalophota*,  
 [p. 117.  
*b*<sup>3</sup>. Hind wing with veins 3 and 5 from the cell.  
*a*<sup>4</sup>. Frons with prominence hollowed out in front ..... *Martia*, p. 118.  
*b*<sup>4</sup>. Frons with disk of scales ..... *Discofrontia*,  
 [p. 118.  
*a*<sup>4</sup>. Frons without disk of scales or prominence ..... *Critonia*, p. 119.  
 C. Hind wing with vein 4 present.  
*a*. Fore wing with vein 10 stalked with 8. [p. 121.  
*a*<sup>1</sup>. Hind wing with vein 8 anastomosing with 7 ..... *Monoctenocera*,  
*b*<sup>1</sup>. Hind wing with vein 8 not anastomosing with 7 ..... *Saborma*, p. 122.  
*b*. Fore wing with vein 10 from the cell.  
*a*<sup>1</sup>. Fore wing with veins 2, 3 stalked ..... *Osacia*, p. 123.  
*b*<sup>1</sup>. Fore wing with veins 2, 3 from the cell.  
*a*<sup>2</sup>. Frons with small rounded prominence with a corneous  
 plate below it ..... *Ragonotia*,  
 [p. 123.  
*b*<sup>3</sup>. Frons without prominence.  
*a*<sup>1</sup>. Fore wing with veins 4, 5 stalked ..... *Polyocha*, p. 124.  
*b*<sup>4</sup>. Fore wing with veins 4, 5 from the cell ..... *Emmalocera*,  
 [p. 126.

## Genus CÆNOCHROA.

- Type.
- Cænochroa* Rag. N. Am. Phyc. p. 20 (1887) ..... *californiella*.  
*Petaluma* Hulst, Trans. Am. Ent. Soc. xvii.  
 p. 215 (1890) ..... *illibella*.

Proboscis absent; palpi downcurved, about three times length  
 of head and thickly scaled; maxillary palpi minute and filiform;  
 frons with conical prominence, thickly scaled above; antennæ  
 of male laminate and almost simple. Fore wing narrow and  
 elongate, the apex rounded; vein 2 from close to angle of cell;  
 3 and 5 strongly stalked, 4 absent; 6 from well below upper  
 angle; 8, 9, 10 stalked, 8 from before 10; 11 from cell. Hind  
 wing with vein 2 from close to angle of cell; 3 and 4 absent,  
 5 sometimes not reaching the termen; 6, 7 from upper angle;  
 8 strongly anastomosing with 7.

## (1) \*CÆNOCHROA ILLIBELLA.

*Anerastia illibella* Hulst, Ent. Am. iii. p. 138 (Oct. 1887);  
 Rag. Rom. Mém. viii. p. 419, pl. 45. f. 9; Dyar, Cat. Lep. N.  
 Am. p. 440.

*Cænochroa puricostella* Rag. N. Am. Phyc. p. 20 (Dec. 1887).  
 U.S.A., Texas, Arizona.

## (2) CÆNOCHROA INSPERGELLA.

*Cœnochroa inspergella* Rag. N. Am. Phyc. p. 20 (1887); id. Rom. Mém. viii. p. 419, pl. 45. f. 10; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Texas, Colorado, Arizona.

## (3) \*CÆNOCHROA CALIFORNIELLA.

*Cœnochroa californiella* Rag. N. Am. Phyc. p. 20 (1887); id. Rom. Mém. viii. p. 420, pl. 45. f. 8; Dyar, Cat. Lep. N. Am. p. 441.

U.S.A., Colorado, California, Arizona; MEXICO, Presidio.

*Auctorum.*

*Cœnochroa monomacula* Dyar, Pr. U.S. Nat. Mus. xlvii. p. 348 (1913) ..... PANAMA.

## Genus CALERA.

Type.

*Calera* Rag. Nouv. Gen. p. 50 (1888) ..... *punctilimbella*.

Proboscis aborted and minute; palpi downcurved, extending about twice the length of head and smoothly scaled; maxillary palpi minute and filiform; frons smooth; antennæ of male somewhat laminate and ciliated, the basal joint somewhat enlarged and flattened on outer side. Fore wing long and narrow, the apex rounded; vein 2 from near angle of cell; 3 and 5 strongly stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 and 4 absent; 6, 7 stalked; 8 anastomosing strongly with 7.

## CALERA PUNCTILIMBELLA.

*Calera punctilimbella* Rag. Nouv. Gen. p. 50 (1888); id. Rom. Mém. viii. p. 417, pl. 40. f. 20; Dyar, Cat. Lep. N. Am. p. 441.

U.S.A., N. Carolina, Iowa, Texas.

## Genus STATINA.

Type.

*Statina* Rag. N. Am. Phyc. p. 19 (1887) ..... *roseotinctella*.

Proboscis aborted and minute; palpi downcurved, extending about two and a half times length of head and rather roughly scaled; maxillary palpi minute, filiform; frons with tuft of scales; antennæ of male laminate and ciliated, the shaft thickened with scales above at base, the basal joint long, dilated and flattened. Fore wing long and narrow, the apex rounded; vein 2 from near angle of cell; 3 and 5 strongly stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10, 11 from cell. Hind wing with vein 2 from close to

angle of cell; 3 and 4 absent; 6, 7 from upper angle; 8 anastomosing strongly with 7.

(1) \*STATINA GAUDIELLA.

*Statina gaudiella* Hulst, Trans. Am. Ent. Soc. xvii. p. 216 (1890); Rag. Rom. Mém. viii. p. 415, pl. 51. f. 5; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Texas.

(2) STATINA ROSEOTINCTELLA.

*Statina roseotinctella* Rag. N. Am. Phyc. p. 19 (1887); id. Rom. Mém. viii. p. 416, pl. 47. f. 7; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Florida, Texas.

(3) †STATINA PUNCTILINEELLA.

*Statina punctilineella* Hmps. Rom. Mém. viii. p. 416, pl. 52. f. 13 (1901).

S. BRAZIL.

(4) †STATINA BIFASCIELLA.

*Statina bifasciella* Hmps. Rom. Mém. viii. p. 416, pl. 52. f. 8 (1901).

U.S.A., Texas.

(5) STATINA RHODOBAPHELLA.

*Statina rhodobaphella* Rag. Nouv. Gen. p. 50 (1888); id. Rom. Mém. viii. p. 417, pl. 45. f. 6.

CELEBES, Sangir I.; N. GUINEA; QUEENSLAND.

(6) †STATINA ROSINELLA, sp. n.

♀. Head and thorax purplish pink; abdomen whitish suffused with red-brown, dorsally fulvous towards base; antennæ, pectus, and legs whitish tinged with red-brown. Fore wing purplish pink, the veins streaked with white; a brown shade below basal half of cell. Hind wing ochreous white.

N. NIGERIA, Minna (*Macfie*), 1 ♀ type. *Exp.* 16 mm.

(7) †STATINA CASHMIRALIS.

*Statina cashmiralis* Hmps. J. Bomb. Nat. Hist. Soc. xv. p. 20 (1901).

KASHMIR.

Genus MENUTHIA.

*Menuthia* Rag. Nouv. Gen. p. 50 (1888) ..... Type. *nanella*.

Proboscis absent; palpi upturned to far above vertex of head, slender and smoothly scaled; maxillary palpi filiform; frons



smooth; antennæ of female almost simple. Fore wing long and narrow, the apex rounded; vein 2 from angle of cell; 3 and 5 stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with the cell short; veins 2 and 5 stalked, 3 and 4 absent; 6, 7 from upper angle; 8 strongly anastomosing with 7.

\*MENUTHIA NANELLA.

*Menuthia nanella* Rag. Nouv. Gen. p. 50 (1888); id. Rom. Mém. viii. p. 418, pl. 40. f. 22.

ZANZIBAR.

Genus TINERASTIA.

*Tinerastia* Hmps. Rom. Mém. viii. p. 414 (1901)... Type. *fissirella*.

Proboscis absent; palpi upturned to rather above vertex of head and nearly smoothly scaled; maxillary palpi minute and filiform; frons with rounded prominence; antennæ of male laminate and ciliated, the basal joint rather long. Fore wing rather long and narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 from angle, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with veins 2 and 5 from angle of cell, 3 and 4 absent; 6, 7 stalked; 8 anastomosing strongly with 7.

(1) †TINERASTIA DISCIPUNCTELLA.

*Menuthia discipunctella* Hmps. Moths Ind. iv. p. 52 (1896); id. Rom. Mém. viii. p. 414, pl. 52. f. 10.

CEYLON.

(2) †TINERASTIA FISSIRELLA.

*Menuthia fissirella* Hmps. Moths Ind. iv. p. 52 (1896); id. Rom. Mém. viii. p. 414, pl. 52. f. 9.

CEYLON.

Genus MESODIPHLEBIA.

*Mesodiphlebia* Zell. Hor. Soc. Ent. Ross. xvi. Type. p. 251 ..... *crassivenia*.

Proboscis absent; palpi porrect, about twice the length of head, almost straight and thickly scaled; maxillary palpi well developed and slightly dilated with scales; frons with conical tuft of hair; antennæ of male laminate and ciliated, the shaft somewhat curved at base and thickened with scales in the sinus, the basal joint rather elongate and flattened. Fore wing long and narrow, the apex rounded; vein 2 from near angle of cell; 3 and 5 separate, 4 absent; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with veins 2 and 5 from angle of cell; 3 and 4 absent; 6, 7 from upper angle; 8 anastomosing strongly with 7.

## (1) \*MESODIPHLEBIA DELIQUELLA.

*Anerastia deliquella* Zell. Isis, 1848, p. 861; Rag. Rom. Mém. viii. p. 413, pl. 45. f. 5.

*Anerastia trinotella* Berg, An. Soc. Arg. 1885, p. 275.

ARGENTINA.

## (2) †MESODIPHLEBIA CRASSIVENIA.

*Anerastia crassivenia* Zell. Hor. Soc. Ent. Ross. xvi. p. 251, pl. xii. f. 52 (1881); Rag. Rom. Mém. viii. p. 415, pl. 40. f. 16.

COLOMBIA:

## (3) MESODIPHLEBIA STRICTICOSTELLA.

*Mesodiphlebia stricticostella* Rag. Ann. Soc. Ent. Fr. 1887, p. 260; id. Rom. Mém. viii. p. 413, pl. 40. f. 15.

N. NIGERIA; SUDAN.

## (4) †MESODIPHLEBIA ROSELLA.

*Calera rosella* Hmps. Moths Ind. iv. p. 53 (1896); id. Rom. Mém. viii. p. 412, pl. 52. f. 7.

MADRAS, Nilgiris.

## (5) †MESODIPHLEBIA OCHRACEELLA, sp. n.

♀. Head and thorax brownish ochreous; pectus, legs, and abdomen white suffused with brownish ochreous. Fore wing uniform brownish ochreous. Hind wing white with a faint ochreous tinge.

ARGENTINA, Corrientes, Goya (*Perrens*), 1 ♀ type. *Exp.* 20 mm.

*Auctorum.*

*Calera albicostella* Grossbeck, Bull. Am. Mus. Nat. Hist. xxxvii. p. 134 (1917) ..... U.S.A., Florida.

## Genus TAMPA.

*Tampa* Rag. N. Am. Phyc. p. 19 (1887) ..... *dimediatella*. Type.

Proboscis aborted and small; palpi obliquely upturned to well above vertex of head and thickly scaled; maxillary palpi well developed and dilated with scales; frons smooth; antennæ of male ciliated. Fore wing long and narrow; the costa highly arched, the apex rounded, the termen very oblique; vein 2 from close to angle of cell; 3 and 5 separate, 4 absent; 6 from below upper angle; 9 and 10 absent; 11 from close to 8. Hind wing with vein 2 from near angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 from upper angle; 8 anastomosing with 7 to near apex.

## TAMPA DIMEDIATELLA.

*Tampa dimediatella* Rag. N. Am. Phyc. p. 20 (1887); id. Rom. Mém. viii. p. 411, pl. 45. f. 4; Dyar, Cat. Lep. N. Am. p. 440. U.S.A., Florida, Texas.

## Genus CEARA.

*Ceara* Rag. Nouv. Gen. p. 45 (1888) ..... <sup>Type.</sup> *discinotella*.

Proboscis absent; palpi upturned to rather above vertex of head and moderately scaled; maxillary palpi small and filiform; frons smooth, with large conical tuft of scales; antennæ of male laminate and ciliated, the shaft with small tuft of scales above at base. Fore wing narrow, the apex rounded; vein 2 from angle of cell; 3 and 5 stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from near angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 stalked; 8 strongly anastomosing with 7.

## (1) \*CEARA DISCINOTELLA.

*Ceara discinotella* Rag. Nouv. Gen. p. 45 (1888); id. Rom. Mém. viii. p. 368, pl. 39. f. 3.

S. BRAZIL.

## (2) †CEARA ALBIFASCIATA, sp. n.

♂. Head white; thorax white tinged with reddish brown; abdomen white tinged with brown and dorsally with fulvous yellow towards base; pectus and legs white tinged with brown. Fore wing with white costal fascia narrowing to a point before apex and with vein 12 defined above and below by grey-brown, the area below it to just below the cell and vein 2 white suffused with grey-brown, leaving the veins streaked with white; the inner area pale pink with a white streak on vein 1. Hind wing white, tinged with brown except on inner area.

BR. E. AFRICA, Eb Urru (*Betton*), 1 ♂ type. *Exp.* 26 mm.

## Genus HOSIDIA.

*Hosidia* Hmspn. Rom. Mém. viii. p. 408 (1901). <sup>Type.</sup> *ochrineuella*.

Proboscis absent; palpi downcurved, extending about one and a half times length of head and roughly scaled; maxillary palpi minute and filiform; frons smooth, with conical tuft of hair; antennæ of male ciliated, the shaft with sinus and tuft of scales at base. Fore wing narrow, the apex rounded; vein 2 from close to angle of cell; 3 and 4 stalked, 5 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from before 10; 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 stalked; 8 anastomosing strongly with 7.

\* *HOSIDIA OCHRINEURELLA*.

*Hosidia ochrineurella* Hmps. Rom. Mém. viii. p. 409, pl. 45. f. 1 (1901).

NATAL.

Genus *DEMBEA*.

*Dembea* Rag. Nouv. Gen. p. 45 (1888) ..... *venulosella*, Type.

Proboscis aborted and minute; palpi upturned to about vertex of head and thickly scaled; maxillary palpi minute and slightly dilated with scales; frons with large rounded prominence thickly clothed with scales; antennæ of male laminate and ciliated, the shaft with ridge of scales at base. Fore wing narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 shortly stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from angle of cell; 3 and 5 stalked, 4 absent; 6, 7 stalked; 8 anastomosing strongly with 7.

† *DEMBEA VENULOSELLA*.

*Dembea venulosella* Rag. Nouv. Gen. p. 45 (1888); id. Rom. Mém. viii. p. 368, pl. 44. f. 19.

N. NIGERIA; ABYSSINIA; BR. C. AFRICA.

Genus *LEOTROPA*, nov.Type, *L. phœnicias*.

Proboscis absent; palpi obliquely upturned to about vertex of head and moderately scaled; maxillary palpi minute and filiform; frons smooth, rounded; antennæ of male laminate and ciliated, with a sinus at base containing a double ridge of scales. Fore wing narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 very strongly stalked, 4 absent; 6, 7 stalked; 8 strongly anastomosing with 7.

(1) † *LEOTROPA PHŒNICIAS*, sp. n.

♂. Head and thorax purplish pink; abdomen pale brownish grey dorsally tinged with fulvous; antennæ brownish; pectus, legs, and ventral surface of abdomen, except towards extremity, brownish tinged with purplish pink. Fore wing purplish pink, the veins streaked with white; a dark brown fascia through upper part of cell to apex, the costal area towards apex white. Hind wing brownish white; a slight brown terminal line.

SIERRA LEONE (*Clements*), 1 ♂ type. *Exp.* 22 mm.

(2) † *LEOTROPA SARCINA*, sp. n.

♂. Head and thorax white mixed with ochreous brown; abdomen white, dorsally faintly tinged with fulvous towards

base; pectus and legs white suffused with brown. Fore wing white tinged with purplish pink, the veins streaked with white; the costal area white narrowing to a point at apex and with vein 12 defined on each side by brown, a brown shade below the costal area. Hind wing white with a faint ochreous brown tinge on costal area and in submedian interspace.

BR. E. AFRICA, Teita (*Jackson*), 1 ♂ type. *Exp.* 16 mm.

(3) †LEOTROPA PAPUANENSIS, sp. n.

♂. Head, thorax, and abdomen whitish suffused with reddish brown, the last dorsally tinged with fulvous towards base. Fore wing whitish irrorated with reddish brown, the costal area rather whiter, narrowing to a point at apex and with slight brown streak below it. Hind wing white slightly tinged with brown, the cilia white.

DUTCH N. GUINEA, Ron I. (*Doherty*), 1 ♂ type. *Exp.* 14 mm.

Genus ALAMOSA.

*Alamosa* Hmps. Rom. Mém. viii. p. 369 (1901). <sup>Type.</sup> *piperatella*.

Proboscis aborted and minute; palpi downcurved, extending about twice the length of head and thickly scaled; maxillary palpi minute and filiform; frons with flattened corneous plate produced to two slight points in front and thickly scaled above; antennæ of male laminate. Fore wing narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 stalked, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 from upper angle; 8 strongly anastomosing with 7.

(1) ALAMOSA PIPERATELLA.

*Alamosa piperatella* Hmps. Rom. Mém. viii. p. 369, pl. 51. f. 25 (1901).

U.S.A., Colorado, New Mexico.

(2) \*ALAMOSA BIPUNCTELLA.

*Alamosa bipunctella* Barnes & McD. Contr. Nat. Hist. Lep. N. Am. ii. 4, p. 184, pl. 1. f. 7 (1913).

U.S.A., Florida.

Genus NAVASOTA.

*Navasota* Rag. N. Am. Phyc. p. 18 (1887) ..... <sup>Type.</sup> *hebetella*.

Proboscis aborted and minute; palpi extending about the length of head and moderately scaled, the 2nd joint oblique, the 3rd porrect; maxillary palpi minute and filiform; frons smooth with conical tuft of hair; antennæ of male laminate and ciliated,

the shaft with sinus at base containing a ridge of scales. Fore wing narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 stalked, 4 absent; 5 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 stalked; 8 anastomosing with 7.

(1) \**NAVASOTA HEBETELLA*.

*Navasota hebetella* Rag. N. Am. Phyc. p. 18 (1887); id. Rom. Mém. viii. p. 369, pl. 39. f. 5; Dyar, Cat. Lep. N. Am. p. 439. U.S.A., Texas.

(2) †*NAVASOTA PERSECTELLA*, sp. n.

♀. Head and thorax purplish red; abdomen white, dorsally suffused with fulvous yellow towards base; pectus and legs white tinged with rufous. Fore wing purplish pink; the costal area creamy white, narrowing to a point at apex, vein 12 defined by the costa above it being purplish red and by a fine streak below, the costal area defined by a red-brown fascia below; veins 4, 3, and 1 slightly streaked with white. Hind wing white slightly tinged with ochreous brown.

TIMOR, Dili (*Doherty*), 1 ♀ type. *Exp.* 16 mm.

(3) †*NAVASOTA HEMAPHÆLLA*, sp. n.

♀. Head and thorax dusky crimson; abdomen fuscous, the base of dorsal area fulvous. Fore wing dusky crimson with a slightly defined rather paler costal fascia attenuated to a point before apex; a very slight irroration of black scales and traces of a terminal series of points. Hind wing ochreous tinged with pale fuscous.

LOUISIADES, St. Aignan I. (*Meek*), 1 ♀ type. *Exp.* 24 mm.

(4) †*NAVASOTA LEUCONEURELLA*, sp. n.

♂. Head and thorax dusky crimson; abdomen ochreous white. Fore wing crimson; the veins streaked with white, the subcostal and median nervures strongly so and the former defined on lower side by brown suffusion from base to apex. Hind wing yellowish white, the costal area tinged with fuscous.

UGANDA, Kampala (*Ansorge*); TRANSVAAL, White R. (*Cooke*), 1 ♂; NATAL, Estcourt (*Hutchinson*), 1 ♂ type; CAPE COLONY, Transkei (*Miss F. Barrett*), 1 ♂. *Exp.* 24 mm.

(5) †*NAVASOTA CHIONOPHLEBIA*, sp. n.

Head and thorax purplish red mixed with some ochreous white; abdomen rufous, dorsally fulvous yellow on basal half; pectus and legs whitish suffused with rufous. Fore wing purplish pink, the veins strongly streaked with white. Hind wing white tinged with rufous.

S. NIGERIA, Yorubaland, Ogbomoso (*Sir G. Carter*), 1 ♀ ;  
N. NIGERIA, Zungeru (*Simpson, Macfie*), 2 ♀, Minna (*Macfie*),  
1 ♂, 1 ♀ type. *Exp.* 16-22 mm.

(6) †NAVASOTA SYRIGGIA, sp. n.

♀. Head and thorax rufous tinged with purplish pink, the metathorax ochreous white; abdomen fulvous yellow; pectus and legs white, the latter tinged with purplish rufous. Fore wing pale purplish pink, the veins slightly streaked with white. Hind wing white with a faint ochreous tinge.

ARGENTINA, Tucuman, Los Vasquez (*Dinelly*), 1 ♀ type. *Exp.* 24 mm.

(7) NAVASOTA DISCIPUNCTELLA, sp. n.

♀. Head, thorax, and abdomen white mixed with brown, the last faintly tinged with fulvous yellow towards base of dorsum. Fore wing white irrorated with fuscous brown and some pale purplish-pink scales; a black discoidal point; a slight blackish postmedial shade from vein 2 to inner margin.

N. NIGERIA, Minna (*Macfie*), 1 ♀ type. *Exp.* 20 mm.

#### Auctorum.

*Navasota myriolecta* Dyar, Pr. U.S. Nat. Mus. xlvii. p. 347  
(1913) ..... PANAMA.

#### Genus HYPSTROPA.

	Type.
<i>Hypsotropa</i> Zell. Isis, 1848, p. 591 .....	<i>limbella</i> .
<i>Heosphora</i> Meyr. P. Linn. Soc. N.S.W. vii. p. 158 (1882) .....	<i>psamathella</i> .
<i>Seleucia</i> Rag. Ann. Soc. Ent. Fr. 1887, p. 259.	<i>semiroSELLA</i> .
<i>Peoria</i> Rag. N. Am. Phyc. p. 19 (1887) .....	<i>approximella</i> .
<i>Ambala</i> Rag. Nouv. Gen. p. 45 (1888) .....	<i>fuscotrīgella</i> .
<i>Lymira</i> Rag. Nouv. Gen. p. 46 (1888) .....	<i>semiroSELLA</i> .
<i>Tiarra</i> Rag. Nouv. Gen. p. 46 (1888) .....	<i>pusillella</i> .
<i>Socora</i> Rag. Nouv. Gen. p. 46 (1888) .....	<i>tenuicostella</i> .
<i>Talamba</i> Rag. Nouv. Gen. p. 47 (1888) .....	<i>tenuinervella</i> .
<i>Wekiva</i> Hulst, Trans. Am. Ent. Soc. xvii. p. 215 (1890) .....	<i>luteicostella</i> .
<i>Tinitinoa</i> Dyar, Pr. U.S. Nat. Mus. xlvii. p. 347 (1913) .....	<i>phyrdes</i> .

Proboscis aborted and minute; palpi typically obliquely up-turned to far above vertex of head, the 2nd joint fringed with scales in front; maxillary palpi slightly dilated with scales; frons smooth, with tuft of scales; antennæ of male typically somewhat laminate and ciliated, the shaft slightly curved at base. Fore wing narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 separate, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind

wing with vein 2 from just before angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 shortly stalked; 8 strongly anastomosing with 7.

SECT. I. Palpi of male upturned.

A. Palpi of male hollowed out to contain the brush-like maxillary palpi; the antennæ with sinus and ridge of scales at base of shaft.

a. (*Ambala*). Antennæ of male with rather long uniseriate branches, the apex ciliated.

(1) \*HYPSOTROPA CONTRASTELLA.

*Ambala contrastella* Rag. Nouv. Gen. p. 45 (1888); id. Rom. Mém. viii. p. 370, pl. 38. f. 11.

NATAL.

(2) HYPSOTROPA FUSCOSTRIGELLA.

*Ambala fuscotrigella* Rag. Nouv. Gen. p. 45 (1888); id. Rom. Mém. viii. p. 371, pl. 38. f. 10.

PUNJAB.

(3) HYPSOTROPA SUBCOSTELLA, sp. n.

Head and thorax white, the tegulæ and patagia suffused with red-brown; antennæ red-brown; palpi irrorated with red-brown; abdomen white, usually irrorated with brown and dorsally suffused with fulvous yellow towards base; legs irrorated with brown. Fore wing white with a faint pink tinge, and strongly irrorated with brown; an ochreous-brown fascia through the cell from base to apex, extending to just below the cell. Hind wing white with a faint ochreous tinge.

N. NIGERIA, Zungeru (*Macfie, Simpson*), 1 ♂, 2 ♀ type; BR. E. AFRICA, N. Kavirondo, Maramas Distr., Ilala (*Neave*), 2 ♂. *Exp.* 20–28 mm.

(4) HYPSOTROPA PERVITTELLA, sp. n.

Head and thorax white mixed with red-brown; abdomen white tinged with red-brown and dorsally suffused with fulvous yellow towards base. Fore wing white thickly irrorated with red-brown; a red-brown fascia through the cell from base to apex, the veins below it streaked with white. Hind wing white with the costa tinged with brown towards apex.

PUNJAB, Ajmere, 1 ♂; BOMBAY, Deesa (*Nurse*), 1 ♂, 1 ♀ type. *Exp.* 20 mm.

b. Antennæ of male with uniseriate branches below the sinus only, then serrate.

(5) HYPSOTROPA HETERO CERELLA.

*Hypsotropa heterocerella* Hmps. Moths Ind. iv. p. 54 (1896); id. Rom. Mém. viii. p. 371, pl. 52. f. 1.

KASHMIR; PUNJAB.



c. Antennæ of male somewhat laminate and ciliated to base.

(6) *HYPSTROPA OCRACEELLA*, sp. n.

♂. Head and thorax brownish ochreous mixed with some white; abdomen ochreous white, dorsally tinged with fulvous yellow towards base. Fore wing brownish ochreous; a dark brown fascia along median nervure; a diffused antemedial line from cell to inner margin; a diffused dark postmedial line tending to form streaks in the interspaces, oblique to vein 6, then inwardly oblique; a slight dark terminal line. Hind wing white tinged with ochreous brown and with a dark terminal line to submedian fold.

TIMOR, Oinainisa (*Doherty*), 1 ♂ type. *Exp.* 14 mm.

B. Maxillary palpi of male filiform.

a. Antennæ of male with sinus at base of shaft containing a ridge of scales.

a'. (*Socora*). Palpi of male with the 2nd joint obliquely upturned and thickly scaled, the third joint porrect.

(7) \**HYPSTROPA TENUICOSTELLA*.

*Socora tenuicostella* Rag. *Nouv. Gen.* p. 46 (1888); id. *Rom. Mém.* viii. p. 374, pl. 39. f. 6.

GAMBIA.

v'. (*Lymira*). Palpi of male slender, the 3rd joint upturned.

(8) \**HYPSTROPA SEMIROSELLA*.

*Seleucia semiroSELLA* Rag. *Ann. Soc. Ent. Fr.* 1887, p. 259; id. *Rom. Mém.* viii. p. 373, pl. 38. f. 9; *Staud. Cat. Lep. pal.* ii. p. 83.

SYRIA.

(9) *HYPSTROPA ILLECTALIS*.

*Addyme illectalis* Wlk. xxx. 959 (1864); *Rag. Rom. Mém.* viii. p. 373, pl. 38. f. 8.

*Seleucia costatella* Rag. *Nouv. Gen.* p. 46 (1888).

BORNEO; CELEBES.

(10) †*HYPSTROPA BISCRENSIS*, sp. n.

Head and thorax white tinged with red-brown; abdomen creamy white, dorsally suffused with ochreous brown towards base. Fore wing white tinged with ochreous except a white costal fascia narrowing to a point at apex, defined below by a red-brown fascia; the median nervure and veins 5, 3 slightly streaked with white. Hind wing creamy white.

ALGERIA, Biskra (*Walsingham*), 1 ♂, 2 ♀ type, Hammam-es-Salahin (*Walsingham*), 1 ♂. *Exp.* 22-28 mm.

(11) †*HYPSTROPA RHODOCHROELLA*, sp. n.

Head and thorax deep rose-red; abdomen ochreous yellow,

dorsally fulvous yellow towards base; antennæ fulvous yellow; pectus, legs, and ventral surface of abdomen ochreous yellow suffused with brown. Fore wing deep rose-red, the costa and veins strongly streaked with white, the interspaces of costal area tinged with brown. Hind wing ochreous white slightly tinged with brown.

*Hab.* UGANDA, Mulema (*Doggett*), 1 ♂, Ketoma (*Doggett*), 1 ♂; BR. C. AFRICA, Mt. Mlanje (*Neave*), 7 ♂, 3 ♀ type; TRANSVAAL, White R. (*Cooke*), 1 ♂; NATAL, Estcourt (*Hutchinson*), 2 ♂. *Exp.* 20-28 mm.

(12) †HYPSOTROPA ALBIVENALIS.

*Ambala albivenalis* Hmps. J. Bomb. Nat. Hist. Soc. xxi. p. 1250 (1912).

CEYLON.

b. Antennæ of male without sinus at base of shaft containing a ridge of scales.

a<sup>1</sup>. (*Hypsotropa*). Palpi long; antennæ of male with the shaft thickened at base.

(13) \*HYPSOTROPA LUTEICOSTELLA.

*Hypsotropa luteicostella* Rag. N. Am. Phyc. p. 19 (1887); id. Rom. Mém. viii. p. 376, pl. 39. f. 9; Dyar, Cat. Lep. N. Am. p. 439.

U.S.A., Florida.

(14) †HYPSOTROPA OCHRICOSTELLA, sp. n.

♀. Head and tegulæ dark red-brown; thorax purplish red; abdomen fulvous yellow; pectus, legs, and ventral surface of abdomen red-brown. Fore wing deep purple-red; a pale ochreous yellow costal fascia narrowing to a point at apex, the costa tinged with purple-red and irrorated with a few dark scales to beyond middle, the costal fascia defined by diffused dark brown below. Hind wing reddish brown.

MASHONALAND (*Dobbie*), 1 ♀ type. *Exp.* 20 mm.

(15) †HYPSOTROPA CHIONORHABDA, sp. n.

Head and thorax black-brown mixed with some purplé-grey, especially on dorsum of thorax; antennæ whitish tinged with red-brown; abdomen pale reddish brown with darker segmental lines; pectus, legs, and ventral surface of abdomen grey suffused with blackish, the tibiæ and tarsi in front white. Fore wing purplish grey irrorated with black-brown; a silvery white costal fascia narrowing to a point at apex and leaving the costal edge black towards base, defined below by a broad black-brown fascia with diffused lower edge. Hind wing grey suffused with reddish brown and with darker terminal line.

S. NIGERIA, Yorubaland (*Sir G. Carter*), 1 ♂, 1 ♀; N. NIGERIA, Zungeru (*Macfie*), 1 ♂; UGANDA, Gondokoro (*Reymes-Cole*), 1 ♂, Ketoma (*Doggett*), 2 ♂; BR. C. AFRICA, Mt. Mlanje

(*Neave*), 5 ♂, 3 ♀, Luchenyia R. (*Neave*), 6 ♂, 2 ♀ type, Ruov Valley (*Neave*), 1 ♂. *Exp.* 16-24 mm.

(16) HYPSTROPA INFUMATELLA.

*Hypsotropa infumatella* Hmps. Rom. Mém. viii. p. 377, pl. 39. f. 8 (1901).

TRANSVAAL; NATAL.

(17) \*HYPSTROPA UNIPUNCTELLA.

*Hypsotropa unipunctella* Rag. Nouv. Gen. p. 47 (1888); id. Rom. Mém. viii. p. 377, pl. 38. f. 12; Staud. Cat. Lep. pal. ii. p. 12. E. SIBERIA, Amurland.

(18) †HYPSTROPA FUSIFASCIATA, sp. n.

♀. Head and thorax whitish suffused with red-brown; abdomen fulvous yellow, the ventral surface white tinged with red-brown. Fore wing whitish tinged with red-brown and irrorated with blackish; a white costal fascia irrorated with blackish, rather diffused below, the costal edge blackish towards base; a black discoidal point; the terminal area suffused with blackish except at costa; cilia with a blackish line near base. Hind wing whitish strongly suffused with brown; a fine dark terminal line and line near base of cilia.

CEYLON, Kandy (*Green*), 1 ♀ type. *Exp.* 18 mm.

(19) \*HYPSTROPA ZOPHOPLEURA.

*Hypsotropa zophopleura* Turner, Pr. R. Soc. Queensl. xviii. p. 117 (1903).

QUEENSLAND.

(20) †HYPSTROPA PURPURELLA, sp. n.

Head and thorax purple-pink; antennæ fulvous yellow; palpi tinged with fuscous; abdomen fulvous yellow; pectus, legs, and ventral surface of abdomen greyish suffused with fuscous, the claspers of male white. Fore wing purple-pink irrorated with black, the costa brownish; a black spot in the cell near base; antemedial spots in the cell and on vein 1; obliquely placed spots at upper and lower angles of cell; a subterminal series of four spots, the spot at discal fold further from termen; a terminal series of black points. Hind wing ochreous white; a terminal black line; cilia blackish at tips.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 9 ♂, 3 ♀ type. *Exp.*, ♂ 20, ♀ 22 mm.

(21) HYPSTROPA LIMBELLA.

*Hypsotropa limbella* Zell. Isis, 1848, p. 591; Herr.-Schäff. Eur. Schmett. iv. p. 110, Tin. f. 38; Rag. Rom. Mém. viii. p. 376; Staud. Cat. Lep. pal. ii. p. 12.

S. FRANCE; ITALY; DALMATIA; ASIA MINOR.

(22) *HYPSTOTROPA SYRIACELLA*.

*Hypsotropa syriacella* Rag. Nouv. Gen. p. 46 (1888); id. Rom. Mém. viii. p. 377, pl. 39. f. 7; Staud. Cat. Lep. pal. ii. p. 12.  
SYRIA.

(23) \**HYPSTOTROPA SOLIPUNCTELLA*.

*Hypsotropa solipunctella* Rag. Rom. Mém. viii. p. 377, pl. 43. f. 23 (1901).  
JAPAN.

(24) \**HYPSTOTROPA PAUCIPUNCTELLA*.

*Hypsotropa paucipunctella* Rag. Bull. Soc. Ent. Fr. 1895, p. cii; id. Rom. Mém. viii. p. 378, pl. 51. f. 10; Staud. Cat. Lep. pal. ii. p. 13.

ASIA MINOR, TAURUS.

(25) \**HYPSTOTROPA ICHORELLA*.

*Anerastia ichorella* Led. Verh. zool.-bot. Ges. Wien, 1855, p. 221, pl. 3. f. 8; Rag. Rom. Mém. viii. p. 378, pl. 39. f. 10; Staud. Cat. Lep. pal. p. 13.

SYRIA.

(26) *HYPSTOTROPA VULNERATELLA*.

*Epischmia vulneratella* Zell. Isis, 1847, p. 769; Rag. Rom. Mém. viii. p. 378, pl. 39. f. 11; Staud. Cat. Lep. pal. ii. p. 13.

*Anerastia ostrinella* Lah. Bull. Soc. Vaud. vi. Contr. Faun. Sic. p. 396 (1861).

*Hypsotropa roseostrigella* Rag. Rom. Mém. viii. p. 379, pl. 39. f. 12 (1901).

SARDINIA; SICILY; DALMATIA; SYRIA.

(27) †*HYPSTOTROPA SCELETELLA*.

*Anerastia sceletella* Zell. Stett. Ent. Zeit. 1867, p. 404; Hampsn. Moths Ind. iv. p. 54; Rag. Rom. Mém. viii. p. 379, pl. 44. f. 22.

BENGAL, CALCUTTA.

(28) *HYPSTOTROPA WERTHEIMSTEINI*.

*Hypsotropa wertheimsteini* Rebel, Rovart. Lep. xx. p. 171 (1913).

HUNGARY.

(29) †*HYPSTOTROPA PUNCTINERVELLA*, sp. n.

Head and thorax pale red mixed with whitish; abdomen creamy white, dorsally fulvous yellow towards base; palpi rufous, white below towards base; pectus and legs creamy white, the latter irrorated with some red-brown. Fore wing pale red slightly

irrorated with dark brown, the veins and costal edge white; a minute antemedial black spot on vein 1 and postmedial spots on veins 3, 2, 1; a terminal series of slight blackish points. Hind wing ochreous white.

CEYLON, Haputale (*Alston*), 1 ♂ type, Kegalle (*Alston*), 1 ♀, Hambantota (*Pole*), 1 ♀. *Exp.* 14-16 mm.

(30) *HYPSTROPA ADUMBRATELLA*.

*Hypsotropia adumbratella* Rag. Nouv. Gen. p. 47 (1888); id. Rom. Mém. viii. p. 380, pl. 38. f. 13.

GAMBIA; NATAL; CAPE COLONY.

*b.* (*Tiarra*). Palpi short; antennæ of male with the shaft curved at base.

(31) \**HYPSTROPA PUSILLELLA*.

*Tiarra pusillella* Rag. Nouv. Gen. p. 46 (1888); id. Rom. Mém. viii. p. 372, pl. 39. f. 4.

ZANZIBAR.

SECT. II. Palpi of male porrect.

A. (*Talamba*). Palpi of male hollowed out to receive the brush-like maxillary palpi; antennæ with sinus at base of shaft containing a ridge of scales.

(32) *HYPSTROPA TENUINERVELLA*.

*Talamba tenuinervella* Rag. Nouv. Gen. p. 47 (1888); id. Rom. Mém. viii. p. 387, pl. 40. f. 25; Hmps. Moths Ind. iv. p. 55.

PUNJAB, Kangra; MADRAS, Nilgiris.

B. Maxillary palpi filiform.

a. Antennæ of male with sinus at base of shaft containing a ridge of scales.

a<sup>1</sup>. (*Timitinoa*). Antennæ of male pectinate with long uniseriate branches to middle.

(33) \**HYPSTROPA PHYRDES*.

*Timitinoa phyrdes* Dyar, Pr. U.S. Nat. Mus. xlvii. p. 348 (1913).

PANAMA.

*b'*. (*Heosphora*). Antennæ of male laminate.

(34) \**HYPSTROPA PAPUASELLA*.

*Heosphora papuasella* Rag. Nouv. Gen. p. 47 (1888); id. Rom. Mém. xxiii. p. 382, pl. 39. f. 14.

N. GUINEA.

(35) \**HYPSTROPA SABULETELLA*.

*Anerastia sabulella* Zell. Lep. Mic. Caffr. p. 73 (1852); Rag. Rom. Mém. viii. p. 383, pl. 39. f. 18.

CAPE COLONY.

## (36) †HYPSOTROPA CREMORICOSTA, sp. n.

♂. Head and thorax ochreous, the head and tegulae suffused with purplish red; antennae ochreous yellow; abdomen ochreous, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen purplish red. Fore wing pale flesh-red, deepening in colour towards the costal fascia which is ochreous white, narrowing to a point at apex, slightly defined by brown below and leaving the costal edge brown towards base. Hind wing ochreous white, the costal area and termen except towards tornus deeper ochreous.

U.S.A., Colorado, Colorado Springs (*Cockerell*), 1 ♂ type. *Exp.* 24 mm.

## (37) †HYPSOTROPA NIVEICOSTA, sp. n.

♀. Head and thorax white suffused with rufous except on dorsum of thorax; abdomen ochreous white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen white suffused with rufous. Fore wing pale flesh-red irrorated with a few red-brown scales and deepening to rufous towards the costal fascia, which is snow-white narrowing to a point at apex and leaving the costal edge rufous towards base. Hind wing white with a faint ochreous tinge.

ARGENTINA, Gran Chaco, Florenzia (*Wagner*), 1 ♀ type. *Exp.* 20 mm.

## (38) †HYPSOTROPA PERIPHLEA, sp. n.

♀. Head and tegulae white tinged with red-brown; thorax pale purplish pink; abdomen white dorsally tinged with fulvous yellow towards base; pectus, legs, and ventral surface of abdomen white tinged with red-brown. Fore wing pale purplish pink; a pure white costal fascia irrorated with a few brown scales towards costa, narrowing to a point at apex and defined below by dark red-brown, diffused below. Hind wing white with a faint ochreous tinge.

N. NIGERIA, Minna (*Macfie*), 2 ♀ type, Borgu, Yelwa Lake (*Migeod*), 1 ♀. *Exp.* 16 mm.

## (39) †HYPSOTROPA TRIPARTALIS, sp. n.

♀. Head white suffused with rufous; thorax pale purplish pink; abdomen ochreous yellow; pectus and legs ochreous yellow, the fore legs tinged with brown. Fore wing with narrow pure white costal fascia leaving the costal edge brown towards base, the area to discal fold red-brown and the area below it bright purplish pink. Hind wing white with a faint ochreous tinge.

FORMOSA, Takow (*Wileman*), 1 ♀ type. *Exp.* 18 mm.

## (40) †HYPSOTROPA LATERCULELLA.

*Anerastia laterculella* Zell. Stett. Ent. Zeit. 1867, p. 403;

Hmps. Moths Ind. iv. p. 55; Rag. Rom. Mém. viii. p. 383, pl. 44. f. 21.

BENGAL.

(41) †HYPSOTROPA ROSESCENS, sp. n.

♂. Head and thorax purplish red-brown, the latter with the dorsum grey-brown; abdomen fulvous yellow; pectus, legs, and ventral surface of abdomen whitish tinged with brown. Fore wing pale grey-brown suffused with crimson-red, rather browner towards the costal fascia, which is white slightly irrorated with pale red and narrowing to apex. Hind wing white tinged with ochreous brown.

CEYLON, Nawalapitiya (*Green*), 1 ♂ type. *Exp.* 20 mm.

(42) \*HYPSOTROPA STEREOSTICHA.

*Hypsotropa stereosticha* Turner, Pr. R. Soc. Queensl. xix. p. 41 (1905).

QUEENSLAND, Thursday I.

(43) HYPSTOTROPA ICASMOPIS.

*Hypsotropa icasmopis* Turner, Pr. R. Soc. Queensl. xviii. p. 116 (1903).

QUEENSLAND.

(44) HYPSTOTROPA EURYZONA.

*Hypsotropa euryzona* Meyr. Ent. Mo. Mag. xix. p. 256 (1882); Rag. Rom. Mém. viii. p. 382, pl. 39. f. 13.

S. AUSTRALIA.

(45) HYPSTOTROPA NIPHOPLEURA.

*Hypsotropa niphopleura* Turner, Pr. R. Soc. Queensl. xxiv. p. 111 (1913).

N. AUSTRALIA.

(46) †HYPSOTROPA DIAPHEA, sp. n.

♀. Head and thorax black-brown, the frons and metathorax rufous; antennæ rufous; palpi black with a greyish gloss; abdomen grey suffused with brown; pectus, legs, and ventral surface of abdomen grey suffused with blackish. Fore wing whitish; the costal edge black with a flesh-red fascia below it to beyond middle, the area below the cell black with a whitish streak along vein 1. Hind wing whitish strongly suffused with fuscous brown. the cilia whiter with a dark line near base.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♀ type. *Exp.* 24 mm.

(47) HYPSTOTROPA DYSEIMATA.

*Hypsotropa dyseimata* Turner, Pr. R. Soc. Queensl. xxiv. p. 112 (1913).

TIMOR LAUT; N. AUSTRALIA.

(48) *Hypsotropia quadripunctella*.

*Hypsotropia quadripunctella* Hmps. J. Bomb. Nat. Hist. Soc. xii. p. 307 (1897); id. Rom. Mém. viii. p. 384, pl. 39. f. 16.

PUNJAB, Oude; BORNEO; PULO LAUT.

(49) *Hypsotropia psamatHELLA*.

*Anerastia psamatHELLA* Meyr. Proc. Linn. Soc. N.S.W. iv. p. 234 (1879); Rag. Rom. Mém. viii. p. 384, pl. 39. f. 15.

†*Anerastia nitens* Butl. Trans. Ent. Soc. 1886, p. 440.

QUEENSLAND; N. S. WALES.

(50) †*Hypsotropia monostidza*, sp. n.

♀. Head and thorax ochreous with a faint purplish pink tinge; abdomen ochreous with a fulvous yellow tinge; pectus, legs, and ventral surface of abdomen ochreous with a brownish tinge. Fore wing ochreous faintly tinged with purplish pink and irrorated with dark brown; a minute blackish discoidal spot. Hind wing white tinged with ochreous especially towards termen.

SIERRA LEONE (*Clements*), 1 ♀ type. *Exp.* 18 mm.

(51) †*Hypsotropia graptophlebia*, sp. n.

♂. Head and thorax white mixed with purplish red-brown; abdomen white slightly tinged with brown; pectus, legs, and ventral surface of abdomen white suffused with red-brown. Fore wing white suffused with purplish red-brown and slightly irrorated with dark brown, the veins white defined on each side by fine dark brown streaks. Hind wing white tinged with ochreous brown.

MASHONALAND, Salisbury (*Marshall*), 1 ♂ type. *Exp.* 20 mm.

(52) †*Hypsotropia polyactinia*.

*Heosphora polyactinia* Hmps. Rom. Mém. viii. p. 384, pl. 52. f. 2 (1901).

UGANDA; MASHONALAND; TRANSVAAL; NATAL.

(53) †*Hypsotropia endorhoda*, sp. n.

♀. Head and thorax ochreous suffused with purplish pink; abdomen ochreous white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen ochreous white suffused with red-brown. Fore wing with the costal half to median nervure and vein 5 ochreous, tinged with purplish pink towards costa and with slight pale streaks on the veins; the inner half purplish pink with slight white streaks on the veins. Hind wing white tinged with ochreous.

N. RHODESIA (*Coryndon*), 1 ♀ type. *Exp.* 24 mm.

(54) *Hypsotropia ramuloseLLA*.

*Heosphora ramuloseLLA* Rag. Bull. Soc. Ent. Fr. 1895, p. cii; id.



Rom. Mém. viii. p. 385, pl. 52. f. 3; Staud. Cat. Lep. pal. ii. p. 12.

SYRIA.

(55) *HYPSTROPA LEUCOPHLEBIELLA*.

*Heosphora leucophlebiella* Rag. Nouv. Gen. p. 47 (1888); id. Rom. Mém. viii. p. 385, pl. 39. f. 17.

BR. C. AFRICA; MASHONALAND; TRANSVAAL; NATAL; CAPE COLONY.

(56) *HYPSTROPA RHODOSTICHA*.

*Hypstrophia rhodosticha* Turner, Pr. R. Soc. Queensl. xviii. p. 116 (1903).

QUEENSLAND.

b. (*Peoria*). Antennæ of male without sinus and ridge of scales at base of shaft

(57) †*HYPSTROPA POLYSTICTELLA*, sp. n.

♂. Head, thorax, and abdomen whitish suffused with rufous. Fore wing ochreous white suffused with rufous in the interspaces leaving the veins pale; the costal edge black towards base; a slight shade formed by black irroration below the costa to apex; a small antemedial black spot on vein 1, a small spot on lower discocellulars and an oblique postmedial series of four small spots on veins 5, 3, 2, 1; a terminal series of small black spots. Hind wing white tinged with ochreous; a fine fuscous terminal line and slight brown line near base of cilia.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 2 ♂ type. *Exp.* 20 mm.

(58) \**HYPSTROPA ACNIDIAS*.

*Hypstrophia acnidias* Turner, Pr. R. Soc. Queensl. xviii. p. 117 (1903).

QUEENSLAND.

(59) †*HYPSTROPA APPROXIMELLA*.

*Eurhodope approximella* Wlk. xxxv. 1722 (1866); Rag. Rom. Mém. viii. p. 386, pl. 40. f. 24; Dyar, Cat. Lep. N. Am. p. 439.

*Anerastia hamatica* Zell, Verh. zool.-bot. Ges. Wien, 1872, p. 555.

*Anerastia roseatella* Pack. Ann. N. Y. Lyc. Nat. Hist. x. p. 270 (1870).

U.S.A., Massachusetts, N. York, Pennsylvania, Ohio, Illinois, N. Carolina, Texas, Colorado.

(60) †*HYPSTROPA LEUCOCRASPIS*, sp. n.

♂. Head, thorax, and abdomen white suffused with ochreous brown. Fore wing pale ochreous brown, the costal edge white. Hind wing white tinged with ochreous brown especially on apical area.

ARGENTINA, Corrientes, Goya (*Perrens*), 1 ♂ type. *Exp.* 20 mm.

## (61) \*HYPSOTROPA BIPARTELLA.

*Peoria bipartella* Rag. N. Am. Phyc. p. 19 (1887); id. Rom. Mém. viii. p. 386, pl. 40. f. 33; Dyar, Cat. Lep. N. Am. p. 439. U.S.A., N. Carolina.

*Auctorum.*

*Peoria albidella* Hulst, Can. Ent. xxxiii. p. 175 (1900); Dyar, Cat. Lep. N. Am. p. 439 ..... U.S.A., California.  
*Hypsotropha laropis* Turner, Pr. R. Soc. Queensl. xxiv. p. 173 (1913) ..... Queensland.  
 ,, *neurica* Turner, Pr. R. Soc. Queensl. xxiv. p. 113 (1913) ..... N. Australia.  
 ,, *castella* Pag. Zoologica, xxix. p. 163 (1900). Bismarck Arch.

## Genus RAPHIMETOPUS, nov.

Type, *R. spinifrontella*.

Proboscis aborted and minute; palpi downcurved, extending about three times length of head and thickly scaled; maxillary palpi minute and filiform; frons with long flattened corneous plate, somewhat trifid in front and produced to short lateral processes, a corneous plate below the frons; antennæ of male laminate. Fore wing narrow, the apex rounded, the termen obliquely curved; vein 2 from close to angle of cell; 4 absent; 5 from above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 closely approximated to or anastomosing with 7.

## (1) RAPHIMETOPUS SPINIFRONTELLA.

*Anerastia spinifrontella* Rag. Nouv. Gen. p. 48 (1888); id. Rom. Mém. viii. p. 399, pl. 40. f. 2; Hmps. Moths Ind. ii. p. 56.

BOMBAY, Sind.

## (2) RAPHIMETOPUS ABLUTELLA.

*Anerastia ablutella* Zell. Isis, 1839, p. 17; Herr.-Schäff. Eur. Schmett. iv. p. 109, Tin. f. 89; Rag. Rom. Mém. viii. p. 403; Hmps. Moths Ind. iv. p. 56; Staud. Cat. Lep. pal. ii. p. 12.

† *Anerastia stigmatella* Rag. Nouv. Gen. p. 49 (1888); id. Rom. Mém. viii. p. 403, pl. 40. f. 4.

*Anerastia bimaculata* Rag. Nouv. Gen. p. 49 (1888); id. Rom. Mém. viii. p. 404, pl. 40. f. 5; Hmps. Moths Ind. iv. p. 56.

*Anerastia majorella* Roths. Nov. Zool. xx. p. 138 (1913).

SPAIN; SICILY; ALGERIA; N. NIGERIA; CONGO, EGYPT; DAMARLAND; TRANSVAAL; ORANGE R. COLONY; ADEN; ASIA MINOR; PERSIA; W. TURKESTAN; JAPAN; KASHMIR; PUNJAB; MADRAS.

*Auctorum.**Anerastia korbi* Curadja, Iris, xxiv. p. 117 (1910).? = *R. ablutella* ..... CASPIAN SEA.

## Genus METACRATERIA, nov.

Type, *M. pulverulella*.

Proboscis absent; palpi downcurved, extending about twice the length of head and thickly scaled; maxillary palpi minute and filiform; frons with long truncate corneous prominence with raised rim at extremity, a flattened plate below the frons; antennæ of male laminate and ciliated. Fore wing rather narrow, the apex rounded, the termen evenly curved; vein 2 from near angle of cell; 4 absent; 5 from above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 approximated to but not anastomosing with 7.

## (1) METACRATERIA METALLACTIS.

*Anerastia metallactis* Meyr. Trans. Ent. Soc. 1887, p. 622; Rag. Rom. Mém. viii. p. 399, pl. 40. f. 11.

N. S. WALES.

## (2) METACRATERIA PULVERULELLA.

*Anerastia pulverulella* Hmps. Moths Ind. iv. p. 56 (1896); id. Rom. Mém. viii. p. 400, pl. 52. f. 4.

CEYLON.

## (3) †METACRATERIA PERIRRORELLA, sp. n.

♀. Head and thorax red-brown tinged with grey and slightly irrorated with fuscous; abdomen grey suffused with red-brown; palpi below, pectus, legs, and ventral surface of abdomen whitish tinged with red-brown. Fore wing whitish suffused with red-brown and thickly irrorated with black; small spots formed by black irroration at upper and lower angle of cell; cilia with a whitish line at base. Hind wing whitish strongly suffused with reddish brown, the cilia whiter.

MASHONALAND (*Dobbie*), 2 ♀ type. *Exp.* 28 mm.

## (4) METACRATERIA MIASTICTA, sp. n.

♀. Head, thorax, and abdomen whitish suffused with red-brown. Fore wing whitish suffused with red-brown and slightly irrorated with black, especially on the veins; a small black spot at lower angle of cell. Hind wing white tinged with red-brown.

MEXICO, Presidio (*Forrer*), 1 ♀ type, Godman-Salvin Coll. *Exp.* 24 mm.

## Genus PRINANERASTIA\*.

Type, *P. lotella*.

Proboscis absent; palpi downcurved, extending about twice the length of head and thickly scaled; maxillary palpi minute and filiform; frons with rounded prominence with slight raised rim at extremity, a corneous plate below the frons; antennæ of male laminate and minutely ciliated. Fore wing narrow, the apex rounded, the termen evenly curved; vein 2 from towards angle of cell; 4 absent; 5 from above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 stalked, 4 absent; 6; 7 shortly stalked; 8 closely approximated to but not anastomosing with 7.

## (1) PRINANERASTIA LACTEALIS.

*Lymire lactealis* Roths. Nov. Zool. xx. p. 138 (1913).

*Enosima albicostalis* Roths. Nov. Zool. xx. p. 138 (1913).

*Lymire strictipennis* Roths. Nov. Zool. xxii. p. 237 (1915).

ALGERIA; TUNIS.

## (2) PRINANERASTIA NITIDICOSTELLA.

*Anerastia nitidicostella* Rag. Ann. Soc. Ent. Fr. 1887, p. 259; id. Rom. Mém. viii. p. 399, pl. 40. f. 12; Staud. Cat. Lep. pal. ii. p. 12.

S. RUSSIA.

## (3) PRINANERASTIA LOTELLA.

*Tinea lotella* Hübn. Eur. Schmett., Tin. f. 344 (1817); Dup. Lép. Fr. x. pl. 283. f. 6; Herr.-Schäff. Eur. Schmett. iv. p. 100, Tin. ff. 90-92; Leech, Pyr. pl. 10. f. 3; Rag. Rom. Mém. viii. p. 397; Staud. Cat. Lep. pal. ii. p. 12.

*Tinea miniosella* Zinck. Germ. Mag. iii. p. 126 (1818).

*Tinea pulverella* Hübn. Eur. Schmett., Tin. f. 454 (1823).

BRITAIN; FRANCE; GERMANY; AUSTRIA; HUNGARY; SWITZERLAND; W. RUSSIA; ASIA MINOR; PERSIA; W. TURKESTAN.

## (4) \*PRINANERASTIA INCARNATELLA.

*Anerastia incarnatella* Rag. Ann. Soc. Ent. Fr. 1887, p. 259; id. Rom. Mém. viii. p. 398, pl. 38. f. 15; Staud. Cat. Lep. pal. ii. p. 12.

S. RUSSIA.

## Genus CHORTONÆCA, nov.

Type, *C. leucoeraspia*.

Proboscis aborted and minute; palpi of male typically obliquely upturned to above vertex of head and thickly scaled, hollowed out to receive the brush-like maxillary palpi, of female down-

\* The type of *Anerastia* Hübn. is *dignella* Hübn.

curved and about twice the length of head; frons with pointed conical prominence; antennæ of male typically with rather long uniseriate branches, the shaft with sinus at base containing a ridge of scales. Fore wing narrow, the apex rounded, the termen evenly curved; vein 2 from towards angle of cell; 3 and 5 from angle, 4 absent; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 closely approximated to 7 but not anastomosing with it.

SECT. I. Palpi of male obliquely upturned and hollowed out to receive the brush-like maxillary palpi; antennæ pectinate with uniseriate branches, the shaft with sinus and ridge of scales at base.

(1) †CHORTONÆCA LEUCOCRASPIA, sp. n.

Head and thorax whitish suffused with rufous; abdomen white tinged with rufous and dorsally suffused with fulvous yellow towards base; palpi white in front; pectus, legs, and ventral surface of abdomen white tinged with rufous. Fore wing creamy white slightly tinged with rufous; a white costal fascia, narrowing to a point at apex, slightly irrorated with rufous and defined below by a rather diffused rufous streak; the veins white defined on each side by fine rufous streaks; a fine rufous streak in submedian fold. Hind wing semihyaline white.

ALGERIA, Hammam-es-Salahin (*Walsingham*). 2 ♂, 3 ♀ type. *Exp.* 30–34 mm.

*Larva*. White with numerous red-brown lines interrupted at the incisures, the head and 1st thoracic somite wholly red-brown. Feeds in the stems of a reed-like grass.

SECT. II. Palpi of male obliquely upturned and not hollowed out to receive the maxillary palpi, which are filiform; antennæ of male laminate and ciliated with slight sinus at base of shaft, but no ridge of scales.

(2) †CHORTONÆCA MINIMELLA.

*Meliarpha minimella* Hmps. Rom. Mém. viii. p. 392, pl. 52. f. 11 (1901).

BORNEO, Pulo Laut; CELEBES, Talaut I.; N. AUSTRALIA.

SECT. III. Palpi of male downcurved and extending about three times length of head, not hollowed out to receive the maxillary palpi which are filiform; antennæ of male laminate and ciliated, with a sinus at base of shaft containing a ridge of scales.

(3) \*CHORTONÆCA MINORALIS.

*Anerastia minoralis* Lower, Tr. R. Soc. S. Austr. 1903, p. 52.

QUEENSLAND.

(4) CHORTONÆCA EURYSTICHA.

*Anerastia eurystica* Turner, Pr. R. Soc. Queensl. xviii. p. 119 (1903).

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*Hypsotropha niphosema* Turner, Pr. R. Soc. Queensl. xxiv. p. 112 (1913).

QUEENSLAND; N. AUSTRALIA.

Genus RHINAPHE.

	Type.
<i>Rhinaphe</i> Berg, Bull. Soc. Imp. Nat. Mosc. xlix. 2, p. 231 (1874) .....	<i>signaticollis</i> .
<i>Ampycophora</i> Meyr. Pr. Linn. Soc. N.S.W. vii. p. 158 (1882) .....	<i>apotomella</i> .
<i>Comorta</i> Rag. Nouv. Gen. p. 48 (1888) .....	<i>nigricostalis</i> .
<i>Maliarpha</i> Rag. Nouv. Gen. p. 48 (1888) .....	<i>separatella</i> .
<i>Homosassa</i> Hulst; Trans. Am. Ent. Soc. xvii. p. 214 (1890) .....	<i>ella</i> .
<i>Enosima</i> Rag. Rom. Mém. viii. p. 389 (1901)...	<i>neesimella</i> .
<i>Ampycodes</i> Hmpsn. Rom. Mém. viii. p. 393 (1901) .....	<i>pallidicosta</i> .
<i>Erythrophlebia</i> Hmpsn. Rom. Mém. viii. p. 393 (1901) .....	<i>enervella</i> .

Proboscis absent; palpi typically downcurved, extending about three times length of head and thickly scaled; maxillary palpi filiform; frons smooth and rounded; antennæ of male typically laminate and ciliated. Fore wing narrow, the apex rounded, the termen obliquely curved; vein 2 from near angle of cell; 4 absent; 5 from above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from just before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 closely approximated to or anastomosing with 7.

SECT. I. Palpi of male hollowed out to receive the brush-like maxillary palpi.

A. Palpi of male upturned.

a. (*Ampycophora*). Antennæ of male uniserrate.

(1) †RHINAPHE APPROXIMELLA, sp. n.

♀. Head and thorax purplish red, the vertex of head and dorsum of thorax whitish tinged with red; abdomen white, dorsally tinged with fulvous yellow towards base; pectus white; legs red-brown. Fore wing whitish suffused with purplish pink, leaving the veins whiter and defined on each side by fine purplish-red streaks; a white costal fascia tinged with purplish pink at costa, narrowing to a point at apex, defined below by a narrow dark brown streak giving off a fine streak above vein 6. Hind wing white, the costal area and termen tinged with brown.

QUEENSLAND, Peak Downs, 1 ♀ type. *Exp.* 24 mm.

(2) RHINAPHE APOTOMELLA.

*Pempelia apotomella* Meyr. Pr. Linn. Soc. N.S.W. iv. p. 224 (1879); Rag. Rom. Mém. viii. p. 388, pl. 40. f. 17.

PUNJAB; CEYLON; SELANGOR; PHILIPPINES; CELEBES, Sangir I. TIMOR, Oinainisa, Dili; QUEENSLAND.

*b.* (*Comorta*). Antennæ of male laminate.

(3) \*RHINAPHE PLINTHINA.

*Anerastia plinthina* Turner, Pr. R. Soc. Queensl. xix. p. 43 (1905).

QUEENSLAND; N. AUSTRALIA.

(4) †RHINAPHE CASTANEALIS.

*Anerastia castanealis* Hmps. J. Bomb. Nat. Hist. Soc. xxi. p. 1251 (1912).

BR. C. AFRICA; TRANSVAAL; CEYLON; BALI.

(5) †RHINAPHE CELSELLA.

*Araxes celsella* Wlk. xxvii. 193 (1863); Hmps. Moths Ind. iv. p. 55; Rag. Rom. Mém. viii. p. 405, pl. 40. f. 7.

CEYLON; PHILIPPINES.

(6) †RHINAPHE NIGRICOSTALIS.

*Trachonitis nigricostalis* Wlk. xxvii. 40 (1863); Hmps. Moths Ind. iv. p. 57; Rag. Rom. Mém. viii. p. 389, pl. 39. f. 22.

*Comorta atricostella* Rag. Nouv. Gen. p. 48 (1888).

GAMBIA; S. NIGERIA; TRANSVAAL; CEYLON; BURMA; ANDAMANS; BORNEO; FIJI.

(7) RHINAPHE HOLOPHÆA.

*Ampycophora holophæa* Turner, Pr. R. Soc. Queensl. xix. p. 42 (1905).

QUEENSLAND; N. AUSTRALIA.

B. Palpi obliquely upturned.

*a.* Antennæ of male with short uniseriate branches, the apical part ciliated.

(8) RHINAPHE VECTIFERELLA.

*Enosima vectiferella* Rag. Rom. Mém. viii. p. 391, pl. 42. f. 24 (1901).

BR. E. AFRICA; UGANDA; BR. C. AFRICA; TRANSVAAL; MADAGASCAR; COMORO IS.

*b.* (*Enosima*). Antennæ of male laminate.

(9) \*RHINAPHE VENELLA.

*Enosima venella* Hmps. Rom. Mém. viii. p. 391, pl. 40. f. 19 (1901).

COCHIN CHINA.

(10) RHINAPHE NEESIMELLA.

*Enosima neesimella* Rag. Rom. Mém. viii. p. 390, pl. 43. f. 22 (1901).

JAPAN; COREA.

## (11) RHINAPHE FLAVESCENTELLA.

*Enosima flavescentella* Hmpsn. Rom. Mém. viii. p. 390, pl. 40.  
f. 18 (1901).

FORMOSA ; C. CHINA.

*c.* (*Ampycodes*). Palpi downcurved in both sexes; antennæ uniserrate and ciliated, with a large sinus at base of shaft containing a ridge of scales.

## (12) †RHINAPHE STICTELLA.

*Anerastia stictella* Hmpsn. J. Bomb. Nat. Hist. Soc. xviii.  
p. 259 (1908).

PUNJAB.

## (13) †RHINAPHE PALLIDICOSTA.

*Anerastia pallidicosta* Hmpsn. Moths Ind. iv. p. 57 (1896);  
id. Rom. Mém. viii. p. 393, pl. 39. f. 23.

ASSAM ; BURMA.

## (14) \*RHINAPHE HAPLOSHEMA.

*Ampycophora haploschema* Turner, Pr. R. Soc. Queensl. xviii.  
p. 117 (1903).

QUEENSLAND.

SECT. II. Palpi of male not hollowed out to receive the maxillary palpi, which are filiform.

A. (*Maliarpha*). Palpi of male obliquely upturned; the antennæ laminate and ciliated, with a large sinus at base of shaft containing a ridge of scales.

## (15) \*RHINAPHE SEPARATELLA.

*Maliarpha separatella* Rag. Nouv. Gen. p. 48 (1888); id. Rom.  
Mém. viii. p. 392, pl. 39. f. 21.

CAMEROONS.

B. Palpi downcurved in both sexes.

*a.* (*Erythphlebia*). Antennæ of male laminate and ciliated, with a large sinus at base of shaft containing a ridge of scales.

## (16) RHINAPHE ENERVELLA.

*Erythphlebia enervella* Hmpsn. Rom. Mém. viii. p. 394, pl. 39.  
f. 24 (1901).

N. GUINEA ; LOUISIADE IS. ; QUEENSLAND ; W. AUSTRALIA.

## (17) RHINAPHE VIRGINELLA.

*Anerastia virginella* Meyr. Proc. Linn. Soc. N.S.W. iv. p. 233  
(1879); Rag. Rom. Mém. viii. p. 394, pl. 40. f. 8.

QUEENSLAND.



b. Antennæ of male bipectinate, without sinus and ridge of scales at base of shaft.

(18) RHINAPHE BISERIELLA.

*Anerastia biseriella* Hmps. Rom. Mém. viii. p. 397, pl. 52.  
f. 18 (1901).

QUEENSLAND.

c. (*Rhinapha*). Antennæ of male laminate and ciliated, without sinus and ridge of scales at base of shaft.

(19) †RHINAPHE HEMIRHODELLA.

*Anerastia hemirhodella* Hmps. Rom. Mém. viii. p. 402, pl. 52.  
f. 12 (1901).

S. BRAZIL.

(20) RHINAPHE LOTRICELLA.

*Anerastia lotricella* Zell. Isis, 1848, p. 861; Rag. Rom. Mém.  
viii. p. 401, pl. 8. f. 21.

S. BRAZIL.

(21) \*RHINAPHE LEUCOTENIELLA.

*Anerastia leucoteniella* Rag. Nouv. Gen. p. 48 (1888); id. Rom.  
Mém. viii. p. 401, pl. 40. f. 3.

JAPAN.

(22) †RHINAPHE SANGIRENSIS, sp. n.

♀. Head and thorax dark red-brown; abdomen grey tinged with brown and dorsally fulvous yellow towards base; pectus and legs grey suffused with brown. Fore wing deep purple-pink; a white costal fascia narrowing to apex, defined below by diffused dark red-brown and with the costal edge and vein 12 purple-pink. Hind wing whitish tinged with red-brown especially on costal area; a fine brown terminal line except towards tornus.

CELEBES, Sangir I. (*Doherty*), 1 ♀ type. *Exp.* 18 mm.

(23) RHINAPHE BRUNNEOVITTELLA.

*Anerastia brunneovittella* Rag. Nouv. Gen. p. 49 (1888); id. Rom. Mém. viii. p. 401, pl. 40. f. 6; Hmps. Moths Ind. iv. p. 56.

C. CHINA; PUNJAB; BOMBAY; CEYLON.

(24) †RHINAPHE PHÆOSTROTELLA, sp. n.

♀. Head and thorax creamy white mixed with red-brown; abdomen creamy white, dorsally fulvous yellow towards base; pectus and legs creamy white. Fore wing creamy white irrorated with pinkish brown; a creamy white costal fascia with hardly

any brown irroration on it, narrowing to apex and defined below by diffused brown. Hind wing white.

CEYLON, Puttalam (*Pole*), 1 ♀ type. *Exp.* 22 mm.

(25) RHINAPHE SYSSEMA.

*Anerastia syssema* Turner, Pr. R. Soc. Queensl. xxiv. p. 114 (1913).

QUEENSLAND; N. AUSTRALIA; W. AUSTRALIA.

(26) †RHINAPHE LATERITIELLA, sp. n.

♀. Head and thorax grey-brown mixed with some white; abdomen whitish suffused with red-brown, the basal segment white. Fore wing reddish brown, darker towards the pure white costal fascia narrowing to apex. Hind wing white slightly tinged with brown.

B. NIGERIA, Yorubaland, Ogbomoso (*Sir G. Carter*), 1 ♀ type. *Exp.* 20 mm.

(27) \*RHINAPHE ELLA.

*Ephestia ella* Hulst, Ent. Am. iii. p. 138 (1887); Rag. Rom. Mém. viii. p. 400, pl. 40, f. 1; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Florida.

(28) RHINAPHE TALIELLA.

*Anerastia taliella* Hmps. Rom. Mém. viii. p. 402, pl. 53, f. 17 (1901).

QUEENSLAND.

(29) †RHINAPHE YENILINEELLA, sp. n.

♀. Head and thorax white irrorated with reddish brown; abdomen white tinged with red-brown, dorsally fulvous yellow towards base. Fore wing white thickly irrorated with reddish brown, the veins white defined on each side by fine brown streaks. Hind wing white.

SUDAN, Port Sudan (*Waterfield*), 1 ♀ type. *Exp.* 24 mm.

(30) \*RHINAPHE INFUMELLA.

*Anerastia infumella* Rag. Ann. Soc. Ent. Fr. 1887, p. 260; id. Rom. Mém. viii. p. 402, pl. 38, f. 16; Staud. Cat. Lep. pal. ii. p. 12.

PERSIA.

(31) \*RHINAPHE CONSPERSELLA.

*Anerastia conspersella* Rag. Rom. Mém. viii. p. 404, pl. 40, f. 13 (1901).

U.S.A., Colorado.

## (32) \*RHINAPHE SEEBOLDI.

*Anerastia seeboldi* Rag. Ann. Soc. Ent. Fr. 1894, p. 177; id. Iris, xi. pl. 1. f. 7; Staud. Cat. Lep. pal. p. 12.

SPAIN.

## (33) †RHINAPHE ENDONEPHELE, sp. n.

♂. Head, thorax, and abdomen white slightly tinged with red-brown and irrorated with dark scales, the last dorsally fulvous yellow towards base; antennæ brownish. Fore wing white irrorated with blackish and faintly tinged with red-brown; a rather diffused rounded blackish antemedial spot on vein 1; a terminal series of blackish points. Hind wing white faintly tinged with ochreous brown; a slight brown terminal line.

BRAZIL, Rio Janeiro, 2 ♂ type. *Exp.* 20 mm.

## (34) †RHINAPHE IGNETINCTA, sp. n.

♀. Head and thorax ochreous white suffused with fiery red; abdomen ochreous. Fore wing ochreous suffused with fiery red and on costal half tinged with purplish pink; oblique diffused antemedial and medial blackish bars on inner area; two slight dark discoidal points; an indistinct oblique brown postmedial line; a terminal series of slight dark points. Hind wing semi-hyaline white tinged with ochreous especially towards termen.

ARGENTINA, Sta. Fé, Ocampo (*Wagner*), 2 ♀ type, Buenos Ayres (*Wilkinson*), 1 ♀. *Exp.* 22 mm.

## (35) \*RHINAPHE MICTOCHROELLA.

*Anerastia mictochroella* Rag. Nouv. Gen. p. 49 (1888); id. Rom. Mém. viii. p. 404, pl. 40. f. 10.

ARGENTINA, Goya.

## (36) †RHINAPHE FURVIMACULA, sp. n.

♀. Head and thorax ochreous faintly tinged with rufous; abdomen ochreous, dorsally fulvous yellow towards base. Fore wing ochreous faintly tinged with rufous and irrorated with dark brown scales; an oblique slightly sinuous red-brown almost medial line with a conical fulvous-red spot on its outer side in submedian interspace; a small dark brown spot at lower angle of cell; an indistinct brown postmedial line, oblique below vein 5. Hind wing ochreous white suffused with purple-brown especially on terminal half except towards tornus; cilia whiter.

ARGENTINA, Tucuman, Los Vasquez (*Dinelly*), 1 ♀ type. *Exp.* 28 mm.

## (37) RHINAPHE SIGNICOLLIS.

*Rhinaphe signicollis* Berg. Bull. Soc. Imp. Nat. Mosc. xlix. 2, p. 233 (1874); Rag. Rom. Mém. viii. p. 405, pl. 40. f. 9.

ARGENTINA, Gran Chaco, Florenzia, Buenos Ayres.

*Auctorum.*

- Anerastia wiphimela* Lower, Tr. R. Soc. S. Austr. 1903, p. 52,  
nr. *R. castanealis* ..... QUEENSLAND.  
 ,, *ablepta* Turner, Pr. R. Soc. Queensl. xxiv. p. 114  
(1913). ? *Metacrateria*. N. QUEENSLAND;  
N. AUSTRALIA.  
 ,, *argosticha* Turner, Pr. R. Soc. Queensl. xxiv. p. 115  
(1913), nr. *R. enervella* ..... N. AUSTRALIA.  
 ,, *anæmopsis* Turner, Pr. R. Soc. Queensl. xxiv. p. 116  
(1913). ? nr. *R. celsella* ..... N. AUSTRALIA.  
 ,, *baliora* Turner, Pr. R. Soc. Queensl. xxiv. p. 116  
(1913). ? nr. *R. plinthina* ..... QUEENSLAND.  
 ,, *acrophora* Turner, Pr. R. Soc. Queensl. xxiv. p. 117  
(1913). ? Sect. *Erythphlebia* ..... N. AUSTRALIA.  
 ,, *pleurochora*, Turner, Pr. R. Soc. Queensl. xxiv.  
p. 117 (1913). ? Sect. *Euosima* ... QUEENSLAND.  
 ,, *crasnia* Turner, Pr. R. Soc. Queensl. xxiv. p. 117  
(1913). ? Sect. *Erythphlebia*..... QUEENSLAND.  
 ,, *ephestiella* Viard, Bull. Soc. Ent. Fr. 1913, p. 82.  
BASSES ALPES.

## Genus SUDANIA.

*Sudania* Hmps. Rom. Mém. viii. p. 380 (1901)... *subcostella*.  
Type.

Proboscis aborted and minute; palpi upturned to just above vertex of head, the 2nd joint moderately scaled, the 3rd moderate; maxillary palpi filiform; frons smooth, with conical tuft of scales; antennæ of male with short uniseriate branches. Fore wing rather narrow, the apex rounded; vein 2 from near angle of cell; 3 and 5 from angle, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing with vein 2 from before angle of cell; 3 and 5 from angle, 4 absent; 6, 7 stalked; 8 not anastomosing with 7.

## \*SUDANIA SUBCOSTELLA.

*Sudania subcostella* Hmps. Rom. Mém. viii. p. 381, pl. 51.  
f. 11 (1901).

GABOON.

## Genus RHODOCHRYSA.

*Rhodochrysa* Hmps. Rom. Mém. viii. p. 387 (1901). *superbella*.  
Type.

Proboscis aborted and minute; palpi downcurved, extending about twice the length of head and thickly scaled; maxillary palpi filiform; frons smooth, with conical tuft of scales; antennæ of male laminate and minutely ciliated, the shaft slightly curved at base but without ridge of scales. Fore wing narrow, the apex rounded, the termen obliquely curved; vein 2 from towards angle of cell; 3 and 5 separate, 4 absent; 6 from below upper angle; 8, 9, 10 stalked, 8 from beyond 10; 11 from cell. Hind wing

with vein 2 from just before angle of cell; 3 and 5 from angle, closely approximated towards origin, 4 absent; 6, 7 shortly stalked; 8 closely approximated to 7 but not anastomosing with it.

*RHODOCHRYSA SUPERBELLA.*

*Rhodochrysa superbella* Hmps. Rom. Mém. viii. p. 387, pl. 39. f. 12 (1901).

TRANSVAAL; NATAL.

Genus *CENOTROPA*, nov.

Type, *C. limitella*.

Proboscis absent; palpi downcurved, extending about three times length of head and thickly scaled; maxillary palpi minute and filiform; frons with rounded prominence; antennæ of female minutely ciliated. Fore wing long and narrow, the apex rounded; vein 2 from towards angle of cell; 4 absent; 5 from above angle; 6 from below upper angle; 8, 10, 11 stalked, 9 absent. Hind wing with vein 2 from towards angle of cell; 3 and 4 absent; 6, 7 from upper angle; 8 anastomosing strongly with 7.

†*CENOTROPA LIMITELLA*, sp. n.

♀. Head and thorax red-brown mixed with some flesh-white; abdomen red-brown, dorsally fulvous towards base. Fore wing pale purplish pink; a white costal fascia slightly irrorated with purplish red, narrowing to apex and defined below by a rather diffused dark brown streak. Hind wing semihyaline white tinged with flesh-colour, the costal area suffused with brown.

PARAGUAY, Sapucay (*Foster*), 1 ♀ type. *Exp.* 22 mm.

Genus *BANDERA*.

<i>Bandera</i> Rag. N. Am. Phyc. p. 19 (1887).....	Type. <i>binotella</i> .
<i>Osceola</i> Hulst, Smith, List N. Am. Lep. p. 85 (1891), non descr. nec Baird, Rept. 1853 .....	<i>perlepidella</i> .
<i>Chipeta</i> Hulst, Can. Ent. xxiv. p. 62 (1892).....	<i>perlepidella</i> .

Proboscis aborted and minute; palpi downcurved, extending about twice the length of head and roughly scaled; maxillary palpi well developed, filiform; frons smooth and rounded; antennæ of male minutely ciliated, the shaft slightly curved at base. Fore wing narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 from a point or separate; 6 from below upper angle; 9 absent; 10, 11 from cell. Hind wing with vein 2 from just before angle of cell; 3, 5 strongly stalked, 4 absent; 6, 7 from upper angle; 8 anastomosing strongly with 7.

(1) *BANDERA BINOTELLA.*

*Anerastia binotella* Zell. Verh. zool.-bot. Ges. Wien, 1872, p. 108;

Rag. Rom. Mém. viii. p. 409, pl. 44. f. 23; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Texas, New Mexico.

(2) \*BANDERA PERLEPIDELLA.

*Chipeta perlepidella* Hulst, Can. Ent. xxiv. p. 62 (1892); Dyar, Cat. Lep. N. Am. p. 441.

U.S.A., Florida.

(3) BANDERA CUPIDINELLA.

*Bandera cupidinella* Hulst, Ent. Am. iv. p. 119 (1888); Rag. Rom. Mém. viii. p. 410, pl. 45. f. 3; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Colorado, New Mexico.

(4) \*BANDERA SUBLUTEELLA.

*Bandera subluteella* Rag. N. Am. Phyc. p. 19 (1887); id. Rom. Mém. viii. p. 410, pl. 40. f. 21; Dyar, Cat. Lep. N. Am. p. 440.

U.S.A., Colorado, California, New Mexico.

*Auctororum.*

*Bandera virginella* Dyar, Proc. Ent. Soc. Wash. x. p. 116 (1908) ..... U.S.A., Washington.  
 ,, *carneella* Barnes & McD. Contr. Nat. Hist. Lep. N. Am. ii. 4. p. 184, pl. i. f. 5 (1913).  
 U.S.A., Florida.

Genus LAURENTIA.

*Laurentia* Rag. Nouv. Gen. p. 49 (1888) ..... <sup>Type.</sup> *inclavella*.

Proboscis absent; palpi of male upturned to vertex of head, thickly scaled and hollowed out to receive the brush-like maxillary palpi, of female long and downcurved; frons smooth, with tuft of scales; antennæ of male ciliated, the shaft with sinus at base of shaft containing a ridge of scales. Fore wing narrow, the apex rounded, the termen obliquely curved; vein 2 from towards angle of cell; 3 and 5 from angle, 4 absent; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from before angle of cell; 3 and 5 from angle, closely approximated towards base, 4 absent; 6, 7 shortly stalked; 8 anastomosing with 7.

(1) †LAURENTIA ALBIVENELLA, sp. n.

♂. Head and thorax creamy white mixed with some red-brown; abdomen white, dorsally tinged with fulvous yellow towards base; legs tinged with brown. Fore wing creamy white irrorated with some dark brown, the veins white defined

on each side by fine dark brown streaks, the median nervure more strongly streaked with white; a dark brown shade through upper part of cell and thence to termen below apex; the interspaces between veins 4 and 2 shaded with brown; cilia chequered with brown except at base. Hind wing white, the costal area and termen tinged with brown.

FORMOSA, Takow (*Wileman*), 1 ♂ type. *Exp.* 22 mm.

(2) \*LAURENTIA INCLARELLA.

*Laurentia inclarella* Rag. *Nouv. Gen.* p. 49 (1888); *id. Rom. Mém.* viii. p. 408, pl. 38. f. 14.

JAVA.

Genus CALAMOTROPA, nov.

Type, *C. pulverivena*.

Proboscis absent; palpi downcurved, about two and a half times length of head and thickly scaled; maxillary palpi well developed and slightly dilated with scales; frons with large pointed conical prominence clothed with rough scales; antennæ of female minutely ciliated. Fore wing long and narrow, the apex rounded; vein 2 from towards angle of cell; 3 and 5 separate, 4 absent; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from just below angle of cell; 3 and 4 absent; 6, 7 shortly stalked; 8 not anastomosing with 7.

†CALAMOTROPA PULVERIVENA, sp. n.

♀. Head and thorax ochreous slightly tinged with brown; pectus, legs, and abdomen ochreous white. Fore wing ochreous with diffused fuscous irroration along the veins except on costal area; a slight black point at lower angle of cell. Hind wing ochreous white, the costal area and termen tinged with brown.

W. AUSTRALIA, Sherlock R. (*Clements*), 3 ♀ type. *Exp.* 24 mm.

Genus EPIDAURIA.

Type.

*Epidauria* Rag. *Rom. Mém.* viii. p. 405

(1901) ..... *transversariella*.

Proboscis absent; palpi downcurved, extending about three times length of head and thickly scaled; maxillary palpi filiform; frons smooth, with tuft of scales; antennæ of male laminate. Fore wing narrow, the apex rounded, the termen evenly curved; vein 2 from towards angle of cell; 4 absent; 5 from above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from before angle of cell; 3 and 5 from angle; 4 absent; 6, 7 from upper angle; 8 approximated to but not anastomosing with 7.

(1) †*EPIDAURIA PERFASCIELLA*, sp. n.

♀. Head and thorax whitish suffused with rufous; abdomen whitish suffused with rufous and with obscure dark dorsal segmental bands. Fore wing whitish suffused with pale purplish red and slightly irrorated with blackish, the costal area rather whiter; a rather diffused black fascia from base through upper part of cell to termen below apex, forking in end of cell on vein 5 to well beyond the cell; vein 1 white at middle with rather diffused short black streaks above and below it; the postmedial line represented by a slight black mark above vein 6, a very oblique line between veins 5 and 2 and a short streak above vein 1; a terminal series of minute rather V-shaped black marks. Hind wing whitish suffused with reddish brown; cilia ochreous white with a slight brown line near base.

SIERRA LEONE (*Clements*), 1 ♀ type. *Exp.* 28 mm.

(2) \**EPIDAURIA TRANSVERSARIELLA*.

*Anerastia transversariella* Zell. *Isis*, 1848, p. 588; Herr.-Schäff. *Eur. Schmett.* iv. p. 109. *Tin.* f. 33; *Rag. Rom. Mém.* viii. p. 406, pl. 38. f. 17; *Staud. Cat. Lep. pal.* ii. p. 12.

DALMATIA; CORFU; ASIA MINOR.

(3) †*EPIDAURIA CHIONOCRASPIS*, sp. n.

♀. Head white tinged with purplish red; thorax pale purplish red; pectus, legs, and abdomen white tinged with brown. Fore wing with narrow silvery white costal fascia, the area below it dark chocolate-brown to median nervure and on terminal area diffused on its lower side; the rest of wing pale purplish red. Hind wing white with a slight ochreous tinge, the costa tinged with brown.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♀ type. *Exp.* 24 mm.

(4) *EPIDAURIA PHENICEELLA*.

*Epidauria pheniceella* Rag. *Bull. Soc. Ent. Fr.* 1895, p. ciii; *id. Rom. Mém.* viii. p. 407, pl. 52. f. 5; *Staud. Cat. Lep. pal.* ii. p. 12.

ASIA MINOR; SYRIA.

(5) \**EPIDAURIA DISCELLA*.

*Epidauria discella* Rag. *Rom. Mém.* ii. p. 407, pl. 40. f. 14 (1901); *Staud. Cat. Lep. pal.* ii. p. 12.

MESOPOTAMIA.

(6) \**EPIDAURIA STRIGOSA*.

*Anerastia strigosa* *Staud. Hor. Soc. Ent. Ross.* xv. p. 225 (1879); *Rag. Rom. Mém.* viii. p. 407, pl. 45. f. 2; *Staud. Cat. Lep. pal.* ii. p. 12.

DALMATIA; ASIA MINOR; SYRIA; E. SIBERIA.



## (7) †EPIDAURIA SUBCOSTELLA, sp. n.

♀. Head, thorax, and abdomen whitish mixed with brown; the last dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen whitish suffused with dark brown. Fore wing whitish suffused with ochreous brown, the costa with a white streak below it to beyond middle defined below by a dark brown streak extending to apex. Hind wing whitish suffused with brown, the inner area whiter.

YUNNAN, Teng. Yeuk (*Hobson*), 1 ♀ type. *Exp.* 26 mm.

## Genus SALURIA.

	Type.
<i>Saluria</i> Rag. Ann. Soc. Ent. Fr. 1887, p. 258.	<i>maculivittella</i> .
<i>Poujadia</i> Rag. Nouv. Gen. p. 42 (1888) .....	<i>sepicostella</i> .
<i>Baroda</i> Rag. Nouv. Gen. p. 42 (1888) .....	<i>paucigraphella</i> .
<i>Goya</i> Rag. Nouv. Gen. p. 43 (1888) .....	<i>albivenella</i> .
<i>Pectinigeria</i> Rag. Nouv. Gen. p. 43 (1888, Apr.) .....	<i>macrella</i> .
<i>Cayuga</i> Hulst, Ent. Am. iv. p. 116 (1888, Sept.) .....	<i>gemmatella</i> .
<i>Atascosa</i> Hulst, Trans. Am. Ent. Soc. xvii. p. 210 (1890) .....	<i>glareosella</i> .
<i>Parramatta</i> Hmps. Rom. Mém. viii. p. 366 (1901) .....	<i>ensiferella</i> .
<i>Ollia</i> Dyar, J. N. Y. Ent. Soc. xii. p. 107 (1904) .....	<i>santaritella</i> .
<i>Eumooera</i> Dyar, Insec. Inscit. Meustr. v. p. 91 (1917) .....	<i>anchridis</i> .

Proboscis aborted and minute; palpi of male typically down-curved, extending about three times length of head and thickly scaled, the 3rd joint moderate; maxillary palpi filiform; frons smooth with slight tuft of hair; antennæ of male typically with long uniseriate branches and without sinus and ridge of scales at base of shaft. Fore wing long and narrow, the apex rounded, the termen evenly curved; vein 3 from close to angle of cell; 4, 5 strongly stalked; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 shortly stalked; 8 typically not anastomosing with 7.

SECT. I. Palpi of male hollowed out to receive the brush-like maxillary palpi.

A. Antennæ of male with a sinus at base of shaft containing a ridge of scales.

a. Antennæ of male pectinate with long uniseriate branches.

a'. Palpi of male oblique.

## (1) SALURIA ERODELLA.

*Poujadia erodella* Rag. Nouv. Gen. p. 48 (1888); id. Rom. Mém. viii. p. 347, pl. 37. f. 5; Hmps. Moths Ind. iv. p. 59.

*Poujadia parviphumella* Hmps. Moths Ind. iv. p. 59 (1896).

PUNJAB; BENGAL; MADRAS; CEYLON.

*♂*. (*Baroda*). Palpi of male downcurved.

(2) SALURIA CTENUCHA.

*Poujadia ctenucha* Turner, Pr. R. Soc. Queensl. xxiv. p. 118 (1913).

N. AUSTRALIA.

(3) \*SALURIA FLAMMELLA.

*Baroda flammella* Hmps. Rom. Mém. viii. p. 348, pl. 51. f. 12 (1901).

GAMBIA.

(4) †SALURIA CAENESCENS, sp. n.

Head and thorax pale rufous; abdomen white tinged with rufous, dorsally fulvous yellow towards base; pectus and legs whitish suffused with rufous. Fore wing with the inner half pale purplish pink shading to rufous towards the white costal fascia, narrowing to apex; the costal edge pale purplish red on basal half. Hind wing white with an ochreous tinge.

ARGENTINA, Sta. Fé, Ocampo (*Wagner*), 1 ♂ type, Gran Chaco, Florenzia (*Wagner*), 1 ♀. *Exp.* 28–30 mm.

(5) †SALURIA PSAMMATELLA, sp. n.

♂. Head, thorax, and abdomen white tinged with ochreous brown; antennæ red-brown, white towards base. Fore wing white tinged with ochreous brown, the costal area rather whiter. Hind wing white faintly tinged with ochreous on costal half; a fine dark terminal line.

♀. Fore wing more strongly suffused with ochreous brown leaving a distinct white costal fascia narrowing to apex.

ALGERIA, Hamman-es-Salahin (*Walsingham*), 1 ♂, 1 ♀ type. *Exp.* 26–32 mm.

(6) †SALURIA PAUCIGRAPHELLA.

*Baroda paucigraphella* Rag. Nouv. Gen. p. 48 (1888); id. Rom. Mém. viii. p. 348, pl. 38. f. 5; Hmps. Moths Ind. iv. p. 60.

BENGAL, Calcutta; BOMBAY, Kutch; MADRAS.

*♂*. Antennæ of male pectinate with short uniseriate branches; palpi oblique.

(7) †SALURIA HEMIPHÆALIS.

*Saluria hemiphæalis* Hmps. J. Bomb. Nat. Hist. Soc. xxi. p. 1251 (1912).

CEYLON.

(8) †SALURIA SEMIROSELLA, sp. n.

Head whitish suffused with rufous; thorax pale purplish pink

with some rufous on shoulders; abdomen white tinged with red-brown, dorsally fulvous yellow towards base; pectus and legs white tinged with red-brown. Fore wing with the inner half pale purplish pink, the veins finely streaked with white; the cell and area beyond it red-brown below the white costal fascia narrowing to apex; the costal edge red-brown towards base, then pale pink to beyond middle. Hind wing white tinged with red-brown, the cilia whiter with a red-brown line near base.

SIERRA LEONE (*Clements*), 1 ♂, 2 ♀; UGANDA, Nakwai Hills (*Lowe*), 1 ♂, Gondokoro (*Reymes-Cole*), 1 ♂ type. *Exp.* 16-20 mm.

c. Antennæ of male strongly serrate; palpi downcurved.

(9) †*SALURIA MINUTELLA*.

*Saluria minutella* Hmps. J. Bomb. Nat. Hist. Soc. xv. p. 20 (1903).

BOMBAY; CEYLON, sp. n.

(10) †*SALURIA NILGIRIENSIS*, sp. n.

♂. Head and thorax pale rufous; abdomen white tinged with rufous; antennæ with some black in the ridge of scales; pectus, legs, and ventral surface of abdomen brown. Fore wing with the inner half creamy white suffused with rufous varying to purplish pink; the upper part of cell and area beyond it brown below the white costal fascia narrowing to apex; the costal edge brown towards base, then irrorated with rufous; a rather oblique post-medial series of short dark streaks on veins 6 to 1 and a terminal series of slight dark points. Hind wing white tinged with brown especially on costal area, the cilia whiter with a slight brown line near base.

MADRAS, Nilgiris, Pykara (*Andrewes*), 4 ♂ type. *Exp.* 26-28 mm.

d. (*Poujadia*). Antennæ of male laminate; palpi oblique.

(11) *SALURIA SEPICOSTELLA*.

*Poujadia sepicostella* Rag. Nouv. Gen. p. 42 (1888); id. Rom. Mém. viii. p. 345, pl. 36. f. 2; Hmps. Moths Ind. iv. p. 58.

FORMOSA; PUNJAB; BORNEO, Pulo Laut.

(12) *SALURIA CLARICOSTELLA*.

*Poujadia claricostella* Rag. Nouv. Gen. p. 42 (1888); id. Rom. Mém. viii. p. 345, pl. 36. f. 26.

GOLD COAST; BR. C. AFRICA.

(13) †*SALURIA GLAREOSELLA*.

*Anerastia glareosella* Zell. Verh. zool.-bot. Ges. Wien, 1872,

p. 553; Rag. Rom. Mém. viii. p. 345, pl. 37. f. 19; Dyar, Cat. Lep. N. Am. p. 438.

U.S.A., Texas.

(14) †*SALURIA STICTOPHORA*, sp. n.

Head and thorax reddish brown; abdomen whitish tinged with brown, dorsally fulvous yellow towards base; antennæ of male with the ridge of scales black; pectus, legs, and ventral surface of abdomen white mixed with brown. Fore wing whitish suffused with brown and thickly irrorated with dark brown; a white costal fascia slightly irrorated with dark brown and rather diffused below; a small round black discoidal spot; an indistinct rather diffused blackish postmedial line not quite reaching the costa; cilia with a fine white line at base. Hind wing whitish suffused with brown.

MASHONALAND, Salisbury (*Marshall*), 1 ♂, 1 ♀ type. *Exp.* 20 mm.

(15) *SALURIA SPURCELLA*.

*Poujadia spurcella* Rag. Nouv. Gen. p. 42 (1888); id. Rom. Mém. viii. p. 346, pl. 37. f. 4; Hmps. Moths Ind. iv. p. 59.

PUNJAB; BOMBAY; MADRAS; BURMA; LABUAN.

(16) †*SALURIA INFICITA*.

*Acrobasis inficita* Wlk. xxvii. 30 (1863); Hmps. Moths Ind. iv. p. 58; Rag. Rom. Mém. viii. p. 346, pl. 44. f. 18.

TRANSVAAL; MADRAS; CEYLON.

(17) †*SALURIA FLAVICOSTA*, sp. n.

Head rufous; thorax grey-brown, the tegulæ dorsally rufous; abdomen grey-brown, the 2nd and 3rd segments dorsally fulvous yellow, the anal segment pale yellow; antennæ brown; palpi yellow with black patch on 2nd segment above; pectus, legs, and ventral surface of abdomen grey-brown and whitish. Fore wing dark brown glossed with grey; a narrow pale yellow costal fascia, the costal edge dark towards base. Hind wing pale grey-brown, the cilia whitish with a brown line near base.

SIERRA LEONE (*Clements*), 1 ♂; N. NIGERIA, Zungeru (*Macfie*), 1 ♂ type. *Exp.* 16 mm.

(18) \**SALURIA FLOSCELLA*.

*Atacoea floscella* Hulst, Trans. Am. Ent. Soc. xvii. p. 210 (1890); Rag. Rom. Mém. viii. p. 346, pl. 51. f. 4; Dyar, Cat. Lep. N. Am. p. 438.

U.S.A., Texas.

(19) †*SALURIA STICTELLA*, sp. n.

♂. Head and thorax brownish ochreous; abdomen ochreous

white, dorsally fulvous yellow towards base; palpi white below towards base; pectus, legs, and ventral surface of abdomen white, the legs tinged with brown. Fore wing white tinged with ochreous brown except the costal area to discal fold, irrorated with black scales, the costal and inner areas less irrorated; small obliquely placed black antemedial spots in and below the cell and a discoidal spot; a postmedial series of black points on veins 6 to 1 and a terminal series of slight black points. Hind wing white tinged with ochreous brown.

BAHAMAS, Andros (*Bonhote*), 1 ♂ type. *Exp.* 16 mm.

(20) SALURIA OCHRIDORSELLA.

*Poujadia ochridorsella* Rag. *Nouv. Gen.* p. 42 (1888); id. *Rom. Mém.* viii. p. 347, p. 37. f. 1; *Hmps. Moths Ind.* iv. p. 58.

PUNJAB; BENGAL; CEYLON.

(21) †SALURIA ROSELLA.

*Poujadia rosella* *Hmps. Moths Ind.* iv. p. 59 (1896); id. *Rom. Mém.* viii. p. 347, pl. 51. f. 20.

MADRAS, Nilgiris.

(22) †SALURIA VERECUNDELLA.

*Poujadia verecundella* Rag. *Rom. Mém.* viii. p. 347, pl. 37. f. 2 (1901).

COLOMBIA; S. BRAZIL; ARGENTINA.

(23) †SALURIA LENTISTRIGELLA, sp. n.

Head and thorax white, the tegulae except dorsally and the patagia slightly tinged with rufous; abdomen white slightly tinged with rufous, dorsally fulvous yellow towards base. Fore wing chalky white, the veins defined by slight streaks of red-brown scales and the inner area slightly irrorated with red-brown; a faint rufous shade below median nervure; a small rather diffused round blackish spot on vein 1 and slight obliquely placed postmedial spots on veins 2 and 1; a fine punctiform blackish terminal line; cilia chequered with blackish near base except towards tornus. Hind wing white with fine brown terminal line except towards tornus.

SIERRA LEONE (*Clements*), 1 ♂; GOLD COAST. Bibianaha (*Spurrell*), 2 ♂, 1 ♀ type. *Exp.* 22-24 mm.

(24) †SALURIA DESERTELLA, sp. n.

♀. Head and thorax white faintly tinged with rufous; abdomen white, dorsally fulvous yellow towards base. Fore wing white tinged with ochreous, the cilia whiter. Hind wing white.

N. AUSTRALIA, Alexandria (*Stalker*), 3 ♀; W. AUSTRALIA, Sherleck R. (*Clements*), 1 ♀ type. *Exp.* 22-32 mm.

PROC. ZOOL. SOC.—1918, No. VII.

B. (*Eumoorea*). Antennæ of male laminate, without sinus and ridge of scales at base of shaft.

(25) \*SALURIA ANCHRIDIS.

*Eumoorea anchridis* Dyar, Insec. Insect. Mentr. v. p. 91 (1917).  
BR. GUIANA.

(26) †SALURIA FLAVIPURPURELLA, sp. n.

♂. Head and thorax rufous mixed with ochreous; abdomen ochreous rufous, dorsally fulvous yellow towards base; pectus and legs white suffused with brown; ventral surface of abdomen brown, whitish at base. Fore wing with creamy white costal fascia narrowing to apex, the costal edge blackish at base, defined below by dark brown followed by deep purple-pink to just below the cell and vein 4, the inner half of wing yellow. Hind wing ochreous white, the apical area tinged with brown.

PARAGUAY, Sapucay (*Foster*), 1 ♂ type. *Exp.* 16 mm.

SECT. II. Maxillary palpi of male filiform.

A. Antennæ of male with a sinus at base of shaft containing a ridge of scales.

a. Antennæ of male pectinate with rather long uniseriate branches to about half length; palpi downcurved.

(27) †SALURIA PARANENSIS.

*Pectinigeria paranensis* Hmps. Rom. Mém. viii. p. 355, pl. 55.  
f. 6 (1901).

S. BRAZIL.

(28) \*SALURIA MUSÆELLA.

*Pectinigeria musæella* Schaus, A. M. N. H. (8) xi. p. 239 (1913).  
COSTA RICA.

(29) †SALURIA TENUICOSTA, sp. n.

Head and thorax rufous tinged with pale pink; abdomen ochreous, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen whitish suffused with red-brown. Fore wing pale purplish red sparsely irrorated with black; a narrow white costal fascia defined below by blackish to beyond middle; a terminal series of slight dark points. Hind wing white, tinged with ochreous brown on costal area and termen.

PARAGUAY, Sapucay (*Foster*), 1 ♂, 1 ♀ type. *Exp.* 18 mm.

(30) SALURIA PLEUROSTICHA.

*Hypsotropha pleurosticha* Turner, Pr. R. Soc. Queensl. xviii.  
p. 115 (1903).

QUEENSLAND.

(31) †SALURIA NEURICELLA, sp. n.

Head and thorax rufous mixed with some whitish; abdomen

ochreous white, dorsally fulvous yellow towards base; pectus and legs white suffused with brown. Fore wing rufous tinged with purplish pink, the veins streaked with white. Hind wing whitish suffused with ochreous brown, the cilia whiter.

QUEENSLAND, Peak Downs, 1 ♂, 1 ♀ type. *Exp.* 22 mm.

b. Antennæ of male laminate and ciliated.

a. (*Goya*). Palpi oblique, the 3rd joint porrect.

(32) SALURIA ALBIVENELLA.

*Goya albivenella* Rag. Nouv. Gen. p. 43 (1888); id. Rom. Mém. viii. p. 349, pl. 37. f. 6.

S. BRAZIL; ARGENTINA.

(33) \*SALURIA VARICOSELLA.

*Goya varicosella* Rag. Nouv. Gen. p. 43 (1888); id. Rom. Mém. viii. p. 350, pl. 37. f. 7.

GAMBIA.

(34) †SALURIA PROLEUCELLA, sp. n.

♂. Head and thorax white suffused with red-brown; abdomen white tinged with red-brown, dorsally fulvous yellow towards base. Fore wing white tinged and irrorated with red-brown, the veins finely streaked with white; a white costal fascia slightly irrorated with red-brown, narrowing to apex. Hind wing creamy white, the costal area faintly tinged with brown.

GOLD COAST, Accrā (*Sir G. Carter*), 1 ♂ type. *Exp.* 22 mm.

(35) †SALURIA GRAMMIVENA, sp. n.

Head, thorax, and abdomen white suffused with red-brown; pectus, legs, and ventral surface of abdomen white irrorated with red-brown. Fore wing white thickly irrorated with red-brown, the veins strongly streaked with white and defined on each side by fine red-brown streaks; cilia whitish. Hind wing white tinged with red-brown.

N. AUSTRALIA, Alexandria (*Stalker*), 1 ♂; W. AUSTRALIA, Sherlock R. (*Clements*), 1 ♀ type. *Exp.* 26 mm.

b'. (*Pectinigeria*). Palpi downcurved.

(36) SALURIA NIGRITELLA.

*Pectinigeria nigritella* Rag. Rom. Mém. viii. p. 353, pl. 37. f. 13 (1901).

GABOON; N. RHODESIA.

(37) \*SALURIA ARDIFERELLA.

*Attoona ardiferella* Hulst, Ent. Am. iv. pl. 118 (1888); Rag. Rom. Mém. viii. p. 506, p. 24. f. 14; Dyar, Cat. Lep. N. Am. p. 439.

*Aurora nigromaculella* Hulst, J. N. Y. Ent. Soc. viii. p. 224 (1900); Dyar, Cat. Lep. N. Am. p. 438.

U.S.A., Texas, Colorado, California, N. Mexico, Arizona.

(38) SALURIA DEVYLDERI.

*Pectinigeria devylderi* Rag. Nouv. Gen. p. 43 (1888); id. Rom. Mém. viii. p. 354, pl. 37. f. 10.

N. RHODESIA; DAMARALAND; NATAL.

(39) SALURIA ARCTICOSTELLA.

*Pectinigeria arcticostella* Rag. Nouv. Gen. p. 43 (1888); id. Rom. Mém. viii. p. 354, pl. 37. f. 9.

N. NIGERIA; ZANZIBAR.

(40) \*SALURIA FURVELLA.

*Pectinigeria furvella* Rag. Nouv. Gen. p. 43 (1888); id. Rom. Mém. viii. p. 355, pl. 37. f. 11.

MADAGASCAR.

(41) SALURIA MACRELLA.

*Pectinigeria macrella* Rag. Nouv. Gen. p. 44 (1888); id. Rom. Mém. viii. p. 355, pl. 37. f. 16.

BR. C. AFRICA; NATAL.

(42) SALURIA SUBCARNELLA.

*Pectinigeria subcarnella* Rag. Nouv. Gen. p. 44 (1888); id. Rom. Mém. viii. p. 356, pl. 37. f. 15.

N. NIGERIA; TRANSVAAL; NATAL; CAPE COLONY.

(43) SALURIA GEMMATELLA.

*Spermatophora gemmatella* Hulst, Ent. Am. iii. p. 134 (1887); Rag. Rom. Mém. viii. p. 356, pl. 37. f. 12; Dyar, Cat. Lep. N. Am. p. 438.

U.S.A., Illinois, Colorado, California.

(44) †SALURIA RHODOPHÆA, sp. n.

♀. Head and thorax vinous purple; abdomen fulvous tinged with brown except dorsally towards base; palpi, pectus, legs, and ventral surface of abdomen red-brown. Fore wing vinous purple with a slight whitish streak on subcostal nervure tending to fork at extremity and defined below by a dark fascia extending through the cell to apex. Hind wing ochreous white tinged with brown especially towards costa.

TRANSVAAL (*Peal*), 1 ♀ type. *Exp.* 24 mm.

(45) †SALURIA SUBCOSTELLA, sp. n.

♀. Head and thorax deep rufous mixed with some whitish especially on metathorax; abdomen fulvous with slight whitish



segmental lines and the extremity whitish; pectus, legs, and ventral surface of abdomen whitish suffused with red-brown. Fore wing whitish tinged with red-brown; the costal edge dark brown to well beyond middle; a white costal fascia narrowing to apex, defined below by a dark brown fascia. Hind wing ochreous white tinged with brown especially towards costa.

BR. C. AFRICA, Mt. Mlanje (*Newe*), 1 ♀ type. *Exp.* 30 mm.

(46) †*SALURIA DISTICTELLA*, sp. n.

♂. Head and thorax whitish, the vertex of head, tegulæ and patagia suffused with red-brown; antennæ tinged with dark brown; palpi with some blackish scales at side of 2nd joint; abdomen white, dorsally fulvous yellow towards base; legs tinged with red-brown. Fore wing white tinged with flesh-pink; a pure white costal fascia narrowing to apex and defined below by rufous which is rather diffused below; an antemedial red-brown point on vein 1 and medial point in submedian fold. Hind wing white.

QUEENSLAND, Brisbane, 1 ♂ type. *Exp.* 20 mm.

(47) †*SALURIA RUFELLA*, sp. n.

♀. Head and thorax rufous; abdomen whitish suffused with brown, dorsally fulvous yellow towards base; pectus and legs whitish suffused with rufous. Fore wing uniform rufous. Hind wing ochreous white.

BENGAL, Oudh (*Pilcher*), 1 ♀ type. *Exp.* 26 mm.

(48) †*SALURIA OPIFICELLA*.

*Anerastia opificella* Zell. Stett. Ent. Zeit. 1867, p. 406; Hmps. Moths Ind. iv. p. 60; Rag. Rom. Mém. viii. p. 357, pl. 44. f. 16.

KASHMIR; BENGAL; CEYLON; BURMA.

(49) \**SALURIA BREVICULELLA*.

*Saluria breviculella* Hmps. J. Bomb. Nat. Hist. Soc. xii. p. 308 (1898); id. Rom. Mém. viii. p. 358, pl. 37. f. 14.

BOMBAY.

B. Antennæ of male without sinus and ridge of scales at base of shaft.

a. (*Parramatta*). Hind wing with vein 8 anastomosing with 7; antennæ of male laminate and ciliated.

(50) *SALURIA DICHROELLA*.

*Saluria dichroella* Rag. Ent. Am. v. p. 113 (1889); id. Rom. Mém. viii. p. 363, pl. 39. f. 1; Dyar, Cat. Lep. N. Am. p. 439.

U.S.A., Texas.

(51) \**SALURIA NEOTOMELLA*.

*Eucarphia neotomella* Meyr. Proc. Linn. Soc. N. S. W. iv. p. 226 (1879); Rag. Rom. Mém. viii. p. 363, pl. 37. f. 25.

N. S. WALES.

## (52) \*SALURIA OSTREELLA.

*Saluria ostreella* Rag. N. Am. Phyc. p. 18 (1887); id. Rom. Mém. viii. p. 362, pl. 38. f. 6; Dyar, Cat. Lep. N. Am. p. 438.  
U.S.A., Arizona.

## (53) †SALURIA TETRADELLA.

*Anerastia tetradella* Zell. Verh. zool.-bot. Ges. Wien, 1872, p. 552; Rag. Rom. Mém. viii. p. 362, pl. 42. f. 23; Dyar, Cat. Lep. N. Am. p. 439.  
U.S.A., Texas, Colorado.

## (54) SALURIA HOLOCHROA.

*Poujadia holochroa* Turner, Pr. R. Soc. Queensl. xviii. p. 121 (1903).  
W. AUSTRALIA; VICTORIA.

## (55) \*SALURIA CANCELLIELLA.

*Saluria cancelliella* Rag. Nouv. Gen. p. 44 (1888); id. Rom. Mém. viii. p. 363, pl. 37. f. 23.  
BRAZIL.

## (56) \*SALURIA ENSIFERELLA.

*Eucarphia ensiferella* Meyr. Proc. Linn. Soc. N.S. W. iii. p. 209 (1878); Rag. Rom. Mém. viii. p. 366, pl. 39. f. 2.  
N. S. WALES.

b. Hind wing with vein 8 not anastomosing with 7.

a'. (*Saluria*). Antenna of male pectinate with long uniseriate branches.

## (57) \*SALURIA PECTIGERELLA.

*Saluria pectigerella* Rag. Ann. Soc. Ent. Fr. 1887, p. 259; id. Rom. Mém. viii. p. 360, pl. 37. f. 24; Staud. Cat. Lep. Pal. ii. p. 13.

W. TURKESTAN.

## (58) SALURIA MACULIVITTELLA.

*Saluria maculivittella* Rag. Ann. Soc. Ent. Fr. 1887, p. 258; id. Rom. Mém. viii. p. 361, pl. 38. f. 7; Staud. Cat. Lep. pal. ii. p. 13.

*Saluria armeniella* Rag. Nouv. Gen. p. 44 (1888).

ALGERIA; TUNIS; ARMENIA; CYPRUS; W. TURKESTAN; CEYLON.

## (59) †SALURIA PULVEROSA.

*Poujadia pulverosa* Hmps. Moths Ind. iv. p. 60 (1896); id. Rom. Mém. viii. p. 361, pl. 37. f. 3.

SIND.

(60) \**SALURIA MAGNESIELLA*.

*Saluria magnesiella* Rag. Nouv. Gen. p. 44 (1888); id. Rom. Mém. viii. p. 360, pl. 37. f. 18; Staud. Cat. Lep. pal. ii p. 13  
W. TURKESTAN.

*b*. Antennæ of male serrate and ciliated.

(61) †*SALURIA MESOMELANELLA*, sp. n.

♀. Head purple-red and black-brown; thorax purple-red and whitish; abdomen whitish suffused with brown, dorsally rufous towards base; pectus, legs, and ventral surface of abdomen whitish suffused with red-brown and dark brown. Fore wing whitish tinged with purplish pink, the costa and termen deep purple-erimson, the medial area suffused with black except at costa, and the costa defined below by black; an antemedial black point on vein 1 with a purple-pink shade below it on inner margin; the inner edge of the medial black area obliquely curved and its outer edge bent inwards below submedian fold; cilia pale fuscous. Hind wing white tinged with brown especially at termen, the cilia with a fine brown line near base.

TRANSVAAL, White R. (*Cooke*), 1 ♀ type. *Exp.* 28 mm.

(62) *SALURIA TRIPARTELLA*.

*Saluria tripartella* Rag. Rom. Mém. viii. p. 359, pl. 39. f. 19 (1901).

TRANSVAAL; NATAL; BASUTOLAND.

(63) *SALURIA CALLIRHODA*.

*Poujadia callirhoda* Turner, Pr. R. Soc. Queensl. xviii. p. 120 (1903).

QUEENSLAND.

(64) †*SALURIA INTERPUNCTELLA*, sp. n.

Head, thorax, and abdomen ochreous suffused with rufous; pectus, legs, and ventral surface of abdomen reddish ochreous mixed with brown. Fore wing ochreous suffused with rufous; the veins white defined on each side by fine black-brown streaks, the submedian fold and vein 1 defined by fine rufous streaks; the costal edge black towards base; an antemedial black point on vein 1, a point in lower angle of cell, an oblique postmedial series in the interspaces, incurved below submedian fold and a terminal series. Hind wing ochreous with a fine brownish terminal line except towards tornus.

MASHONALAND (*Dobbie*), 2 ♂, 2 ♀ type; TRANSVAAL, Kranspruit (*Janse*), 1 ♀, Pretoria (*Distant*), 1 ♀. *Exp.* 20–24 mm.

(65) †*SALURIA INSIGNIFICELLA*, sp. n.

♀. Head and thorax white mixed with red-brown; abdomen white tinged with brown, dorsally fulvous yellow towards base.

Fore wing whitish tinged with red-brown, especially towards costa; the costa narrowly white. Hind wing white tinged with red-brown.

PARAGUAY, Sapucay (*Foster*), 1 ♀ type *Exp.* 18 mm.

*Auctororum.*

- Atascosa quadricolorella* Dyar, Proc. Ent. Soc. Wash. vi. p. 114 (1904). Sect. *Poujadia* ..... U.S.A., N. Mexico.  
*Poujadia pinella* Dyar, J. N. Y. Ent. Soc. xiv. p. 31 (1906).  
 U.S.A., Arizona.  
*Pectinigeria pamponerella* Dyar, Proc. Ent. Soc. Wash. x. p. 107 (1908) ..... U.S.A., Colorado.  
*Ollia parvella* Dyar, J. N. Y. Ent. Soc. xiv. p. 31 (1906). Sect. *Saluria* ..... U.S.A., Texas.  
*Ollia honoponerella* Dyar, Proc. Ent. Soc. Wash. x. p. 107 (1908). Sect. *Saluria* ..... U.S.A., Arizona.  
*Ollia santaritella* Dyar, J. N. Y. Ent. Soc. xii. pp. 107-8 (1904). Sect. *Saluria* ..... U.S.A., Arizona.  
*Poujadia leuconaura* Turner, Pr. R. Soc. Queensl. xxiv. p. 118 (1913). ?Sect. *Paramatta* ..... N. AUSTRALIA.  
*Pectinigeria violodis* Dyar, Pr. U. S. Nat. Mus. xlvii. p. 347 (1913) ..... PANAMA.  
*Poujadia cyttarella* Dyar, Pr. U. S. Nat. Mus. xlvii. p. 347 (1913) ..... PANAMA.

Genus PROPHTASIA.

*Prophtasia* Rag. Ann. Soc. Ent. Fr. 1887, p. 259... *platycerella*. Type.

Proboscis aborted and minute; palpi typically obliquely upturned, the 3rd joint porrect; maxillary palpi filiform; frons smooth, with slight tuft of scales; antennæ of male typically laminate, the shaft slightly curved at base and without distinct ridge of scales. Fore wing long and narrow, the apex rounded, the termen evenly curved; veins 2 and 3 typically from angle of cell; 4, 5 stalked; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from well before angle of cell; 3 and 5 from angle, typically approximated for some distance, 4 absent; 6, 7 shortly stalked; 8 typically not anastomosing with 7.

SECT. I. Fore wing with veins 2, 3 from a point at angle of cell; hind wing with vein 8 not anastomosing with 7.

(1) PROPHTASIA PLATYCERELLA.

*Prophtasia platycerella* Rag. Ann. Soc. Ent. Fr. 1887, p. 259; id. Rom. Mém. viii. p. 252, pl. 37. f. 8; Staud. Cat. Lep. pal. ii. p. 13.

ARMENIA.

SECT. II. Fore wing with vein 2 from well before angle of cell, 3 from before angle; hind wing with veins 3 and 5 not approximated towards base.

A. Hind wing with vein 8 anastomosing with 7; palpi obliquely upturned and hardly reaching to vertex of head, the maxillary palpi filiform; antennæ of male with the shaft slightly curved at base and without distinct ridge of scales.

(2) †PROPHTASIA SPHALMATELLA, sp. n.

♂. Head and thorax black-brown tinged with grey; abdomen brownish ochreous, dorsally fulvous yellow towards base, ventrally grey-brown. Fore wing black-brown mixed with some grey, especially on inner area; a pure white fascia on costal area, leaving the costa black-brown and not reaching the apex; an indistinct diffused dark antemedial spot on vein 1 and oblique postmedial line. Hind wing whitish suffused with brown; a darker terminal line and white line at base of cilia.

MASHONALAND, Salisbury (*Marshall*), 1 ♂ type. *Exp.* 28 mm.

(3) †PROPHTASIA EPITEUXIS, sp. n.

♂. Head and thorax glossy black-brown; abdomen grey suffused with brown; palpi white below towards base; pectus, legs, and ventral surface of abdomen black-brown, the femora and tibiæ streaked with white. Fore wing glossy black-brown, the inner area tinged with grey; a pure white costal fascia, narrowing to apex; an indistinct diffused dark antemedial line from cell to inner margin and oblique postmedial line. Hind wing grey suffused with fuscous; a slight punctiform dark terminal line and white line at base of cilia.

BURMA, Hsipaw (*de Nicéville*), 2 ♂ type. *Exp.* 24-28 mm.

(4) †PROPHTASIA GLAUCOPHÆA, sp. n.

Head and thorax grey-brown tinged with white; abdomen white suffused with grey-brown; palpi white in front except towards tips; pectus, legs, and ventral surface of abdomen white mixed with some brown. Fore wing pale grey-brown, black-brown towards the rather broad white costal fascia which does not narrow to apex. Hind wing creamy white slightly tinged with brown.

KASHMIR (*Pilcher*), 1 ♂; PUNJAB, Kangra (*Dudgeon*), 1 ♂, Moghal Sarai (*Betton*), 1 ♂; BENGAL, Oudh (*Pilcher*), 1 ♂; SIND, Karáchi (*Swinhoe*), 1 ♀; MADRAS, Belgaum (*Watson*), 1 ♂ type. *Exp.* 18-22 mm.

(5) †PROPHTASIA AMPHICHEA, sp. n.

Head and thorax grey-brown mixed with white; abdomen white tinged with brown; pectus and legs white mixed with brown. Fore wing pale purplish brown mixed with white, the costal area broadly white with slight brown irroration; indistinct diffused dark curved ante- and postmedial lines except towards

costa; two slight blackish discoidal spots. Hind wing white tinged with brown; a slight dark spot at upper angle of cell and fine terminal line; cilia whiter.

SIERRA LEONE (*Clements*), 1 ♂, 4 ♀; N. NIGERIA, Minna (*Macfie*), 1 ♂ type, Zungeru (*Simpson*), 1 ♀. *Exp.* 16–20 mm.

B. Hind wing with vein 8 not anastomosing with 7.

a. Palpi of male obliquely upturned to above vertex of head and hollowed out to receive the brush-like maxillary palpi, the 3rd joint porrect; antennæ serrate with sinus at base of shaft containing a large ridge of scales.

(6) †PROPHTASIA PYROSTROTA, sp. n.

♂. Head and thorax creamy white suffused with rufous; abdomen, pectus, and legs creamy white. Fore wing ochreous white irrorated with fiery red, the costal fascia only defined by a red-brown fascia below it from base to apex; minute antemedial black streaks on median nervure and vein 1 and an oblique post-medial series; two slight black discoidal spots; a terminal series of black points. Hind wing creamy white.

PUNJAB, Kangra Valley, 4500' (*Dudgeon*), 1 ♂ type. *Exp.* 26 mm.

b. Palpi of female downcurved and extending about three times length of head.

(7) PROPHTASIA BISTRATELLA.

*Cayuga bistratella* Hulst, Trans. Am. Ent. Soc. xvii. p. 209 (1890); Dyar, Cat. Lep. N. Am. p. 438.

*Peoria discostrigella* Dyar, Proc. Ent. Soc. Wash. vi. p. 115 (1904).

U.S.A., N. Mexico, Arizona.

#### Genus AURORA.

*Aurora* Rag. N. Am. Phyc. p. 18 (1887)..... <sup>Type.</sup> *longipalpella*.

Proboscis aborted and minute; palpi porrect, extending about four times length of head, thickly fringed with hair, the 2nd joint slightly downcurved; maxillary palpi slight and filiform; frons smooth, with long pointed tuft of hair; antennæ of female minutely ciliated. Fore wing long and narrow, the apex rounded, the termen obliquely curved; vein 3 from close to angle of cell; 4, 5 strongly stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 anastomosing with 7.

†AURORA LONGIPALPELLA.

*Aurora longipalpella* Rag. N. Am. Phyc. p. 18 (1887); id. Rom. Mém. viii. p. 337, pl. 44. f. 2; Dyar, Cat. Lep. N. Am. p. 437.

U.S.A.

## Genus FOSSIFRONTIA.

Type.

*Fossifrontia* Hmps. Rom. Mém. viii. p. 388  
(1901) ..... *leuconeurella*.

Proboscis absent; palpi upturned to about middle of frons, thickly scaled and hollowed out to receive the brush-like maxillary palpi; frons with truncate conical prominence hollowed out in front; antennæ of male uniserrate and ciliated, the shaft with large sinus and ridge of scales at base; fore femora with tuft of hair above, the mid tibiæ fringed with long hair on outer side. Fore wing narrow, the apex rounded, the termen evenly curved; vein 3 from before angle of cell; 4, 5 stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell; the male with small fold on underside from medial part of costa fringed with large scales and with some androconia below it above, in and below the cell. Hind wing with vein 2 from towards angle of cell; 3 and 5 from angle and closely approximated for some distance, 4 absent; 6, 7 shortly stalked; 8 closely approximated to 7 but not anastomosing with it.

## FOSSIFRONTIA LEUCONEURELLA.

*Fossifrontia leuconeurella* Hmps. Rom. Mém. viii. p. 339,  
pl. 52. f. 19 (1901).

QUEENSLAND, Cooktown, Cedar Bay.

## Genus COMMOTRIA.

Type.

*Commotria* Berg, An. Soc. Arg. xix. p. 278  
(1885) ..... *invenustella*.  
*Mangala* Rag. Nouv. Gen. p. 41 (1888)..... *crassiscapella*.  
*Tolimã* Rag. Nouv. Gen. p. 41 (1888) ..... *oberthuri*.  
*Altoona* Hulst, Ent. Am. iv. p. 116 (1888) ... *opacella*.  
*Volusia* Hulst, Trans. Am. Ent. Soc. xvii.  
p. 206 (1890), nec Rob. Desv. Dipt. 1830 ... *roseopennella*.  
*Trivolusia* Dyar, Cat. Lep. N. Am. p. 438  
(1902)..... *roseopennella*.

Proboscis absent; palpi downcurved, extending about three times length of head and thickly scaled; maxillary palpi slight and filiform; frons rounded and with short tuft of hair; antennæ of male typically unipectinate, the apical part ciliated, the shaft with ridge of scales above at base. Fore wing long and narrow, the apex rounded, the termen obliquely curved; vein 3 from angle of cell; 4, 5 stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 2 from angle of cell; 3 and 5 strongly stalked, 4 absent; 6, 7 shortly stalked; 8 anastomosing with 7.

SECT. I. (*Commotria*.) Antennæ of male unipectinate, the apical part ciliated.

(1) *COMMOTRIA MESIELLA*, sp. n.

Head and thorax purple-pink mixed with some whitish; abdomen pale fulvous yellow, ochreous white at base and extremity; pectus, legs, and ventral surface of abdomen whitish tinged with purple. Fore wing purple-pink, the veins white defined on each side by fine brown streaks, the white on median nervure stronger and more strongly defined by black-brown below; a minute black-brown spot at upper angle of cell and point at lower angle. Hind wing whitish tinged with ochreous brown.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 9 ♂, 3 ♀ type. *Exp.* 20-22 mm.

(2) *COMMOTRIA LATICOSTELLA*.

*Commotria laticostella* Hmps. Rom. Mém. viii. p. 343, pl. 52. f. 14 (1901).

BRAZIL, Amazons.

(3) *COMMOTRIA INVENUSTELLA*.

*Commotria invenustella* Berg, An. Soc. Arg. xix. p. 278 (1885); Rag. Rom. Mém. viii. p. 343, pl. 36. f. 24.

S. BRAZIL; ARGENTINA.

(4) *COMMOTRIA ARRHABDELLA*, sp. n.

♀. Head and thorax pale red-brown; abdomen whitish tinged with red-brown, dorsally fulvous yellow towards base; pectus and legs whitish tinged with red-brown. Fore wing pale flesh-red slightly irrorated with dark scales; a terminal series of slight dark points.

PERU, R. Pachaya, 1 ♀ type. *Exp.* 24 mm.

SECT. II. (*Tolima*.) Antennæ of male serrate.

(5) \**COMMOTRIA ROSEOPENNELLA*.

*Folusia roseopennella* Hulst, Trans. Am. Ent. Soc. xvii. p. 206 (1890); Rag. Rom. Mém. viii. p. 340, pl. 51. f. 3; Dyar, Cat. Lep. N. Am. p. 438.

U.S.A., Florida.

(6) \**COMMOTRIA OBERTHURI*.

*Tolima oberthurii* Rag. Nouv. Gen. p. 41 (1888); id. Rom. Mém. viii. p. 341, pl. 38. f. 4.

COLOMBIA.

(7) \**COMMOTRIA OPACELLA*.

*Anerastia opacella* Hulst, Ent. Am. iii. p. 138 (1887); Rag. Rom. Mém. viii. p. 341, pl. 36. f. 23; Dyar, Cat. Lep. N. Am. p. 438.

U.S.A., Texas.



## (8) †COMMOTRIA PHYCITELLA.

*Tolima phycitella* Rag. Nouv. Gen. p. 41 (1888); id. Rom. Mém. viii. p. 341, pl. 44. f. 17.

GOLD COAST.

SECT. III. (*Mangala*.) Antennæ of male laminate and ciliated.

## (9) †COMMOTRIA TRIPARTELLA, sp. n.

♀. Head and thorax purple-pink; abdomen white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen white tinged with purplish pink; anal tuft yellow below. Fore wing with white costal fascia narrowing to apex leaving the costal edge dark towards base, then pinkish, defined below by a dark reddish-brown fascia, the inner half of wing rose-pink, whiter towards inner margin. Hind wing white.

N. CHINA, Pekin (*Hughes*), 1 ♀ type. *Exp.* 20 mm.

## (10) †COMMOTRIA NEURIAS, sp. n.

Head and thorax white suffused with red-brown; abdomen white, dorsally tinged with fulvous yellow towards base; pectus and legs white tinged with brown. Fore wing white tinged with reddish brown, the veins white defined on each side by slight dark brown streaks; the costal area defined below by a brown shade; obliquely placed almost medial dark brown points in submedian fold and on vein 1; a dark point just above lower angle of cell; obliquely placed postmedial dark points on veins 6 to 2 and in submedian fold and a point nearer the termen on vein 1; a terminal series of black points. Hind wing white slightly tinged with ochreous brown.

N. NIGERIA, Zungeru (*Macfie*), 1 ♂; BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♂, 1 ♀ type. *Exp.* 16 mm.

## (11) †COMMOTRIA ERYTHROGRAPTA, sp. n.

♂. Head and thorax white tinged with rufous; abdomen white tinged with ochreous yellow; pectus and legs white mixed with red-brown. Fore wing white tinged with rufous, the veins and submedian fold white defined on each side by slight rufous streaks; the costal area defined below by a dark brown streak and a dark streak below basal half of median nervure; obliquely placed almost medial dark points below the cell and on vein 1; a dark point just above lower angle of cell and obliquely placed postmedial dark points on veins 6 to 2. Hind wing white with a slight ochreous tinge.

BR. C. AFRICA, Katungas (*de Jersey*), 1 ♂ type. *Exp.* 20 mm.

## (12) †COMMOTRIA RUFIMEDIA, sp. n.

♂. Head and thorax white tinged with red-brown; abdomen creamy white. Fore wing white faintly tinged with rufous and irrorated with fuscous; a rufous shade below median nervure;

a minute antemedial black spot on vein 1 and minute discoidal spot; an oblique postmedial series of black points on veins 4 to 2 and a point on vein 1; a terminal series of black points. Hind wing white tinged with ochreous.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♂ type. *Exp.* 16 mm.

(13) †COMMOTRIA RHODONEURA, sp. n.

♀. Head and thorax rufous; abdomen whitish tinged with rufous; palpi whitish below; fore legs red-brown; mid and hind legs whitish tinged with rufous. Fore wing yellowish white, the veins streaked with purplish pink and the costal area suffused with purplish pink; a black antemedial point on vein 1, a discoidal point and postmedial points on veins 4, 2, 1; a terminal series of black points. Hind wing white tinged with ochreous rufous.

TRANSVAAL, White R. (*Cooke*), 1 ♀ type. *Exp.* 20 mm.

(14) †COMMOTRIA RUFIDELINEATA, sp. n.

Head and thorax whitish suffused with rufous; abdomen creamy white, dorsally fulvous yellow towards base; pectus and legs white tinged with red-brown. Fore wing ochreous white, the veins defined on each side by fine rufous streaks, the costal area defined below by a slight rufous shade; two antemedial blackish points on vein 1 and obliquely placed postmedial points on veins 4 to 1; a terminal series of black points. Hind wing ochreous white.

BR. E. AFRICA, Nairobi (*Anderson*), 1 ♀ type; BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♂. *Exp.* 24 mm.

(15) †COMMOTRIA MIOSTICTA, sp. n.

♂. Head and thorax white tinged with rufous; abdomen creamy white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen white suffused with brown. Fore wing white tinged with rufous, the veins white defined on each side by fine rufous streaks; the costal edge blackish towards base; the costal area defined below by a slight red-brown shade; a black point just above lower angle of cell. Hind wing white slightly tinged with ochreous.

SIERRA LEONE (*Clements*), 1 ♂ type. *Exp.* 22 mm.

(16) \*COMMOTRIA CRASSISCAPELLA.

*Mangala crassiscapella* Rag. Nouv. Gen. p. 41 (1888); id. Rom. Mém. viii. p. 342, pl. 37. f. 17.

SUDAN.

(17) †COMMOTRIA PHENICIAS, sp. n.

♂. Head and thorax whitish suffused with rufous; abdomen yellowish white; pectus and legs whitish suffused with brown. Fore wing white very thickly irrorated with deep purple-pink,

the lower part of cell and the area just beyond it much whiter, the costa tinged with brown; a small black-brown discoidal spot; the veins towards termen with slight brown streaks. Hind wing yellowish white, the costa tinged with brown towards apex.

N. NIGERIA, Zungeru (*Macfie*), 1 ♂; UGANDA, Katesa (*Betton*), 1 ♂ type. *Exp.* 20-22 mm.

(18) †COMMOTRIA ROSELLA, sp. n.

Head and thorax bright rose-pink; abdomen ochreous; pectus whitish; legs and abdomen pink. Fore wing bright rose-pink mixed with some whitish except on costal area, the median nervure and veins beyond the cell with fine deep pink streaks; a small deep pink spot on upper discocellular; cilia fuscous at apex. Hind wing pale ochreous, the costa and cilia at apex tinged with pink.

Ab. 1. Fore wing with a dark reddish-brown shade along subcostal nervure and thence to apex, the spot on upper discocellular dark brown.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 4 ♂, 5 ♀ type. *Exp.* 22-26 mm.

(19) †COMMOTRIA ALBINERVELLA, sp. n.

♀. Head and thorax pale purplish pink; abdomen ochreous white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen whitish tinged with pink. Fore wing pale purple-pink, the veins streaked with white; the costal area white tinged with pink, narrowing to apex and defined below by a slight brown shade; a slight dark point at upper angle of cell. Hind wing white with a slight ochreous tinge.

RHODESIA, Bulawayo (*Eyles*), 1 ♀ type. *Exp.* 20 mm.

(20) †COMMOTRIA VENOSELLA, sp. n.

♂. Head, thorax, and abdomen whitish suffused with rufous; fore femora and tibiæ black-brown in front. Fore wing whitish suffused with purplish rufous and slightly irrorated with blackish in the interspaces; the veins prominently streaked with white. Hind wing ochreous whitish, with a slight reddish-brown terminal line except towards tornus.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♂ type. *Exp.* 30 mm.

(21) †COMMOTRIA RHODOCHROA, sp. n.

♂. Head and thorax pale rose-pink; abdomen ochreous white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen whitish suffused with red-brown. Fore wing pale rose-pink, the costal area with a slight red-brown tinge; the veins streaked with white and defined on each side by fine deeper pink streaks. Hind wing ochreous white.

NATAL, Tugela R., Bonds' Drift (*Reynolds*), 1 ♂ type. *Exp.* 26 mm.

## (22) †COMMOTRIA CASTANEIPARS, sp. n.

♀. Head, thorax, and abdomen deep red-brown; hind tibiae white towards base. Fore wing with narrow white costal fascia narrowing to a point before apex, the area below it deep chestnut-brown to median nervure and vein 2, the inner area purplish pink. Hind wing red-brown.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♀ type. *Exp.* 22 mm.

## (23) †COMMOTRIA PROFÆELLA, sp. n.

♀. Head and thorax pale flesh-red; abdomen ochreous; palpi tinged with brown; pectus and legs whitish suffused with brown. Fore wing pale flesh-red, the costal area broadly suffused with brown, extending on basal half to median nervure; the veins beyond the cell finely streaked with brown. Hind wing ochreous white.

BR. C. AFRICA, Mt. Mlanje (*Neave*), 1 ♀ type. *Exp.* 22 mm.

## (24) †COMMOTRIA PHLEBICELLA, sp. n.

♀. Head and thorax pale flesh-pink mixed with some whitish; abdomen whitish, dorsally tinged with fulvous-yellow towards base; pectus, legs, and ventral surface of abdomen white tinged with brown. Fore wing pale flesh-pink, the costal area broadly suffused with brown, extending to the median nervure towards base; the costal edge and veins finely streaked with white. Hind wing ochreous white.

MASHONALAND, Salisbury (*Marshall*), 2 ♀ type. *Exp.* 26 mm.

## (25) †COMMOTRIA ENERVELLA, sp. n.

♂. Head and thorax whitish suffused with pale flesh-red; abdomen ochreous white. Fore wing whitish suffused with pale purplish pink and the costal half tinged with brown; the veins, except on inner area, streaked with white and defined on each side by fine brown streaks. Hind wing white tinged with brown except towards base and inner margin.

FORMOSA, Takow (*Wileman*), 1 ♂ type. *Exp.* 18 mm.

## Genus SIBOGA.

*Siboga* Hampsn. Rom. Mém. viii. p. 338 (1901)..... <sup>Type.</sup> *falsella*.

Proboscis aborted and minute; palpi upturned, the 2nd joint reaching to vertex of head and hollowed out to receive the brush-like maxillary palpi, the 3rd joint moderate and porrect; frons with conical prominence; antennæ of male typically serrate and ciliated, the basal joint elongate, the shaft with double ridge of scales at base above enclosing a hollow. Fore wing long and narrow, the apex rounded, the termen obliquely curved; vein 3 from close to angle of cell; 4, 5 strongly stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with

vein 2 from well before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 not anastomosing with 7.

SECT. I. Antennæ of male unipectinate with moderate branches, the apical part ciliated.

(1) *SIBOGA ALBIMEDIELLA*, sp. n.

Head and thorax white tinged with pink and brown; abdomen ochreous, the first three segments ochreous on dorsum. Fore wing pale pink, the veins streaked with white; the costal area tinged with brown; a white fascia from base to termen above median nervure and vein 5. Hind wing white slightly tinged with ochreous especially towards termen.

PUNJAB, Simla, 1 ♂ type. *Exp.* 26 mm.

SECT. II. (*Siboga*.) Antennæ of male serrate and ciliated.

(2) \**SIBOGA FALSELLA*.

*Hypstrophia falsella* Snell. Midden-Sumatra Lep. p. 82 (1880); Rag. Rom. Mém. viii. p. 338, pl. 38. f. 3.

SUMATRA.

SECT. III. Antennæ of male laminate and almost simple.

(3) †*SIBOGA DIALEUCELLA*, sp. n.

♂. Head and thorax white, suffused with rufous except on vertex of head and dorsum of thorax; abdomen creamy white, dorsally fulvous yellow towards base; palpi white in front; pectus and legs white slightly tinged with red-brown. Fore wing white suffused with rufous; the veins white defined on each side by fine rufous streaks, the median nervure defined below by a rufous fascia; a white fascia through the cell, then narrower along discal fold to termen. Hind wing ochreous white.

KASHMIR, Goorais Valley (*Leech*), 1 ♂ type. *Exp.* 24 mm.

(4) †*SIBOGA ZEAVORA*, sp. n.

♀. Head, thorax, and abdomen whitish suffused with rufous, the last dorsally fulvous yellow towards base. Fore wing whitish tinged with rufous, the veins defined on each side by streaks formed of red-brown scales, the cell with two streaks in it; the inner margin irrorated with red-brown; a terminal series of prominent black points. Hind wing ochreous white with a terminal series of brown striae except towards tornus.

MALAY STATES, 1 ♀ type. *Exp.* 30 mm.

*Larva* feeds on maize.

## Genus EMATHEUDES.

*Ematheudes* Zell. Stett. Ent. Zeit. 1867, p. 385 ... <sup>Type.</sup> *punctella*.

Proboscis aborted and minute; palpi downcurved, extending about three times length of head and thickly scaled; maxillary palpi minute and filiform; frons with large tuft of scales; antennæ of male minutely serrate and ciliated. Fore wing narrow, the apex rounded, the termen evenly curved; vein 3 from close to angle of cell; 4, 5 stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 2 from well before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 not anastomosing with 7.

## (1) EMATHEUDES PUNCTELLA.

*Chilo punctella* Treit. Schmett. Eur. ix. 2, p. 268 (1833); Dup. Léop. Fr. pl. 273. f. 4; Herr.-Schäff. Eur. Schmett. iv. p. 108, Tin. f. 85; Rag. Rom. Mém. viii. p. 333; Staud. Cat. Lep. pal. ii. p. 13.

S. FRANCE; SPAIN; CORSICA; ITALY; SICILY; MOROCCO; GREECE; TURKEY; CYPRUS; ASIA MINOR; SYRIA.

## (2) \*EMATHEUDES PSEUDOPUNCTELLA.

*Ematheudes pseudopunctella* Rag. Nouv. Gen. p. 40 (1888); id. Rom. Mém. viii. p. 334, pl. 36. f. 22; Staud. Cat. Lep. pal. ii. p. 13.

SYRIA. Probably an aberration of *E. punctella*.

## (3) EMATHEUDES STRAMINELLA.

*Ematheudes straminella* Snell. Tijd. v. Ent. 1872, p. 107, pl. 8. f. 9.

GAMBIA; SIERRA LEONE; ANGOLA; BR. C. AFRICA; PORTUGUESE E. AFRICA.

## (4) †EMATHEUDES LENTISTRIGALIS.

*Emmatheudes lentistrigalis* Himpsn. Tr. Zool. Soc. xix. p. 134, pl. iv. f. 65 (1909).

GOLD COAST; N. NIGERIA; BR. E. AFRICA; UGANDA; BR. C. AFRICA.

## (5) EMATHEUDES PALEATELLA.

*Ematheudes paleatella* Rag. Nouv. Gen. p. 40 (1888); id. Rom. Mém. viii. p. 334, pl. 36. f. 20.

BR. E. AFRICA; UGANDA; BR. C. AFRICA; MASHONALAND; TRANSVAAL; NATAL; BASUTOLAND; CAPE COLONY.

## (6) EMATHEUDES TUNESIELLA.

*Ematheudes tunesiella* Rag. Iris, v. p. 298 (1892); id. Rom. Mém. viii. p. 335, pl. 42. f. 22; Staud. Cat. Lep. pal. ii. p. 13,

S. ITALY; TUNIS; SYRIA; W. TURKESTAN.

(7) *EMATHEUDES CRASSINOTELLA*.

*Emattheudes crassinotella* Rag. Nouv. Gen. p. 41 (1888); id. Rom. Mém. viii. p. 335, pl. 35. f. 26.

ZANZIBAR; BR. E. AFRICA; MASHONALAND; NATAL.

(8) \**EMATHEUDES VARICELLA*.

*Emattheudes varicella* Rag. Ann. Soc. Ent. Fr. 1887, p. 258; id. Rom. Mém. viii. p. 336, pl. 35. f. 27; Staud. Cat. Lep. pal. ii. p. 13.

ARMENIA; W. TURKESTAN.

(9) \**EMATHEUDES VITELLINELLA*.

*Emattheudes vitellinella* Rag. Ann. Soc. Ent. Fr. 1887, p. 258; id. Rom. Mém. viii. p. 336, pl. 49. f. 22; Staud. Cat. Lep. pal. ii. p. 13.

ASIA MINOR, Georgia.

(10) \**EMATHEUDES EUCHLYTELLA*.

*Emattheudes euchlytella* Rag. Nouv. Gen. p. 41 (1888); id. Rom. Mém. viii. p. 337, pl. 36. f. 21.

ARGENTINA.

Genus *BIAFRA*.

*Biafra* Rag. Nouv. Gen. p. 40 (1888)..... *concinella*.<sup>Type.</sup>

Proboscis aborted and minute; palpi downcurved, extending about three times length of head and moderately scaled; maxillary palpi slightly dilated with scales; frons smooth, with large pointed tuft of hair; antennæ of male minutely serrate and ciliated, the basal joint rather long, the shaft with double ridge of scales at base enclosing a hollow. Fore wing very narrow, the apex rounded, the termen obliquely curved; vein 3 from near angle of cell; 4, 5 separate; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 2 from near angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 anastomosing with 7.

(1) *BIAFRA CONCINNELLA*.

*Biafra concinnella* Rag. Nouv. Gen. p. 40 (1888); id. Rom. Mém. viii. p. 330, pl. 38. f. 2.

N. NIGERIA; BR. C. AFRICA; MASHONALAND; TRANSVAAL; NATAL.

(2) †*BIAFRA RHODINELLA*.

*Biafra rhodinella* Rag. Nouv. Gen. p. 40 (1888); id. Rom. Mém. viii. p. 381, pl. 44. f. 20.

GOLD COAST; N. NIGERIA; MASHONALAND; TRANSVAAL.

## Genus ETHIOTROPA, nov.

Type, *E. pyromerella*.

Proboscis aborted and minute; palpi porrect and slightly downcurved, extending about twice the length of head, the 2nd joint fringed with rough scales below, the 3rd moderate; maxillary palpi strongly dilated with scales; frons smooth, with pointed tuft of hair above; antennæ of male somewhat laminate and minutely ciliated, the basal joint long, the shaft with ridge of scales above at base. Fore wing long and very narrow, the apex rounded, the termen obliquely curved; veins 3, 4 stalked on one side of the specimen from a point on the other; 5 separate; 6 from below upper angle; 8, 10, 11 stalked, 9 absent. Hind wing with vein 2 from well before angle of cell; 3 and 5 from angle and approximated for some distance, 4 absent; 6, 7 shortly stalked; 8 anastomosing with 7.

## ETHIOTROPA PYROMERELLA, sp. n.

♂. Head, tegulæ, and base of patagia fiery red, the rest of thorax brownish ochreous; abdomen ochreous white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen whitish suffused with brown. Fore wing with whitish costal fascia narrowing to apex, the costal edge fiery red to beyond middle, defined below by a black-brown fascia; the rest of wing fiery red. Hind wing white tinged with ochreous brown.

N. NIGERIA, Akassa (*Lugard*), 1 ♂ type. *Exp.* 22 mm.

## Genus BAPTOTROPA, nov.

Type, *B. tricolorella*.

Proboscis aborted and minute; palpi porrect and slightly downcurved, extending about three times length of head, the 2nd joint fringed with rough scales above, the 3rd moderate; maxillary palpi minute and filiform; frons smooth and rounded, without tuft of hair; antennæ of male strongly uniserrate, the basal joint long, the shaft with double ridge of scales at base enclosing a hollow. Fore wing narrow, the apex rounded, the termen evenly curved; vein 3 from before angle of cell; 4, 5 from angle; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 2 from well before angle of cell; 3 and 5 from angle, 4 absent; 6, 7 shortly stalked; 8 anastomosing with 7.

## †BAPTOTROPA TRICOLERELLA.

*Patna tricolorella* Hmps. *J. Bomb. N. H. Soc.* xii, p. 308 (1899); *Rag. Rom. Mém.* viii. p. 340, pl. 52. f. 15.

ASSAM, Khâsis.



## Genus PATNA.

*Patna* Rag. Nouv. Gen. p. 39 (1888)..... Type.  
*eboricostella*.

Proboscis absent; palpi porrect and almost straight, extending about three times length of head, the 2nd joint slightly fringed with hair above towards extremity, the 3rd moderate; maxillary palpi small and filiform; frons smooth and rounded, without tuft of hair; antennæ of female almost simple. Fore wing rather narrow, the costa typically almost straight, the apex rounded, the termen evenly curved; vein 3 from near angle of cell; 4, 5 from angle and approximated for a short distance; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 2 from well before angle of cell; 3 and 5 from angle, 4 absent; 6, 7 from upper angle; 8 not anastomosing with 7.

## (1) PATNA EBORICOSTELLA.

*Patna eboricostella* Rag. Nouv. Gen. p. 39 (1888); Hmspn. Moths Ind. iv. p. 57; Rag. Rom. Mém. viii. p. 330, pl. 38. f. 1. SIKHIM; BHUTÁN.

## (2) †PATNA VENATELLA, sp. n.

♀. Head and thorax pale rufous; palpi whitish except above; pectus, legs, and abdomen whitish tinged with red-brown. Fore wing white, the veins, discal fold in the cell and the submedian fold defined by fine purplish-pink streaks; a minute dark brown spot just above lower angle of cell; a terminal series of black points. Hind wing white slightly tinged with ochreous.

BR. E. AFRICA, Tagas (*Betton*), 1 ♀, Aios (*Betton*), 1 ♀ type. *Exp.* 32 mm.

## (3) †PATNA BRUNNEICOSTELLA, sp. n.

♀. Head and thorax pale flesh-pink; abdomen ochreous white; palpi, pectus, legs, and ventral surface of abdomen whitish suffused with red-brown. Fore wing white, the costal area tinged with brown, the area below the cell and vein 2 suffused with pale pink; the veins white, those beyond the cell defined on each side by fine pink streaks, the median nervure and vein 2 defined below by stronger streaks; a dark point in lower angle of cell. Hind wing ochreous white.

TRANSVAAL, White R. (*Cooke*), 1 ♀ type. *Exp.* 32 mm.

## Genus MEGALOPHOTA, nov.

Type, *M. leonella*.

Proboscis absent; palpi obliquely upturned, the 2nd joint reaching to above vertex of head, dilated and hollowed out to receive the brush-like maxillary palpi, the 3rd minute; frons

with long truncate conical prominence; antennæ of male pectinate with rather long uniseriate branches to near apex, the shaft with large sinus at base containing a double ridge of scales enclosing a hollow. Fore wing rather long and narrow, the apex rounded, the termen evenly curved; vein 2 from well before angle of cell; 3 from before angle; 4, 5 from angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from well before angle of cell; 3 and 5 stalked, 4 absent; 6, 7 shortly stalked; 8 not anastomosing with 7.

MEGALOPHOTA LEONELLA, sp. n.

♂. Head and thorax ochreous white with a slight red-brown tinge on shoulders, the antennal tufts black on inner side; abdomen ochreous; pectus and legs ochreous white tinged with red-brown. Fore wing ochreous white irrorated with brown, the costal area slightly irrorated to near apex. Hind wing ochreous white.

SIERRA LEONE (*Dudgeon*), 1 ♂ type. *Exp.* 20 mm.

Genus MARTIA.

	Type.
<i>Martia</i> Rag. N. Am. Phyc. p. 18 (1887) .....	<i>arizonella</i> .
<i>Urula</i> Hulst, Can. Ent. xxxii. p. 175 (1900) .....	<i>arizonella</i> .

Proboscis absent; palpi with the 2nd joint porrect, extending about twice the length of head, the 3rd rather oblique, long, slender, and somewhat acute at extremity; maxillary palpi slight and filiform; frons with large truncate conical prominence; antennæ of male minutely serrate and with fascicles of long cilia. Fore wing rather narrow, the apex rounded, the termen evenly curved; vein 2 from long before angle of cell; 3 from before angle; 5 from above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from long before angle of cell; 3 and 5 from angle, approximated for a short distance, 4 absent; 6, 7 from upper angle; 8 not anastomosing with 7.

MARTIA ARIZONELLA.

*Martia arizonella* Rag. N. Am. Phyc. p. 18 (1887); id. Rom. Mém. viii. p. 367, pl. 38. f. 20; Dyar, Cat. Lep. N. Am. p. 439.  
*Urula incongruella* Hulst, Can. Ent. xxxii. p. 175 (1900); Dyar, Cat. Lep. N. Am. p. 437.

U.S.A., Colorado, Arizona.

Genus DISCOFRONTIA.

	Type.
<i>Discofrontia</i> Hampsn. Rom. Mém. viii. p. 350 (1901).	<i>normella</i> .

Proboscis aborted and minute; palpi upturned, the 2nd joint reaching to vertex of head and moderately scaled and flattened,

the 3rd moderate; maxillary palpi slight and filiform; frons broad, with a disk of concentric white scales converging to middle; antennæ of male strongly serrate, with a large sinus and ridge of scales at base of shaft. Fore wing rather narrow, the apex rounded, the termen evenly curved; vein 2 from well before angle of cell; 3 from before angle; 4, 5 from angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from before angle of cell; 3 and 5 from angle, 4 absent; 6, 7 from upper angle; 8 not anastomosing with 7.

\*DISCOFRONTIA NORMELLA.

*Discofrontia normella* Hmps. Rom. Mém. viii. p. 350, pl. 52. f. 20 (1901).

NATAL.

Genus CRITONIA.

Type.

*Critonia* Rag. Bull. Soc. Ent. Fr. 1890, p. ccciv. *subconcinella*.

*Singhalia* Hmps. J. Bomb. Nat. Hist. Soc. xii.

p. 309 (1898); id. Rom. Mém. viii. p. 351

(1901) ..... *sarcoglauca*.

Proboscis aborted and minute; palpi typically downcurved, extending about three times length of head and moderately scaled; maxillary palpi small and filiform; frons smooth and with slight tuft of hair; antennæ of male typically serrate and fasciculate, the shaft with sinus at base containing a large ridge of scales. Fore wing rather long and narrow, the apex rounded, the termen evenly curved; vein 3 from before angle of cell; 4, 5 from just above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell, 10 approximated to 8, 9. Hind wing with veins 3 and 5 from angle of cell and approximated for a short distance, 4 absent; 6, 7 shortly stalked; 8 not anastomosing with 7.

SECT. I. Palpi of male obliquely upturned, the 2nd joint hollowed out to receive the brush-like maxillary palpi, the 3rd short; antennæ laminate, with large sinus and ridge of scales at base of shaft.

(1) †CRITONIA PLEONEURA, sp. n.

♂. Head and thorax whitish suffused with red-brown; abdomen ochreous white, dorsally fulvous yellow towards base; pectus and legs whitish tinged with brown. Fore wing whitish tinged with red-brown, the veins except on inner area blackish defined on each side by fine white streaks; the costal area white, narrowing to apex and defined below by a red-brown shade, the costal edge brown to beyond middle and the veins on costal area finely streaked with black; a minute antemedial black spot on vein 1, a point at middle of submedian fold and minute post-medial streaks above vein 2 and on vein 1; cilia flesh-white with

series of minute black streaks near base except towards tornus. Hind wing whitish tinged with brown especially on costal area and at termen.

FORMOSA, Banshorio (*Wileman*), 1 ♂ type. *Exp.* 18 mm.

(2) †CRITONIA PROMELENA.

*Critonia promelena* Hmps. J. Bomb. Nat. Hist. Soc. xii. p. 309 (1898); id. Rom. Mém. viii. p. 366, pl. 51. f. 23.

SIKHIM.

(3) †CRITONIA PURPUREOTINCTA.

*Critonia purpureotincta* Hmps. Moths Ind. iv. p. 61 (1896); id. Rom. Mém. viii. p. 365, pl. 51. f. 22.

SIKHIM; BHUTÁN.

(4) †CRITONIA HOLORHODA.

*Critonia holorhoda* Hmps. J. Bomb. Nat. Hist. Soc. xviii. p. 259 (1908).

CEYLON.

SECT. II. Maxillary palpi of male filiform.

A. (*Critonia*). Antennæ of male serrate, with larger sinus and ridge of scales at base of shaft; palpi downcurved and about three times length of head.

(5) \*CRITONIA SUBCONCINNELLA.

*Critonia subconcinella* Rag. Bull. Soc. Ent. Fr. 1890, p. cexiv; id. Rom. Mém. viii. p. 365, pl. 6. f. 20.

BURMA.

(6) †CRITONIA LEUCOPLEURÀ, sp. n.

♂. Head and thorax whitish suffused with purplish pink; abdomen whitish suffused with ochreous brown; antennæ with the tuft blackish; palpi, pectus, and legs whitish tinged with brown. Fore wing whitish suffused with purplish pink, the veins streaked with blackish, vein 1 only towards termen; the costal area pure white, narrowing to apex and defined below by a blackish shade; the costal edge dark to beyond middle and the interspaces of terminal area with slight dark streaks except towards tornus. Hind wing whitish, the costal area broadly suffused with brown.

BASUTOLAND, Maseru (*Crawshay*), 1 ♂ type. *Exp.* 26 mm.

(7) †CRITONIA ROSEISTRIGELLA.

*Critonia roseistrigella* Hmps. Moths Ind. iv. p. 61 (1896); id. Rom. Mém. viii. p. 365, pl. 51. f. 21.

MADRAS, Nilgiris; PHILIPPINES, Luzon.

## (8) CRITONIA OCHRACEALIS.

*Critonia ochracealis* Hmps. J. Bomb. Nat. Hist. Soc. xxi. p. 1251 (1912).

PUNJAB, Kangra; MADRAS, Nilgiris.

## (9) \*CRITONIA HILGERTI.

*Pectinigeria hilgerti* Roths. Nov. Zool. xxii. p. 236.

ALGERIA.

B. Antennæ of male laminate and without sinus and ridge of scales at base of shaft.

a. (*Singhalia*.) Palpi of male with the 2nd joint obliquely upturned to vertex of head and thickly scaled, the 3rd porrect, long and blunt.

## (10) †CRITONIA SARCOGLAUCA.

*Critonia sarcoglauca* Hmps. Moths Ind. iv. p. 60 (1896); id. Rom. Mém. viii. p. 351, pl. 51. f. 24.

CEYLON.

b. Palpi of male downcurved and extending about three times length of head.

## (11) CRITONIA RHODESSA.

*Saluria rhodessa* Turner, Pr. R. Soc. Queensl. xviii. p. 120 (1903).

QUEENSLAND.

## (12) †CRITONIA SARCOIDA, sp. n.

Head and thorax purplish pink, the head and shoulders tinged with brown; abdomen ochreous white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen ochreous tinged with brown. Fore wing purplish pink, the costal area tinged with brown; the veins, discal fold in the cell, and submedian fold white defined on each side by fine purplish-pink streaks, the median nervure rather more strongly streaked with white and with a brown streak below it. Hind wing ochreous white, the costal area tinged with brown.

BR. E. AFRICA, Njora (*Cholmley*), 1 ♂; BR. C. AFRICA, Mt. Manje (*Neave*), 3 ♀; PORTUGUESE E. AFRICA, Kola Valley (*Neave*), 3 ♀; MASHONALAND, Salisbury (*Marshall*), 1 ♀; TRANSVAAL (*Peud*), 1 ♂ type. *Exp.* 28-34 mm.

## Genus MONOCTENOCERA.

Type.

*Monoctenocera* Hmps. J. Bomb. Nat. Hist. Soc. xii.

p. 310 (1898); id. Rom. Mém. viii. p. 311 (1901). *brachiella*.

Proboscis aborted and minute; palpi obliquely upturned, the 2nd joint reaching to just above vertex of head and hollowed out to receive the brush-like maxillary palpi, the 3rd short and

thickly scaled; frons smooth, with large tuft of hair; antennæ of male unipectinate, typically with very short branches, the apical part serrate, the shaft with large sinus and ridge of scales at base; mid and hind tibiæ typically fringed with long hair. Fore wing narrow, the apex rounded, the termen evenly curved; vein 3 from close to angle of cell; 4, 5 strongly stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 3 closely approximated to 4, 5 for some distance; 4, 5 strongly stalked; 6, 7 shortly stalked; 8 anastomosing with 7.

SECT. I. Antennæ of male with the branches long; mid tibiæ fringed with hair at base only, the hind tibiæ at extremity only.

(1) MONOCTENOCERA LEUCANIA.

*Catagela leucania* Feld. Reis. Nov. pl. 137. f. 13 (1874); Hmps. Moths Ind. iv. p. 63; id. Rom. Mém. viii. p. 312, pl. 51. f. 17.

*Hab.* MADRAS, Nilgiris; TRAVANCORE; CEYLON.

SECT. II. Antennæ of male with short branches towards base, then serrate: mid and hind tibiæ fringed with long hair throughout.

(2) MONOCTENOCERA BRACHIELLA.

*Polyocha brachiella* Hmps. J. Bomb. Nat. Hist. Soc. xii. p. 310 (1898); id. Rom. Mém. viii. p. 312, pl. 36. f. 6.

*Hab.* SIKKIM; BENGAL, Calcutta; BORNEO.

Genus SABORMA.

*Saborma* Rag. Nouv. Gen. p. 37 (1887) ..... <sup>Type.</sup> *forcipella*.

Proboscis aborted, minute; palpi of male upturned to about vertex of head, slender, typically hollowed out to contain the brush-like maxillary palpi; frons smooth; antennæ of male typically strongly serrate, with sinus and large double ridge of scales at base. Fore wing narrow, the apex rounded, the termen evenly curved; vein 3 from close to angle of cell; 4, 5 strongly stalked; 6 from below upper angle; 8, 9, 10 stalked; 11 from cell. Hind wing with vein 3 approximated for some distance to 4, 5 which are strongly stalked; 6, 7 shortly stalked; 8 not anastomosing with 7.

SECT. I. Palpi of male with the 2nd joint hollowed out to receive the brush-like maxillary palpi; antennæ serrate.

(1) \*SABORMA FORCIPELLA.

*Saborma forcipella* Rag. Nouv. Gen. p. 37 (1888); id. Rom. Mém. viii. p. 310, pl. 35. f. 22.

SUMATRA.

(2) \**SABORMA VICINA*.

*Anerastia vicina* Saalm. Ber. Senck. Ges. 1879, p. 307; id. Lep. Madag. p. 511; Rag. Rom. Mém. viii. p. 309, pl. 42. f. 21.

MADAGASCAR.

SECT. II. Maxillary palpi of male filiform; antennæ laminate and ciliated.

(3) †*SABORMA PAPUACOLA*, sp. n.

♂. Head and thorax whitish tinged with red-brown; abdomen whitish tinged with brown, dorsally fulvous yellow towards base; antennæ with the tuft blackish on inner side; pectus and legs whitish tinged with brown. Fore wing white tinged with ochreous brown, the veins, discal fold in the cell, and the submedian fold white defined on each side by streaks formed of blackish scales; a terminal series of black points. Hind wing ochreous white with terminal series of dark points and striæ.

DUTCH N. GUINEA, Mimika R. (*Wollaston*), 3 ♂ type. *Exp.* 26-30 mm.

Genus *OSACIA*.

*Osakia* Rag. Rom. Mém. viii. p. 318 (1901) ..... <sup>Type.</sup> *lineolella*.

Proboscis aborted and minute; palpi obliquely upturned to about vertex of head, moderately scaled; maxillary palpi each a minute brush of scales; frons smooth and rounded; antennæ of male ciliated, the shaft with sinus and double ridge of scales at base; tibiæ fringed with hair. Fore wing rather narrow, the apex rounded, the termen evenly curved; veins 2 and 3 stalked from before angle of cell; 4, 5 separate; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 3 from angle of cell; 4 and 5 strongly stalked; 6, 7 strongly stalked; 8 not anastomosing with 7.

\**OSACIA LINEOLELLA*.

*Osakia lineolella* Rag. Rom. Mém. viii. p. 319, pl. 43. f. 21 (1901).

JAPAN.

Genus *RAGONOTIA*.

*Ciris* Rag. N. Am. Phyc. p. 17 (1887), nec Grote, <sup>Type.</sup>  
Lep. 1863 ..... *totalis*.  
*Ragonotia* Grote, Can. Ent. xx. p. 75 (1888)..... *totalis*.

Proboscis aborted and minute; palpi downturned, about three times length of head and rather broadly fringed with scales below; maxillary palpi filiform; frons with small rounded prominence with corneous plate below it; antennæ of male ciliated, the basal joint large. Fore wing long and narrow, the apex rounded, the termen obliquely curved; vein 2 from towards angle of cell; 3 and 5 from close to angle; 6 from below upper

angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 approximated for some distance to 4, 5 which are strongly stalked, or 4 rarely absent; 6, 7 stalked; 8 not anastomosing with 7.

RAGONOTIA DOTALIS.

*Anerastia dotalis* Hulst, Trans. Am. Ent. Soc. xiii. p. 164 (1886); Rag. Rom. Mém. viii. p. 329, pl. 38. f. 19; Dyar, Cat. Lep. N. Am. p. 437.

*Ciris discigerella* Rag. N. Am. Phyc. p. 17 (1887).

U.S.A., Colorado, Arizona.

Genus POLYOCHA.

	Type.
<i>Polyocha</i> Zeller, Isis, 1848, p. 876.....	<i>sanguinariella</i> .
<i>Polyochodes</i> Chretien, Bull. Soc. Ent. Fr. 1911, p. 13.....	<i>stipella</i> .

Proboscis aborted and minute; palpi typically downcurved, extending about three times length of head, the 2nd joint moderately scaled, the 3rd rather long and naked; maxillary palpi dilated with scales; frons smooth, with tuft of scales; antennæ of male typically laminate and without sinus and ridge of scales at base. Fore wing long and narrow, the apex rounded, the termen obliquely curved; vein 3 from close to angle of cell; 4, 5 strongly stalked; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing with vein 2 from close to angle of cell; 3 approximated for some distance to 4, 5 which are strongly stalked; 6, 7 shortly stalked; 8 not anastomosing with 7.

SECT. I. Palpi of male obliquely upturned; antennæ serrate, with sinus and ridge of scales at base of shaft.

(1) †POLYOCHA PLINTHOCHROA, sp. n.

Head and thorax bright rufous mixed with some ochreous; abdomen ochreous, dorsally fulvous yellow towards base; antennæ ochreous. Fore wing bright rufous with a faint purplish gloss, some ochreous in lower part of cell and below and just beyond the cell, the veins remaining rufous; a narrow yellowish-white costal fascia, tapering to a point just before apex. Hind wing ochreous white, the costal area and termen tinged with red-brown.

TRANSVAAL, Karina (*Cooke*), 1 ♂ type, White R. (*Cooke*), 1 ♀. *Exp.* 26 mm.

(2) †POLYOCHA LEUCOPLEURELLA.

*Emmalocera leucopleurella* Rag. Nouv. Gen. p. 38 (1888); id. Rom. Mém. viii. p. 317, pl. 44. f. 15.

GOLD COAST; S. & N. NIGERIA; KASHMIR; MADRAS.



## (3) †POLYOCHA GENSANALIS.

*Emmalocera gensanalis* South, Trans. Ent. Soc. 1901, p. 405,  
pl. xiv. f. 30.

COREA.

SECT. II. Palpi of male downcurved; antennæ without sinus and ridge of scales at base of shaft.

A. (*Polychodes*). Antennæ of male pectinate with uniseriate branches.

## (4) \*POLYOCHA STIPELLA.

*Polychodes stipella* Chretien, Bull. Soc. Ent. Fr. 1911, p. 13.

ALGERIA.

B. (*Polyocha*). Antennæ of male laminate.

## (5) †POLYOCHA CINERELLA.

*Polyocha cinerella* Hmps. Moths Ind. iv. p. 62 (1896); id.  
Rom. Mém. viii. p. 328, pl. 55. f. 4.

PUNJAB; BENGAL.

## (6) POLYOCHA VENOSA.

*Epischmia venosa* Zell. Isis, 1847, p. 31; Herr.-Schäff. Schmett.  
Eur. iv. p. 109; Rag. Rom. Mém. viii. p. 327; Staud. Cat. Lep.  
pal. ii. p. 13.

CYPRUS; SYRIA.

## (7) POLYOCHA SANGUINARIELLA.

*Polyocha sanguinariella* Zell. Isis, 1848, p. 876; Rag. Rom.  
Mém. viii. p. 327, pl. 8. f. 20.

BR. C. AFRICA; MASHONALAND; TRANSVAAL; MADAGASCAR.

## (8) POLYOCHA VESCULELLA.

*Polyocha vesculella* Rag. Nouv. Gen. p. 39 (1888); id. Rom.  
Mém. viii. p. 323, pl. 36. f. 11; Hmps. Moths Ind. iv. p. 63.

MADRAS, Palni Hills; TRAVANCORE.

## (9) \*POLYOCHA FLAGRANTELLA.

*Polyocha flagrantella* Rag. Rom. Mém. viii. p. 323, pl. 44. f. 24  
(1901).

MADAGASCAR.

## (10) †POLYOCHA STRIGIVENELLA.

*Polyocha strigivenella* Hmps. J. Bomb. Nat. Hist. Soc. xii.  
p. 310 (1898); id. Rom. Mém. viii. p. 322, pl. 51. f. 19.

BURMA.

## (11) \*POLYOCHA NEUROPTERELLA.

*Polyocha neuropterella* Rag. Ann. Soc. Ent. Fr. 1887, p. 258; id. Rom. Mém. viii. p. 322, pl. 35. f. 23; Staud. Cat. Lep. pal. ii. p. 13.

W. TURKESTAN.

## (12) \*POLYOCHA FOUCARTI.

*Polyocha foucarti* Rag. Ann. Soc. Ent. Fr. 1887, p. 258; id. Rom. Mém. viii. p. 322, pl. 35. f. 24; Staud. Cat. Lep. pal. ii. p. 13.

ALGERIA.

## (13) †POLYOCHA ACHROMATELLA, sp. n.

♀. Head and thorax white tinged with ochreous; abdomen white, dorsally fulvous yellow towards base; pectus and legs ochreous white. Fore wing pale ochreous, the veins white, less distinctly so on costal area. Hind wing white.

N. S. WALES, Broken Hill (*Lower*), 3 ♀ type. *Exp.* 28 mm.

## (14) \*POLYOCHA DETRITELLA.

*Polyocha detritella* Rag. Nouv. Gen. p. 39 (1888); id. Rom. Mém. viii. p. 326, pl. 36. f. 14; Hmps. Moths Ind. iv. p. 63.

PUNJAB.

## (15) †POLYOCHA FUSCICOSTELLA, sp. n.

♀. Head and thorax glossy fuscous brown; abdomen fuscous brown, pale red-brown at sides and extremity; pectus and legs pale red-brown, the tarsi fuscous brown. Fore wing pale red-brown, the costal area broadly glossy fuscous brown and the inner basal area tinged with fuscous brown. Hind wing ochreous white, the costal area tinged with brown.

N. NIGERIA, Zungeru (*Macfie*), 2 ♀ type. *Exp.* 24 mm.

## Genus EMMALOCERA.

	Type.
<i>Emmalocera</i> Rag. Nouv. Gen. p. 38 (1888).....	<i>leucocincta</i> .
<i>Lodiana</i> Rag. Nouv. Gen. p. 38 (1888) .....	<i>umbrivittella</i> .
<i>Papua</i> Rag. Bull. Soc. Ent. Fr. 1889, p. cexx...	<i>latilimbella</i> .

Proboscis aborted and minute; palpi of male typically obliquely upturned to above vertex of head, the 2nd joint hollowed out to receive the brush-like maxillary palpi, the 3rd short and porrect; frons smooth, obliquely flattened; antennæ of male typically with short uniseriate branches, the basal joint large, the shaft with large sinus and ridge of scales at base. Fore wing rather long and narrow, the apex rounded, the termen evenly curved; vein 3 from near angle of cell, 5 from just above angle; 6 from below upper angle; 8, 9 stalked; 10, 11 from cell. Hind wing

with vein 2 from well before angle of cell; 3 approximated for some distance to 4, 5 which are strongly stalked; 6, 7 shortly stalked; 8 not anastomosing with 7.

SECT. I. Palpi of male upturned, the 2nd joint hollowed out to receive the brush-like maxillary palpi; antennæ with sinus and ridge of scales at base of shaft.

A. Antennæ of male with rather long uniseriate branches.

(1) †EMMALOCERA ORNATELLA.

*Polyocha ornatella* Hmps. J. Bomb. Nat. Hist. Soc. xv. p. 21 (1903).

PUNJAB.

(2) †EMMALOCERA PULVEREALIS.

*Polyocha pulverealis* Hmps. J. Bomb. Nat. Hist. Soc. xv. p. 20 (1903).

ASSAM.

(3) †EMMALOCERA ENDOPYRELLA, sp. n.

♂. Head ochreous tinged with purplish pink, the antennæ ochreous; thorax bright purplish pink; abdomen fulvous yellow; pectus and legs ochreous tinged with red-brown. Fore wing with narrow pure white costal fascia, the rest of wing bright purplish pink, suffused with red-brown to median nervure and veins 4. Hind wing ochreous white, the costa slightly tinged with brown.

ASSAM, Khâsis, 1 ♂ type. *Exp.* 26 mm.

(4) EMMALOCERA LONGIRAMELLA.

*Emmalocera longiramella* Hmps. Rom. Mém. viii. p. 315, pl. 52. f. 16 (1901).

QUEENSLAND.

(5) \*EMMALOCERA RADIATELLA.

*Emmalocera radiatella* Hmps. Rom. Mém. viii. p. 315, pl. 52. f. 21 (1901).

QUEENSLAND.

(6) †EMMALOCERA ACTINOLEUCA, sp. n.

♂. Head and thorax pale purplish pink mixed with white; abdomen creamy white, dorsally fulvous yellow towards base; antennæ white; frons, palpi, pectus, and legs white suffused with rufous. Fore wing pale purplish pink, the veins, two streaks in the cell and one in submedian fold white. Hind wing white faintly tinged with ochreous.

SIERRA LEONE (*Clements*), 1 ♂ type. *Exp.* 24 mm.

## (7) †EMMALOCERA DEPRESSELLA.

*Melissoblastes depressella* Swinh. P. Z. S. 1885, p. 876, pl. 57. f. 5; Hmpsn. Moths Ind. iv. p. 63; id. Rom. Mém. viii. p. 324, pl. 36. f. 12.

*Polyocha saccharella* Dudgeon, J. Bomb. Nat. Hist. Soc. xvi. p. 405 (1905).

ADEN; PUNJAB; BENGAL; BOMBAY. The larva feed on the roots of sugar-cane.

## (8) †EMMALOCERA STRIGICOSTELLA.

*Polyocha strigicostella* Hmpsn. P. Z. S. 1896, p. 270; id. Rom. Mém. viii. p. 315, pl. 31. f. 18.

ADEN.

B. (*Emmalocera*). Antennæ of male with short uniseriate branches.

## (9) †EMMALOCERA LEUCOCINCTA.

*Crambus leucocinctus* Wlk. xxvii. 169 (1863); Hmpsn. Rom. Mém. viii. p. 316, pl. 36. f. 9.

*Emmalocera crenatella* Rag. Nouv. Gen. p. 38 (1888).

SINGAPORE; BORNEO; PHILIPPINES.

C. (*Papua*). Antennæ of male laminate, serrate towards base.

## (10) †EMMALOCERA SANGUIFUSALIS.

*Polyocha sanguifusalis* Hmpsn. P. Z. S. 1910, p. 493, pl. xl. f. 9.

N. RHODESIA.

## (11) †EMMALOCERA AURIFUSELLA.

*Crambus aurifusellus* Wlk. xxxv. 1756 (1866); Hmpsn. Moths Ind. iv. p. 62; id. Rom. Mém. viii. p. 317, pl. 36. f. 18.

KASHMIR; PUNJAB; BOMBAY; MADRAS.

## (12) EMMALOCERA BIFIDELLA.

*Polyocha bifidella* Wileman, Trans. Ent. Soc. 1911, p. 357, pl. 31. f. 22.

JAPAN.

## (13) †EMMALOCERA POLYCHROELLA, sp. n.

Head and thorax ochreous mixed with fiery red; abdomen ochreous; antennæ of male with the tuft blackish on inner side; palpi, pectus, legs, and ventral surface of abdomen ochreous tinged with red-brown. Fore wing with narrow creamy white costal fascia leaving the costal edge red-brown towards base, defined below by a fiery rufous streak to beyond middle, the area below it red-brown to median nervure and vein 4; the inner

half of wing yellow thickly irrorated with fiery red, the terminal half of inner margin tinged with brown.

W. AFRICA (*Dudgeon*), 1 ♂, 1 ♀; S. NIGERIA, Mama (*Dudgeon*), 1 ♂ type. *Exp.*, ♂ 22, ♀ 28 mm.

(14) EMMALOCERA UMBRICOSTELLA.

*Emmalocera umbricostella* Rag. Nouv. Gen. p. 38 (1888); id. Rom. Mém. viii. p. 316, pl. 36. f. 10; Hmps. Moths Ind. iv. p. 62.

COREA; C. CHINA; SIKHIM; BORNEO, Pulo Laut; PHILIPPINES; JAVA; FLORES; BALI.

(15) EMMALOCERA LUCIDICOSTELLA.

*Emmalocera lucidicostella* Rag. Nouv. Gen. p. 38 (1888); id. Rom. Mém. viii. p. 316, pl. 35. f. 20; Hmps. Moths Ind. iv. p. 62.

PUNJAB; BENGAL; CEYLON; SUMATRA.

(16) EMMALOCERA ANERASTICA.

*Nephoptyx anerastica* Snell. Veth's Midden-Sumatra, Lep. p. 81 (1880); Rag. Rom. Mém. viii. p. 317, pl. 36. f. 8.

SIERRA LEONE; FORMOSA; PUNJAB; NICOBARS; JOHORE; SELANGOR; SINGAPORE; SUMATRA; BORNEO, Pulo Laut; PHILIPPINES; LOUISIADE Is., St. Aignan I.

(17) EMMALOCERA LATILIMBELLA.

*Papua latilimbella* Rag. Bull. Soc. Ent. Fr. 1889, p. cexx; id. Rom. Mém. viii. p. 313, pl. 36. f. 7.

*Polyocha rhabdota* Turner, Pr. R. Soc. Queensl. xviii. p. 122 (1903).

*Polyocha achrosta* Turner, Pr. R. Soc. Queensl. xviii. p. 122 (1903).

N. GUINEA; QUEENSLAND.

D. Antennæ of male laminate, not serrate towards base.

(18) EMMALOCERA LAMINELLA.

*Emmalocera laminella* Hmps. Rom. Mém. viii. p. 318, pl. 51. f. 8 (1901).

SIERRA LEONE; BR. E. AFRICA; BR. C. AFRICA.

SECT. II. Palpi of male downcurved; maxillary palpi filiform.

A. Antennæ of male with sinus and ridge of scales at base of shaft.

a. Antennæ of male with long uniseriate branches.

(19) EMMALOCERA VARIEGATELLA.

*Polyocha variegatella* Rag. Nouv. Gen. p. 39 (1888); id. Rom. Mém. viii. p. 326, pl. 36. f. 16; Hmps. Moths Ind. iv. p. 63.

PUNJAB.

## (20) †EMMALOCERA TRICOLORALIS.

*Polyocha variegatella* Hmspn. J. Bomb. Nat. Soc. Hist. xii p. 320 (nec Rag.).

*Polyocha tricoloralis* Hmspn. J. Bomb. Nat. Hist. Soc. xv. p. 20 (1903).

SIKKIM; PHILIPPINES.

## (21) EMMALOCERA DIVERSELLA.

*Polyocha diversella* Hmspn. J. Bomb. Nat. Hist. Soc. xii. p. 310 (1898); Rag. Rom. Mém. viii. p. 324, pl. vi. f. 21.

MADRAS, Nilgiris.

## (22) \*EMMALOCERA COSTELLA.

*Polyocha costella* Rag. Nov. Gen. p. 39 (1888); id. Rom. Mém. viii. p. 326, pl. 36. f. 15.

GAMBIA.

## (23) EMMALOCERA CREMORICOSTA.

*Polyocha cremoricosta* Rag. Bull. Soc. Ent. Fr. 1895, p. cii; id. Rom. Mém. viii. p. 325, pl. 51. f. 9; Staud. Cat. Lep. pal. ii. p. 13.

ASIA MINOR; SYRIA.

## (24) †EMMALOCERA ERYTHRINELLA.

*Polyocha erythrinella* Rag. Nouv. Gen. p. 38 (1888); id. Rom. Mém. viii. p. 323, pl. 44. f. 14.

N. NIGERIA; ABYSSINIA; BR. E. AFRICA; BR. C. AFRICA.

## (25) \*EMMALOCERA CARNATELLA.

*Polyocha carnatella* Rag. Nouv. Gen. p. 39 (1888); id. Rom. Mém. viii. p. 325, pl. 35. f. 25; Hmspn. Moths Ind. iv. p. 63.

PUNJAB.

## (26) \*EMMALOCERA MONOCHROMELLA.

*Polyocha monochromella* Rag. Nouv. Gen. p. 39 (1888); id. Rom. Mém. viii. p. 325, pl. 36. f. 13; Staud. Cat. Lep. pal. ii. p. 13.

## (27) †EMMALOCERA EREMOCHROA, sp. n.

♀. Head and thorax whitish suffused with ochreous brown; abdomen creamy white, dorsally fulvous yellow towards base; pectus, legs, and ventral surface of abdomen white tinged with brown. Fore wing pale ochreous, the costal half and terminal area suffused with brown, the cell and veins beyond it with some whitish irroration, the interspaces beyond the cell with

slight ochreous streaks, the area below the cell with slight red-brown irroration. Hind wing creamy white.

W. AUSTRALIA, Sherlock R. (*Clements*), 1 ♀ type. *Exp.* 44 mm.

*b.* (*Lodiana*). Antennæ of male serrate.

(28) EMMALOCERA UMBRIVITTELLA.

*Lodiana umbrivittella* Rag. Nouv. Gen. p. 38 (1888); id. Rom. Mém. viii. p. 319, pl. 35. f. 19; Hmps. Moths Ind. iv. p. 62.

*Polyocha venosella* Wileman, Trans. Ent. Soc. 1911, p. 357.

JAPAN, Yezo; PUNJAB; SIKKIM; ASSAM.

(29) EMMALOCERA ALBICOSTALIS.

*Lodiana albicostalis* Hmps. Trans. Ent. Soc. 1900, p. 375; Staud. Cat. Lep. pal. ii. p. 13.

PALESTINE; PUNJAB.

B. Antennæ of male without sinus and ridge of scales.

(30) EMMALOCERA SUBFASCIATELLA.

*Polyocha subfasciatella* Rag. Ann. Soc. Ent. Fr. 1887, p. 258; id. Rom. Mém. viii. p. 328, pl. 36. f. 17; Staud. Cat. Lep. pal. ii. p. 13.

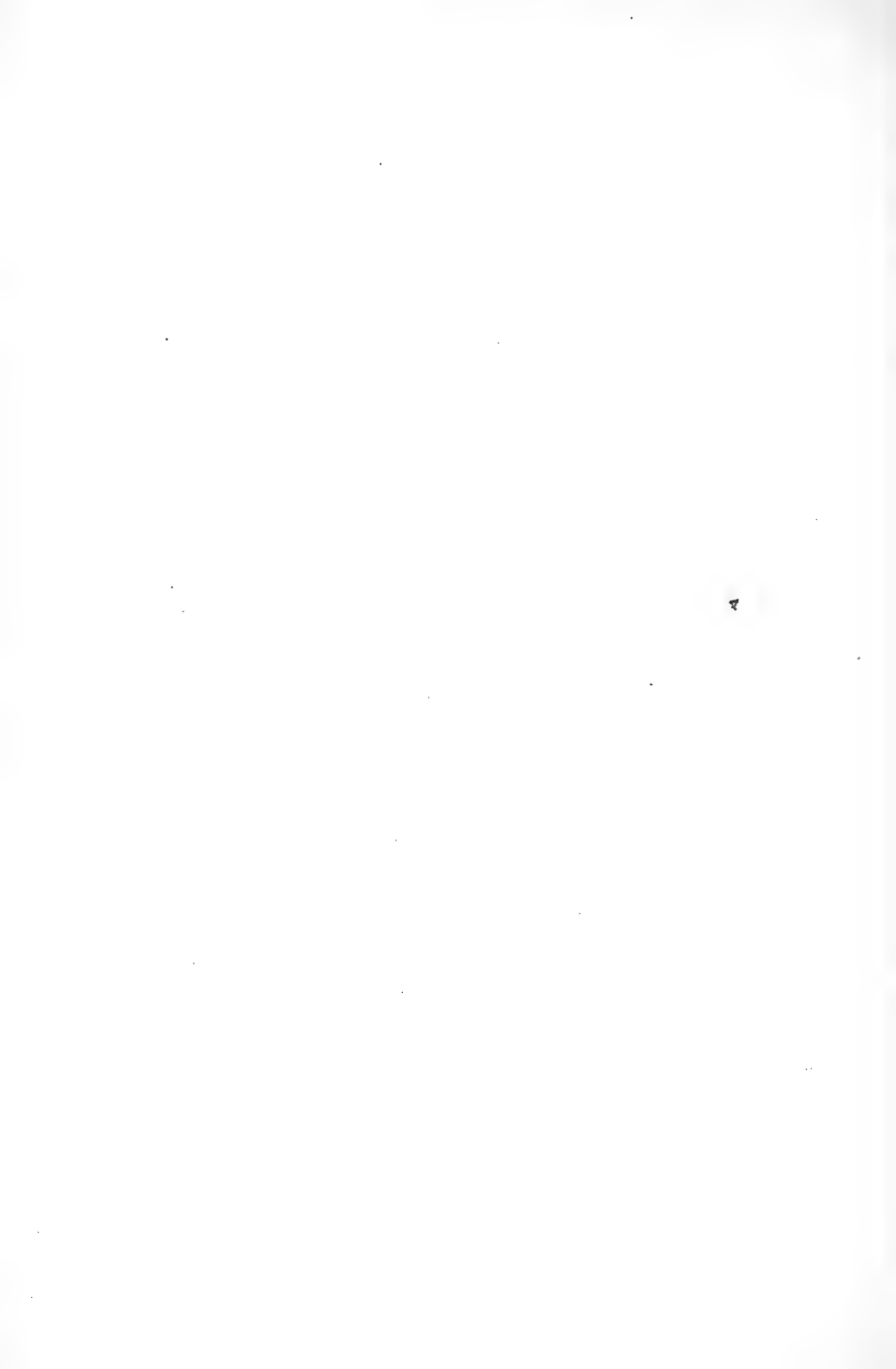
ARMENIA; PERSIA.

*Auctorum.*

*Polyocha rhodesia* Strand, Archiv. f. Naturg. 75. 1, 3, p. 384 (1909)..... N. RHODESIA.

GENERA AUCTORUM.

*Barberia affinitella* Dyar, Proc. Ent. Soc. Wash. vii. p. 39 (1905), nr. *Rhinaphe* ..... U.S.A., TEXAS.  
*Cabnia myronella* Dyar, J. N. Y. Ent. Soc. xii. p. 108 (1904), nr. *Saluria*..... U.S.A., Washington.  
*Fondoukia translucidella* Chretien, Bull. Soc. Ent. Fr. 1911, p. 11, nr. *Dembea* ..... ALGERIA.  
*Schenectadia merilesella* Dyar, Pr. U.S. Nat. Mus. xlviii. p. 349 (1913), nr. *Tinerastia*..... PANAMA.  
*Sabormania pia* Strand, Arch. Naturg. 78. A. Hft. 12, p. 80 1913. ?=*Monoctenocera*..... SPANISH GUINEA.





6. First Report on the Inheritance of Visible and Invisible Characters in Silkworms. By Miss MAUDE L. CLEGHORN, F.Z.S., F.L.S., F.E.S.

[Received December 3, 1917: Read March 9, 1918.]

The mulberry silkworm races of Bengal are all with the exception of one (*Bombyx textor*) multivoltine, but their cocoons are not so good as those of the European or Japanese races, and therefore when the question of reviving the Indian silk industry arose, the following suggestions were put forward, viz.: that endeavours should be made to obtain an improved multivoltine race by crossing an indigenous variety with a European one, and that our knowledge of hybridization according to Mendel's law should be utilised to help in the process.

With these suggestions in my mind I obtained from Italy, in December 1910, some European silkworm seed (eggs of the *Bombyx mori*) and some Nistri (*Bombyx croesi*) seed cocoons from the Berhampore Government Nursery.

The European seed was of the Italian-Japanese Hybrid, and was the first generation of a cross between the univoltine (producing one brood a year) yellow Italian (Indigeno giallo) male, and the univoltine white Japanese female—pure yellow Italian seed not having been available at the time. This Italian-Japanese Hybrid is very hardy, being a first cross, and so I started my cross-breeding experiments with it.

The cocoons of the multivoltine Nistri silkworm weighed (with the chrysalis removed) from 1 grain to 1.6 grains, whilst the cocoons of the Italian-Japanese Hybrid (being of a univoltine race and therefore bigger) weighed from about 2.5 grains to 4.6 grains. My aim in my experiments with these two varieties of silkworms has been (1) to make a multivoltine race (because though its cocoons are smaller than those of the univoltine, yet they are compensated for by the numerous broods produced during the year), producing cocoons of about 4 grains in weight, and (2) to see how far the good qualities of the univoltine varieties can be combined with the multivoltine character.

I made two series of experiments:—

- A. A cross between the multivoltine Nistri ♀ and the univoltine Italian-Japanese Hybrid ♂.
- B. A cross between the univoltine Italian-Japanese Hybrid ♀ and multivoltine Nistri ♂.

Experiment A was made with individuals selected usually from three or four families in each generation, except in one of the experiments in  $F_2$ , which was made with a whole family.

Experiment B was made with the complete family in each generation, with the exception of  $F_1$ , when only a few worms were reared out of four layings.

The layings produced in  $F_1$  by Experiment A and those

produced by Experiment B were entirely different from each other, for they resembled the maternal parent in each case, all the layings of the Nistri ♀ and Ital.-Jap. ♂ being multivoltine, and all those of the Ital.-Jap. ♀ and Nistri ♂ proving univoltine.

*Result of the Experiment as regards the Size of the Cocoon.*

*Experiment A.*—The parent cocoons of the Ital.-Jap. ♂ and Nistri ♀ cross weighed 2.9 and 1.5 grains respectively. The cocoons of this cross generation of this cross resembled those of the Nistri (*i. e.* the maternal parent) more than those of the Ital.-Jap. parent, being rounded at both ends and very thick but of the loose texture of the Nistri, the firm texture of the Ital.-Jap. being entirely unrepresented. They were uniform in size and shape, but varied in weight from 2.5 to 4.1 grains.

In the second and the immediately succeeding generations, the cocoons were not so uniform in size and shape. Many were large and rather pointed at the ends, whilst they were all thinner and firmer than those of  $F_1$ , and I found that in the earlier generations moths which gave complete multivoltine layings had nearly always cut out from cocoons which were about 3 grains or less in weight. I did not make use of these 3-grain cocoons for rearing purposes, even though they were far better than the original multivoltine Nistri cocoon, but I carefully selected the best out of the most multivoltine layings of cocoons weighing from about 3.5 grains to 5 grains in weight. The cocoons in all the generations of the cross were far superior to the original Nistri cocoon, and in many of the generations they are also superior to that of the Ital.-Jap. Hybrid.

Up to  $F_5$  many of the cocoons were 4 grains in weight, in  $F_3$ ,  $F_4$ ,  $F_5$ , many were over 4.5 grains, while some weighed 5 grains and over. In  $F_7$  and  $F_8$  there were no 4-grain cocoons, and on the whole the cocoons of these two generations were very poor compared with those of the preceding generations, but they were nevertheless still superior to the original Nistri cocoon. As the layings from which these cocoons were produced were nearly entirely multivoltine, the cocoons appeared to be also becoming more multivoltine in character. The rearings in  $F_5$  from which  $F_6$  hatched were all entirely multivoltine, while the  $F_6$  silkworm were better again and seriposited cocoons, nearly all of which were over 3.5 grains, many over 4 grains, and some nearly 5 grains in weight (with chrysalis and outer fluff removed). The layings of the moths from these cocoons were also entirely multivoltine, which showed that it is possible to obtain a 4- or 5-grain cocoon from entirely multivoltine layings in  $F_5$  after a cross without any recrossing. Care was, however, always taken to have the parent moths as distantly related as possible. (Table 1.)

In this experiment I found that, after the direct influence of the fresh cross seemed to have disappeared, every third generation produced the best cocoons, for the cocoons of  $F_6$ ,  $F_9$ ,  $F_{12}$ ,  $F_{15}$

TABLE 1, SHOWING THE DESCENT OF COCOONS UP TO THE NINTH GENERATION, WITH DATES OF *ELEVAGES*.

Ital.-Jap. Hyb. ♂		× Nistri ♀		.....		Jan. 31, 1911	$P_1$
No. 1, 2.9 grs.		No. Af <sup>3</sup> 1.5 grs.					
No. 22 ♀	× No. 15 ♂	No. 26 ♀	× No. 13 ♂	.....		March 28	$F_1$
3.7 grs.	3.8 grs.	3.3 grs.	2.8 grs.				
No. 26 ♂		×		No. 33 ♀		April 28	$F_2$
4.2 grs.				3.7 grs.			
No. 43 ♀	No. 21 ♂	× No. 20 ♀		.....		June 6	$F_3$
4.1 grs.	5.1 grs.	5 grs.					
No. 59 ♂	× No. 15 ♀	No. 5 ♀	× No. 4 ♂	.....		July 8	$F_4$
3.8 grs.	4.3 grs.	4.8 grs.	5 grs.				
No. 52 ♂	× No. 19	No. 25 ♀	× No. 18 ♂	No. 15 ♀	× No. 50 ♂	No. 52 ♂	.....
4 grs.	3.8 grs.	4.4 grs.	3.4 grs.	3.6 grs.	3.2 grs.	4 grs.	Aug. 30
No. 10 ♂	× No. 5 ♀	No. 1 ♂	No. 17 ♀	× No. 1 ♂		.....	
2.2 grs.	2.8 grs.	3.6 grs.	3.6 grs.	3.6 grs.		Oct. 10	
No. 41 ♂	× No. 55 ♀	No. 61 ♀	× No. 27 ♂	No. 41 ♂		.....	
2.5 grs.	2.4 grs.	1.9 grs.	2.9 grs.	2.5 grs.		Nov. 30	
No. 40 ♀	× No. 37 ♂	No. 23 ♂	× No. 20 ♀	.....		Feb. 1, 1912	$F_8$
3 grs.	2.8 grs.	2.2 grs.	2.4 grs.				
No. 115	No. 113	No. 119	No. 221	No. 216	.....		Mar. 22
3.7 grs.	4.8 grs.	4.1 grs.	4 grs.	3.3 grs.			$F_9$

were much superior to those of the intervening generations. Even those of  $F_{12}$  seriposited during the rains in July were much better than those of  $F_{10}$  (April) and  $F_{14}$  seriposited in October. As the raiyats in India grow about three or four crops of cocoons a year (only rearing a few to keep the breed alive when they are short of leaf) it would be to their advantage to arrange that the crops reared are of every third generation.

The cocoons obtained from this multivoltine race are much superior to the Nistri; those of  $F_9$  were valued at about 9½ francs per kilo in the Milan market, which is close up to the price of good Italian cocoons, and the cocoons of  $F_{13}$ , which were not near as good as those of  $F_9$ , were valued at about 7 francs per kilo. The correct rendement could not be obtained, as the 175 cocoons sent to be tested were too few, 1 lb. weight of cocoons being necessary.

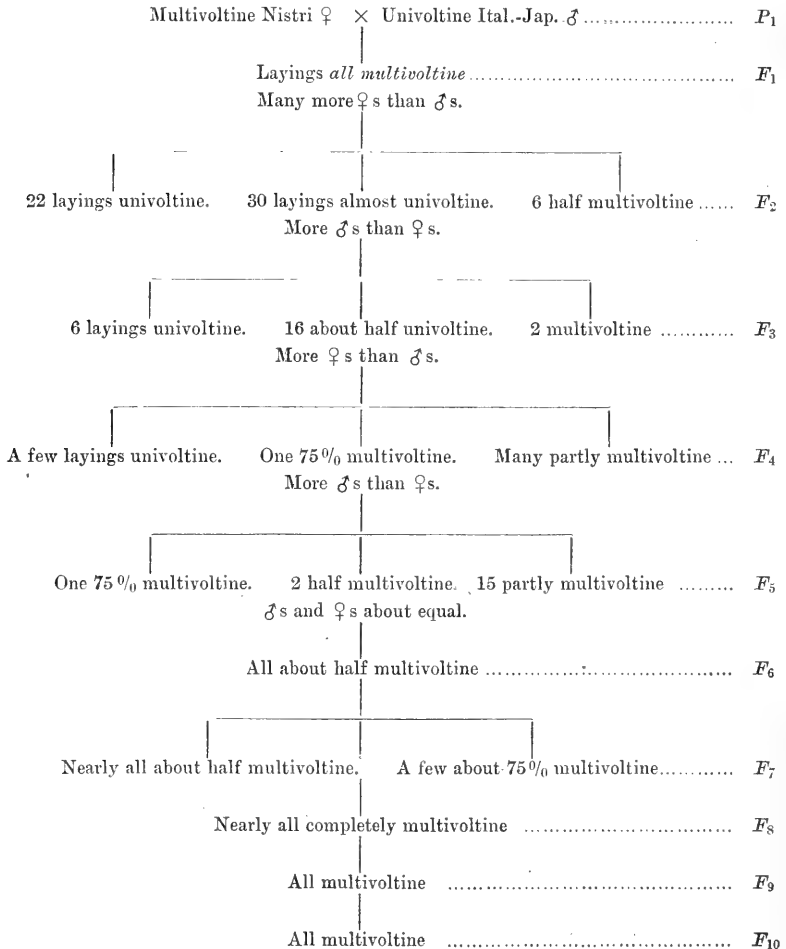
*Experiment B.*—Cross between univoltine Ital.-Jap. Hybrid ♀ and multivoltine Nistri ♂.

This was carried out for four generations only and then discontinued, as the cocoons were not as good as those of the reciprocal cross, rarely averaging a weight of 3.5 grains.

*Results of Experiment as regards the Multivoltine and Univoltine character of the Silkworm Moths.*

*Experiment A.*

TABLE 2, ILLUSTRATING THE DESCENT OF THE UNIVOLTINE CHARACTER IN THE CROSS BETWEEN ITAL.-JAP. ♂ AND NISTRI ♀.



From the results obtained it will be seen that all the eggs in the layings of the multivoltine Nistri ♀ when crossed with the univoltine Ital.-Jap. ♂ hatched, *i.e.*, the layings were all multivoltine, whilst the univoltine paternal parent had no visible effect on the character of the layings. This showed that the multivoltine character was dominant in the ♀, but recessive in the ♂. Toyama, the Japanese authority on silkworms, also found that in crossing pure breeds the first cross always resembled the maternal parent.

I usually found that the completely multivoltine layings did not give the most multivoltine results as might be expected, but the half multivoltine laying produced the least number of univoltine layings in the long run.

In the Nistri ♀ and Ital.-Jap. ♂ cross I discarded the multivoltine layings which appeared in the earlier generations, and mostly selected from the half, or partly multivoltine layings, till in  $F_3$  when most of the layings were almost entirely multivoltine. Some of the families have been entirely multivoltine since  $F_2$ , others have had a few partly univoltine layings, but in none of the generations since  $F_1$  have any of the layings been entirely univoltine.

Toyama does not give any detailed account of the results he obtained in the brood characters. It would have been interesting and useful, as the inheritance of these invisible characters appears to be complicated. He selected from multivoltine forms, but does not say if they were entirely or partly multivoltine. He states as follows:—"Those forms raised from the first cross do not remain true to the parents in subsequent generations. Even when we selected multivoltine forms for five generations we failed to get any constant multivoltine breed."

In his interesting pamphlet "Sulla riproduzione degli Incroci" Dott. Quajjat, when referring to his experiments with bivoltine and univoltine races, states that "nelle successive riproduzioni, bivoltinismo tende a diminuire, ed alcune volte anzi a scomparire completamente. Sarà oria interessante constatare se le ovature ottenute univoltine, abbiano allo stato lateute il bivoltinismo, e se questo si potrà manifestare in seguito a nuovi incroci o spontaneamente."

I found that from  $F_3$  the layings began to show a great tendency to become completely multivoltine, and in those of the  $F_{11}$  moths, from which  $F_{15}$  worms hatched, only one laying out of the whole generation was half univoltine, all the others were completely multivoltine.

To account for the 22 layings in  $F_2$  appearing univoltine, the univoltine character must have dominated in the maternal parents of these layings. When a female  $F_1$  was crossed with a "pure" multivoltine Nistri ♂ only 3 eggs out of 250 hatched, and from the results obtained, in the reciprocal cross, it was found that if the maternal parent was a pure univoltine none of the eggs hatched for about a year, and if she was a pure multivoltine all

the eggs were multivoltine. As this female of  $F_1$  had hatched from a completely multivoltine laying, it might naturally be expected that, when the paternal parent was pure multivoltine all the eggs laid would be multivoltine, but as only a few eggs hatched it showed that the maternal parent was dominant in the univoltine character, and that *the dominance of the univoltine character was inherited by the  $F_1$  ♀ from the paternal parent in which it was not a dominant character.*

It is clear that the female influences the reappearance of the character in a dominant form, and shows that the descent is of a sex-limited inheritance.

In my experiments I found that the univoltine or multivoltine character of the maternal parent showed itself in the layings and not that of the paternal, for the character of the paternal parent always appeared to be masked or suppressed.

Besides the difficulties a sex-limited inheritance presents the univoltine and multivoltine characters are not visible in the moths but only in their layings, for moths which outwardly resemble the univoltine parent may have a multivoltine laying and *vice versa*.

When all the moths of a generation are bred *inter se* the character of only the maternal parents can be determined by the eggs laid; but to prove that the males and females of each generation are either homozygous or heterozygous, dominant or recessive, they have each to be bred with pure univoltines and multivoltines. So to find out the exact composition of all the moths in each generation would require a multitude of experiments, and I could not spare many moths from  $F_3$ , for I knew that in  $F_2$  only a very small percentage of eggs would hatch.

The layings in  $F_3$  which were laid by the  $F_2$  moths give a clue to the character of some of the parent moths in  $F_2$ . For the maternal parents of the six univoltine layings (Table 2) must have been dominant in the univoltine character, and those of the two multivoltine layings, in the multivoltine character, but the sixteen 50 per cent. univoltine layings point to the maternal parents being heterozygous.

#### *Experiment B.*

From the results obtained in the Ital.-Jap. ♀ and Nistri ♂ cross (Table 3) it will be seen that although all the layings in  $F_1$  were univoltine, yet there were some multivoltine, and partly multivoltine layings in  $F_2$ ,  $F_3$  and  $F_4$ ; and, again, though the moths of  $F_3$  were reared from one of the multivoltine layings of  $F_2$ , yet 37 layings of the  $F_3$  moths were univoltine.

Forty-seven moths from an  $F_2$  family of the Ital.-Jap. ♀ and Nistri ♂ cross were tested with pure multivoltine Nistri moths and the results obtained were as follows:—

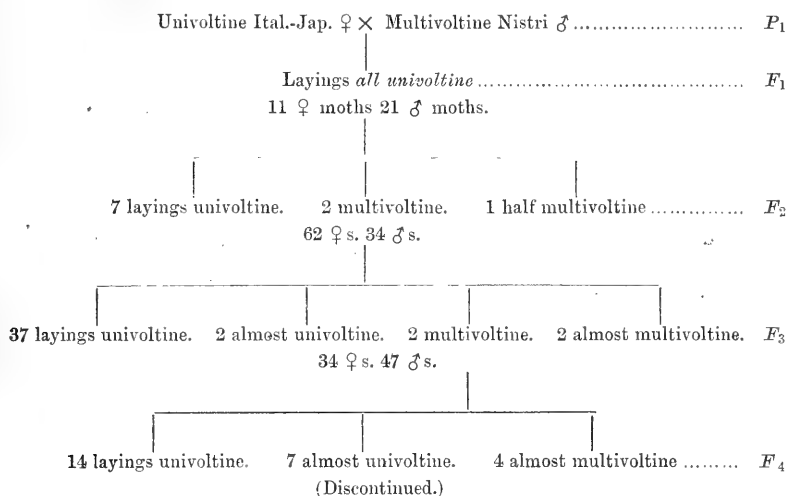
- (1) Out of 21 layings of the  $F_2$  ♀s and pure multivoltine Nistri ♂s 19 layings were entirely univoltine and 2 entirely multivoltine.

- (2) Out of 26 layings of pure multivoltine Nistri ♀s and F<sub>2</sub> ♂s all the eggs hatched, thus all being multivoltine.

These results give a clue to the gametic composition of the F<sub>2</sub> moths, for they show:—

- (1) that 19 F<sub>2</sub> ♀s were dominant in the univoltine character and 2 in the multivoltine character.  
 (2) that all the F<sub>2</sub> ♂s which may have been univoltine were recessive in the univoltine character.

TABLE 3, ILLUSTRATING DESCENT OF THE UNIVOLTINE AND MULTIVOLTINE CHARACTER IN THE CROSS BETWEEN THE UNIVOLTINE ITAL.-JAP. ♀ AND MULTIVOLTINE NISTRİ ♂.



*Unequal Sex-ratios.*

I had noticed that in the earlier generations of the Nistri ♀ and Ital.-Jap. ♂ cross (which were reared a year previous to that of the Ital.-Jap. ♀ and Nistri ♂ cross), the number of males and females seemed very unequal, and that in one generation males predominated, and in another, females. However, these remarkable fluctuations gradually decreased in the latter generations.

In my second series of experiments, which were with the Ital.-Jap. ♀ and Nistri ♂, I noted the exact number of males and females in each generation, and found that in this reciprocal cross the sex-ratios were also very unequal, but just the reverse in the character of the predominating sex, for in F<sub>1</sub> of the Nistri ♀ cross there were many more females than males, while in F<sub>1</sub> of the Ital.-Jap. ♀ cross there were more males than females.

The unequal sex-ratios could be accounted for by supposing

that in some of the generations the univoltine females do not hatch, and in others the univoltine males, but in  $F_1$  when all the eggs hatched the sex-ratios were also unequal.

#### *Method of Rearing of Worms.*

To ensure choosing distantly related moths for rearing from, I reared the silkworms of each laying separately, and the cocoons were also kept separate by keeping the silkworms after their fourth moult in rounded trays with a double inner circle of plaited strips of bamboo, about an inch and a half from the outer edge, forming a space into which the silkworms readily crawl to sereposit their cocoons. When the cocoons are removed from the trays, they are placed in rows on large sheets of white paper on which is noted the number of the laying from which they were reared.

Each cocoon is covered over with a small earthen cup, the common Indian *chilum*. A day or two before the moths come out, the cocoon is cut open to remove chrysalis and weighed.

The weight is noted and the chrysalis put back. When the moths emerge, the pierced cocoons are removed from under the earthen covers and placed within the opening at the top of the covers for reference, and this also to prevent the moths from getting out. By referring to the number of the layings and to the numbers of the two parent cocoons (which is also noted on the paper), the choosing of the distantly related moths for rearing is simplified.

If I had been rearing on a large scale I should have kept four or six families separate for seven or eight generations, then bred them together, and from these again four or six families would have been separated out.

In these experiments the silkworms have always been fed most during the night, as I have noticed that, in the wild state, the larvæ of moths mostly feed up to 9 or 10 a.m., and then restart feeding at about 5 or 6 p.m. Even young silkworms, which I kept on a small potted mulberry plant under observation, hardly ate at all during the day, though surrounded by fresh leaf on all sides. I find that silkworms always eat most voraciously between 10 p.m. and 4 a.m., so it is unnatural for them to be forced to feed all day, which is usually the case by the native rearers, and may well be one of the causes of their degeneracy.

They should have a rest of at least seven or eight hours during the day, and be fed every three or four hours during the night, starting late in the afternoon at about 6 p.m. If there is an abundant supply of leaf, they might with advantage be fed every two hours. Newly hatched worms should always be fed every two hours between 5 p.m. and 10 a.m. The worms if fed well in the last stage after the fourth moult will give good cocoons, even if not very well fed in the earlier stages, but it is most essential that they be well fed throughout the larval stage for them to be vigorous and healthy.



One of the advantages gained by the nocturnal feeding of worms is that the leaf can be gathered at sundown, and so keeps fresher, and does not fade as readily as when plucked in the morning. There is also very little chance of attacks from the dreaded silkworm fly, which is always on the alert during the brightest and hottest hours of the day.

I have found that the leaf from male trees of *Morus Indica* gives better results in feeding silkworms than that of the female trees. The dioecious character of the mulberry is not, as far as I know, known to sericulturists, for in most handbooks on the subject they advise rearers to select trees which bear little or no fruit. The inconspicuousness of the catkins and pseudo-spikes of the mulberry has evidently led to the difference between the trees being overlooked by all but botanists. As the flowers are inconspicuous they are anemophilous, and the trees, when in flower in February, may be seen giving off pollen in little puffs like smoke. This is best observed when there is no breeze.

*Additional Observations made during Experiments.*

The inheritance of the visible colour character of the cocoons is clearly Mendelian.

The parent cocoons of the Ital.-Jap. Hyb. were of the yellow Italian ♂ and white Japanese ♀.

The colour of the yellow Italian cocoon is of a deep pinkish yellow (*carneo-giallo* or flesh colour), which sometimes varies from a deep orange to almost white, but never of the vivid yellow of the Indian cocoon. All the cocoons of F<sub>1</sub> of this hybrid were of a pale flesh colour, none were white like that of the Japanese parent. A character which dominates after a cross is made was described by Mendel as dominant, and the character which seemed to have disappeared he called recessive. So the flesh colour of a cocoon is a dominant character, and the white a recessive. All observed results in the study of heredity point to the dominance of a character being due to the presence of that character, and the recessive to the absence of the dominant character.

The flesh colour of the Italian is due to the presence of the flesh colour and to the absence of the vivid yellow colour of the Nistri. While the white colour of the Japanese cocoon is due to the absence of both the pinkish yellow and bright yellow colours—the example of the inheritance of eye-colour in man might make this clearer. Here *the dominance of brown eyes can be traced to the presence of a brown pigment; and the recessiveness of blue eyes to the absence of the brown pigment.* All human eyes (except those of Albinos) have a layer of deep purple pigment on the inner surface of the iris, but in brown, hazel, green, and grey eyes there is also a layer of brown on the outer surface of the iris, and it is this brown layer which entirely (if abundant) or partly conceals the purple layer. In clear grey and clear deep and pale

blue eyes the brown pigment is absent and the purple pigment shows through the tissue forming the iris, and makes it appear of a clear deep blue, when the tissue through which it is seen is very delicate—and of a clear grey or pale blue when the tissues are more or less coarse. So, to trace the dominance of brown eyes the real nature of the various kinds of light eyes must be carefully made out; it then becomes clear that *the presence of the brown pigment makes brown eyes dominant to blue eyes in which it is absent*. If one parent has very dark brown eyes and the other clear blue eyes, all the children will have dark eyes, which sometimes include hazel, green or grey, but none will have clear grey or blue eyes. The reason for there being no blue-eyed children is apparent, for all the children inherit a factor, or unit character for pigment from the dark-eyed parent, but a factor lacking in pigment from the blue-eyed parent—and the presence of this pigment in all the children makes brown eyes dominant to blue.

To return to the colour of the cocoons the simplest explanation will be found in the interaction of two simple Mendelian characters. These two characters are flesh colour F, and yellow colour Y, and the two pairs of unit-characters involved are—

1. Flesh colour F. Absence of flesh colour f.
2. Yellow colour Y. Absence of yellow colour y.

The parent moths, then, have the following constitution:—

- (1) Yellow Italian possessing the flesh colour and lacking the yellow colour of the Nistri ... .. FFyy
- (2) Japanese white lacking both characters ... .. ffyy
- (3) Nistri lacking the flesh colour and possessing the yellow colour ... .. YYff

The actual parents in the experiment were:—

$P_1$  the Ital.-Jap. Hyb. an  $F_1$  of a cross between the Yellow Italian and White Japanese.

$P_2$  the Nistri.

The Yellow Italian has a deep pinkish yellow (flesh coloured) cocoon. It inherits two factors, one for the flesh colour F, and one for the absence of the yellow colour y, from each parent, and so consists of the union of two similar pairs of factors Fy and Fy. The Yellow Italian is therefore pure (homozygous) as regards the colour, for the germ-cells (gametes) by the union of which it was formed, each carried the same kinds of factors Fy and Fy. So the gametic composition of the Yellow Italian for the colour of its cocoon is represented as FFyy in Table 4, Diagrams (1) and (2).

As the whiteness of the Japanese cocoon is due to the absence of both the flesh colour of the Italian, and the yellow of the

Nistri, the gametic composition is represented in small letters as  $ffyy$  (Table 4). There was no colour in either of its parents for it to inherit, for the gametes, from the union of which it was formed, bore the factors  $fy$  and  $fy$ . Table 4, Diagram (1).

The cocoons of the Ital.-Jap. Hyb. are a pale flesh colour as they inherited the flesh colour from the Yellow Italian parent only, for the gamete from the White Japanese parent bore colour factors lacking in both the flesh and yellow colours. The colour factors inherited from the Yellow Italian parent were  $Fy$  and from the white Japanese parent  $fy$ . The Ital.-Jap. Hyb. is therefore not pure as regards the colour of its cocoon, for the two gametes, from the union of which it was formed, were unlike and did not carry pairs of similar factors. It is a hybrid (heterozygote), the gametic composition being  $Ffyy$ , and it will give gametes  $Fy$  and  $fy$ . When the Nistri ( $YYff$ ), which has a deep yellow coloured cocoon, was crossed with the Ital.-Jap. Hyb. all the cocoons of  $F_1$  of this cross were of a bright yellow colour, but not quite the deep yellow of the Nistri. So the bright yellow of the Nistri was dominant to the pale flesh colour of the Ital.-Jap. Hyb., for the deeper yellow entirely masked the pale pinkish yellow of the flesh colour even when it was present (Table 4). The gametic composition of  $F_1$  of the Nistri ♀ and Ital.-Jap. ♂ cross was  $YyFf$  and  $Yyff$ , and it therefore contained two classes, both numerically equally represented. Table 4, Diagram (1). All the cocoons were yellow, but not quite uniform in tin.

The gametes given off by these two classes were:—

$YyFf$  giving  $YF$ ,  $Yf$ ,  $Fy$ ,  $fy$ .  
 $Yyff$  „  $Yf$ ,  $yf$ .

In  $F_2$  there were a few deep yellow cocoons like those of the Nistri, a good many bright yellow like those of  $F_1$ , a few pinkish yellow and a very few white out of 52 cocoons. The exact numbers were—13 deep yellow, 29 yellow, 6 flesh coloured, and 4 white out of 52 cocoons.

The gametes for the colour character in  $F_1$  were  $YF$ ,  $Yf$ ,  $Fy$ , and  $yf$ , and their union at random would give, in  $F_2$ , cocoons of the following gametic compositions— $YYFF$ ,  $YYFf$ ,  $YYff$ ,  $YyFF$ ,  $YyFf$ ,  $Yyff$ ,  $yyFF$ ,  $yyFf$ , and  $yyff$ , which resulted in cocoons of various shades with just a few white ones.

This is just what occurred, and it will be seen that the proportions of the various colours obtained out of 52 cocoons run the proportion calculated very close, for according to the analysis in Table 4 there should be 12 deep yellow, 24 yellow, 5 flesh coloured, and 7 white out of every 48 cocoons. Table 4, Diagram (2). There was a difficulty, however, in distinguishing between the deep yellow and the bright yellow from the intermediate forms which occurred.

In  $F_3$  cocoons I found that in some cases when both the parent cocoons were deep yellow, all the cocoons produced by the offspring

were deep yellow too; in other cases, two deepish yellow  $F_2$  cocoons produced some flesh-coloured and even white ones.

I also found that flesh-coloured parent cocoons would, in some cases, give only flesh-coloured ones, and in others flesh-coloured and white.

Table 2 shows that among all the yellows in  $F_2$  there are two kinds—the pure (homozygous) dominants  $YYff$  and  $YYFF$  and the hybrid (heterozygous) dominants  $Yyff$ ,  $YyFF$ , and  $YyFf$ . So when  $YYff$  and  $YYFF$  are chosen as the parents, all the offspring will produce deep yellow cocoons, but if  $YyFF$  and  $YyFf$  are chosen, about a quarter of the cocoons will be flesh-coloured, and if the light yellow  $Yyff$  and  $Yyff$  are chosen as the parents, about a quarter of the cocoons will be white.

In his experiments with the white Japanese and yellow Siamese, Toyama obtained from the  $F_2$  yellows some which produce only yellows, and 2 yellow cocoons which gave 221 yellow and 77 pinkish yellow, and 2 yellows which produce 254 yellow and 77 white cocoons. These results obtained by him give almost the exact proportions (75 per cent. and 25 per cent.) I have obtained in my analysis of the colour factors, Diagrams (2) and (3) Table 4.

Among the flesh-coloured cocoons they are two kinds—the homozygous  $FFyy$  and the heterozygous  $Ffyy$ . Parent cocoons which are both  $FFyy$  will produce all flesh-coloured ones, but two  $Ffyy$  parent cocoons will give a few white ones. Table 4, Diagram (3). Toyama appears to have obtained both the pure and impure flesh-coloured cocoons in his experiments. For, referring to them, he states “the pale-pinkish-yellow form produces some uniform (producing only pale-pinkish-yellow) and some mixed (the white 25 per cent. and the pale-pinkish-yellow 75 per cent.) offspring in each succeeding generation.”

The pure white cocoon bred *inter se* always gave white cocoons. The yellowish white cocoons. The yellowish-white ones, however, mostly gave a small percentage of yellow cocoons.

In the gametes of the pure white cocoons there is no colour factor, so when the parent cocoons are both pure white the offspring inherit only colourless factors and will all be white. Table 4, Diagram (3).

The white recessives are also easily distinguished from the dominant yellows, and as they are pure (homozygous) in the colour character, a race with white cocoons can be easily made from white cocoons which appear in any of the generations. Toyama also found that “every white form from its first production remains true to itself.”

The recessive character always breeds true in whatever generation it occurs, but as it never is present in the  $F_1$ , after a cross, the  $F_1$  individuals must always be reared, as the recessives make their first appearance in  $F_2$ .

On the whole the results of these experiments, excepting that

TABLE 4.—DIAGRAMS TO ILLUSTRATE THE MENDELIAN INHERITANCE OF COCOON COLOUR IN CROSS BETWEEN NISTRİ ♀ AND ITALIAN-JAPANESE ♂.

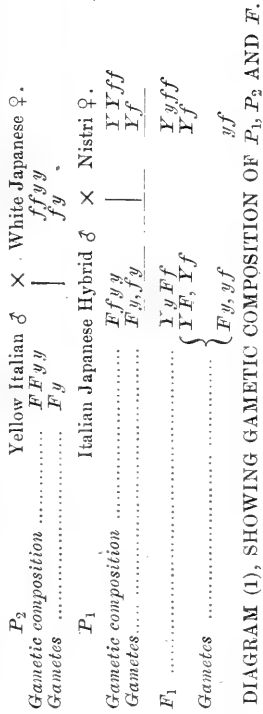


DIAGRAM (1), SHOWING GAMETIC COMPOSITION OF  $F_1$ ,  $F_2$  AND  $F$ .

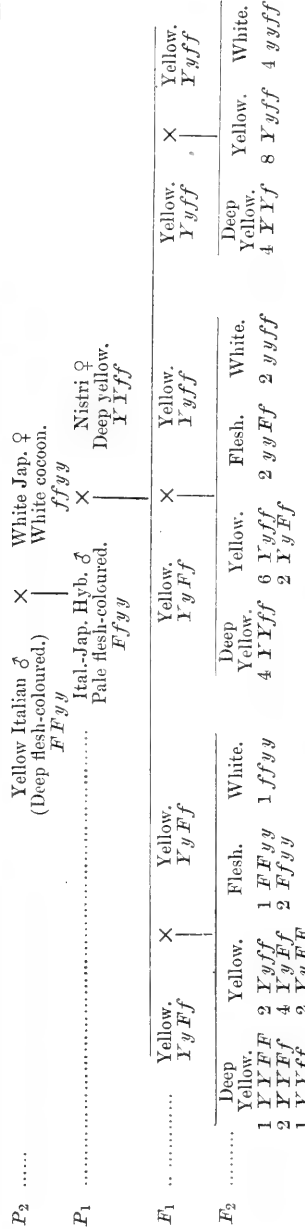


DIAGRAM (2), ILLUSTRATING DESCENT OF COLOUR.

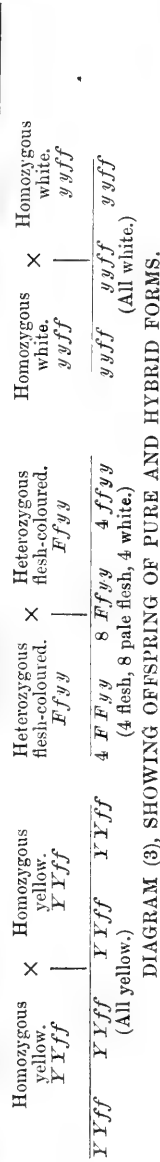


DIAGRAM (3), SHOWING OFFSPRING OF PURE AND HYBRID FORMS.

of the visible colour character, show great complications. The univoltine layings which appeared in the generations after  $F_1$  in the multivoltine Nistri ♀ and univoltine Ital.-Jap. ♂ cross, and the multivoltine layings which appeared in the reciprocal cross, show that the maternal parents are dominant in the *univoltine* and *multivoltine character* respectively, and that these characters were inherited from the paternal grand-parents in which they were dominant characters. So these recessive characters in males appear to become dominant when inherited by the females. Either the female sex is in some way closely associated with the dominance of the multivoltine and univoltine characters, or there is some factor present in the male which makes the univoltine and multivoltine characters lie latent, but does not hinder them from being handed down to the offspring, the females of which may show, in a dominant form, the latent character of their paternal parent. The inheritance of the invisible univoltine and multivoltine character does not appear to be quite Mendelian; however, it may be that the sex-limited descent affects the inheritance, and there is really no failure in the segregation of the unit characters

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7. Notes on Cetacea stranded on the British Coasts during 1913-1917. By SIDNEY F. HARMER, Sc.D., F.R.S., F.Z.S., Keeper of Zoology in the British Museum (Natural History) \*.

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The stranding of specimens of Cetacea on various parts of the British Coasts is no new thing, but in the majority of cases the evidence derivable from these occurrences has not been sufficiently used. About six years ago the Trustees of the British Museum decided to examine this evidence more systematically; and an arrangement was accordingly made with the Board of Trade and with the Admiralty, by which instructions were issued to Receivers of Wreck and members of H.M. Coastguard that the stranding of specimens of Whales should be reported by telegram to the Museum. These orders were given during 1912, and the system had become fully operative by the beginning of 1913. The notes here recorded give a summary of the results thus obtained.

The telegrams received are based on leaflets which were distributed on behalf of the Museum, calling attention to some of the more obvious characters by which the species of Cetacea can be distinguished. They have generally been sufficient to give some preliminary idea of what the stranded animal was likely to be; and further evidence has been obtained, wherever possible, by means of correspondence and by securing the specimen in question, or some part of it, when this could be done. A written Report, on a form requesting answers to certain specified questions has generally proved very instructive, particularly in cases where the answers have been supplemented by sketches or photographs.

The species of Whalebone Whales can usually be distinguished by the characters of their whalebone or baleen; and a special effort has accordingly been made, in each such case, to obtain a blade of baleen. In the case of the Toothed Whales, the receipt of a lower jaw is often sufficient for specific determination; but in a number of instances the entire head and flippers have been secured, or even the entire animal or its skeleton. The records may accordingly claim to have been based on satisfactory evidence, in the majority of instances in which a positive result has been recorded.

During the five years under review, fifteen species out of some twenty generally recognized as British have been recorded. The species which have not at present been reported are the Atlantic Right Whale or Nordkaper (*Balæna glacialis* Bonn.), the Blue Whale or Sibbald's Rorqual (*Balænoptera musculus* L.), the

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Humpback (*Megaptera nodosa* Bonn.), the White Whale (*Delphinapterus leucas* Pall.), and the Narwhal (*Monodon monoceros* L.). The following observations refer in the first instance to specimens actually recorded as having been stranded during the five years in question (Harmer, 1914-1918); though the statements of previous observers are noticed to some extent.

It may be remarked that the number of records of the larger Cetacea in the neighbourhood of the British coasts has been largely increased during recent years by the results of the Whaling Companies which have operated at certain Stations in Scotland and Ireland. Information on this subject is given, for the Scotch Stations, by Thompson (1912, p. 393), and for the Irish Stations in a paper by Lillie (1910), and in the Reports to the British Association by Burfield (1913) and Hamilton (1915, 1916); as well as in other memoirs cited by those authors.

### . MYSTACOCETI or WHALEBONE WHALES.

#### (1) LESSER RORQUAL (*Balenoptera acutorostrata* Lacep.).

This has proved to be the species of Whalebone Whale most commonly stranded on our coasts; and twelve specimens have been definitely recorded (including two from 1911 and 1912 respectively), besides one or two others which probably belonged to the same species. All have been found during the summer or early autumn, from June to October; and from two distinct regions of the coast:—(a) the Eastern coast of Scotland and England, from Caithness to Yorkshire; (b) the South-Western district, including the North coast of Cornwall, the Welsh coast and the South-West of Ireland.

The Lesser Rorqual reaches a length of about 33 feet, and it can be recognised by the broad white band which runs across the outer side of its pectoral limb or flipper and by the colour of its baleen, which is entirely white or yellow, with hairy fringes of the same colour. The baleen-blades may, however, have a rosy tinge at their base, owing to the presence of vascular papillæ containing blood.

Although the British Museum possesses but little material bearing on this point, I believe that there is a material difference in the thickness of the hairs of the baleen-blades between young and fully adult specimens. Thus I find that in the baleen of a Lesser Rorqual, stranded at Perranporth, Cornwall, on June 5, 1916, the hairs are much finer than in an individual of the same species stranded at Ulrome, Yorkshire, on Oct. 21, 1915. In both instances the determination of the species is confirmed by other evidence. Thus in the specimen from Perranporth the pectoral fin was described as having a white band on its outer surface—a marked specific character of the Lesser Rorqual; and this evidence was completed by a sketch of the part in question. In the animal from Ulrome the baleen was described as



being all of one colour, white or yellow—another distinguishing feature of the same species. The Perranporth Whale was only 18 feet long, while that from Ulrome measured 33 feet. The much finer character of the baleen-hairs of the former specimen was thus probably due to immaturity.

This species is known to occur off the Norwegian coast at all times in the year, and it feeds to a large extent on fish.

(2) RUDOLPHI'S RORQUAL OR SEI WHALE (*Balenoptera borealis* Less.).

In my Annual Reports on Stranded Cetacea (1914–1918) I have recorded the following four specimens as belonging to this species:—

- 1914, Feb. 28.—Derrynane, Co. Kerry, 60 ft.  
 „ Sept. 21.—Crosskirk, Caithness, 43 ft.  
 „ Nov. 17.—John o' Groats, Caithness, 47 ft.  
 1917, Oct. 13.—Annet, Scilly Islands, 45 ft.

These determinations were made mainly on the evidence of single blades of baleen; and I have to admit that on a re-examination of these specimens, and taking into consideration the other evidence available, I have come to the conclusion that they were probably incorrect in three of the four cases. The mistakes (if they were wrong conclusions) arose principally from the comparison of young specimens with old ones.

There can be little doubt that the specimen from Crosskirk was correctly determined. Its baleen-fringes are composed of extremely fine, flexible hairs, which have the curly, wool-like texture which has been noticed by other writers on Rudolphi's Rorqual. In this respect they agree precisely with a series of baleen-plates, 1912.6.25.1 in the British Museum collection, obtained from one of the Shetland Whaling Companies and undoubtedly correctly determined. In the other three specimens which were referred to *B. borealis*, the baleen-hairs, although relatively fine, particularly in the individuals from John o' Groats and the Scilly Islands respectively, were straight and not curly. The fact that they are finer than those of the large blades of a fully grown Common Rorqual is probably due to immaturity\*, and perhaps to the small size of the blades, which may have been taken from near one end of the baleen-series. I am accordingly led to the conclusion that the three individuals in question were Common Rorquals; and some further evidence in support of this conclusion is forthcoming.

It was pointed out by G. O. Sars (1881, pp. 3, 5) that the Common Rorqual is characterized by a very remarkable asymmetry in the coloration of the head, and that this feature is invariable in both sexes and at all ages, at any rate in the Northern

\* See the remarks on this subject under the preceding species.

specimens which were examined by this observer. On the left side of the head, the upper jaw and the lower lip are dark in colour, like the dorsal surface generally. On the right side, the anterior end of the upper jaw, the greater part of the lower jaw and a number of the anterior baleen-blades are white; these blades, as Sars points out, being much like those of the Lesser Rorqual.

In the specimen from John o' Groats the baleen-plates were described as being blue on one side, and white for a distance of two and a half feet from the front end of the beak on the other side, the remaining plates of the same side being blue. It is fortunate that two photographs of this individual were supplied, taken from the two sides. In these, the upper part of the head and the lower jaw appear dark on the left side, while no difference in the colour of the baleen is apparent anywhere in the series. On the right side, the front part of the upper jaw, the lower lip and the baleen-plates of the anterior end of the series are white; and these characters make the reference of the specimen to *B. physalus* practically certain.

In the individual from the Scilly Islands the evidence is less complete, though the baleen in the fore part of the mouth was described as having been white, "getting gradually darker till it becomes black." In the photographs received of this individual (see p. 13 of my Report on the specimens stranded during 1917), the left side is not visible. On the right side, however, the lower lip at least is white, and apparently part of the upper region of the head. The baleen is not visible. The blade received is a small one, probably from near one end of the series. It agrees so closely with that of the individual from John o' Groats, in the fineness and straight character of the hairs, that I feel little doubt that it belongs to the same species; while it may further be remarked that its coloration agrees better with that of the baleen in the Common Rorqual than with that in Rudolphi's Rorqual. This specimen, too, thus seems to have been an immature *B. physalus*.

The evidence with regard to the specimen from Derrynane was very inadequate; but I am inclined to refer this one also to *B. physalus* on the evidence of a single incomplete baleen-blade, in which the hairs are not curly, but straight and somewhat coarser than in the other two specimens, in correlation with its greater size. In my original record of this specimen I remarked, on the assumption that it was a Rudolphi's Rorqual, that the length (60 ft.) recorded was probably too great; but if the determination then made was incorrect there is no reason to suppose that the size of the animal was overestimated.

If the foregoing corrections are justifiable, the only record of *B. borealis*, in these observations, is the specimen from Crosskirk, Sept. 1914. According to Collett (1912, p. 597), this species, which feeds principally on pelagic Crustacea, only reaches the Norwegian coast during the summer. It becomes from 45 to 50

feet long when adult, and its baleen is usually black in colour, though some of the blades are partly white, with white hairy fringes of the fine, silky texture and curly character noted above. An elaborate account of this species has recently been given by Andrews (1916); while the memoir of Allen (1916, p. 234) may also be consulted for its coloration and other characters. The maximum length of *B. borealis* is said to be about 53 ft.

(3) COMMON RORQUAL (*Balænoptera physalus* L.).

Including three of the individuals which were originally referred to *B. borealis*, as above explained, this species is represented by eight records: namely, North Devon (Feb., 1913), Kerry (Feb., 1914), Northumberland (May, 1915), Caithness (July, 1913), Donegal (Aug., 1913), North Kent (Oct., 1914), Scilly Islands (Oct., 1917), and Caithness (Nov., 1914).

The Common Rorqual usually reaches a length of 65 to 70 feet in Northern waters. Its baleen-blades are for the most part slate-coloured, with darker and lighter longitudinal streaks; but, as pointed out in the account of the preceding species, a number of them at the anterior end of the right series are white. Their hairy fringes are yellowish in colour. The food consists partly of fish and partly of pelagic Crustacea, the species showing a preference for the latter form of diet (Collett, 1912, pp. 581, 582). Like the Lesser Rorqual, it occurs off the Norwegian coast at all times in the year.

*B. physalus* is known to be very variable in colour; and to such an extent that various forms of the species have been distinguished by the Norwegian whalers. For information on this subject see Cocks (1884, p. 458; 1887, p. 215), True (1904, p. 119), and Allen (1916, p. 181). The specimen here recorded from the Scilly Islands appeared to have a good deal of white on the dorsal surface, a type of coloration which is unusual for this species. But I have recently been informed by Mr. King, who took the photographs published on p. 13 of my Report for 1917, that in his opinion much of the white colour observable was due to the loss of the skin in patches and the consequent exposure of the underlying blubber.

## ODONTOCETI or TOOTHED WHALES.

Fam. PHYSETERIDÆ.

Subfam. PHYSETERINÆ.

(4) SPERM WHALE (*Physeter catodon* L.).

Three records, from E. Caithness (May, 1917), Galway (Sept., 1916), and Inverness (Dec., 1913).

The Sperm Whale, which occurs principally in the warmer seas, is remarkable for the striking difference in size between the

males and the females; the males reaching a length of at least 60 feet, and the females probably not much more than half that length. Its most obvious character is the possession of a long series of extremely large teeth, about 20-25 in number, as much as  $8\frac{1}{2}$  in. in length and  $3\frac{1}{2}$  or even  $3\frac{3}{4}$  in. in basal diameter, on each side of a narrow lower jaw; the upper jaw being edentulous or with vestigial teeth of irregular form. The maxillary teeth of the Sperm Whale are figured by Owen (1840-1845, pl. 89, figs. 3, 4), and by Sir William Turner (1912, pl. ix.), according to whom they may be as many as 15 in number, and may reach a length of 80 mm. (p. 74). Owen (p. 354) gave the number as 8 on each side. Other striking features of the species are the enormous truncated head extending some distance in front of the tip of the lower jaw, and the position of the blow-hole on the left side, at the anterior end of the head.

Many records of the occurrence of the Sperm Whale in the British seas have previously been published, a large proportion of them having been on the Scotch coast (cf. Turner, 1871, 1872, 1904). Part of the skull of a large Sperm Whale, stranded in 1582 at Caister, on the Norfolk coast, may be seen in the Church of St. Nicholas at Great Yarmouth. Mr. A. B. Van Deinsen has just published a paper (1918) on 37 specimens recorded on the Dutch coast during the period 1531 to 1788. It is a remarkable fact that, with very rare exceptions, the Sperm Whales recorded in European waters are of large size and are therefore presumably males. It is believed by the Whalers that these are roving individuals which have been driven away from the herds by the competition of other males (cf. Thompson, 1912, p. 397); the species being polygamous. Although two of the records here given conform to the general rule, the third, from Galway, is of special interest; having been a young individual, with uncut teeth, of only 18 feet in length. The condition of the dentition shows that this individual was a "sucker"; and that an adult female must have been somewhere in the neighbourhood, although its presence was not recorded.

The Sperm Whale feeds largely on Cuttlefish, but partly at any rate on fish.

#### Subfam. ZIPHIINÆ.

The Ziphioid Whales are distinguished from the Physterinae by a further reduction of the dentition; the functional teeth being commonly a single pair, or more rarely two pairs, in the lower jaw. Other vestigial teeth have, however, been recorded in both jaws in all the three genera known in British seas. The functional teeth generally remain beneath the gum in young individuals and in the females even when adult; but they pierce the gum in males sooner or later, sometimes only when fully adult. In *Hyperoodon* and *Ziphius* there are, moreover, strongly marked differences in cranial characters between the adults of the two sexes.

(5) BOTTLE-NOSED WHALE (*Hyperoodon rostratus* Müll.).

Fourteen records, mostly from the Northern coast of Scotland, along the entire Eastern coast of Scotland and England, and in the South of England as far west as Somerset.

The Bottle-nosed Whale has long been hunted in Northern seas (cf. Collett, 1906), and its movements are better known than those of many other species. According to Hjort (1912, p. 649, chart on p. 650) it is present in considerable numbers in the Norwegian Sea during April-July; extending as far North as Lat. 76° in June. In September, when it is migrating South, the Færoe Islanders get their last Bottle-noses. The localities where it is principally found are on the Western side of the Gulf Stream water, in the transition-belt between the Arctic and Atlantic currents. The individuals of this species are said to follow the 800-fathom line during their migration.

It has been pointed out by several authorities (cf. Turner, 1886, p. 45) that Bottle-nosed Whales are most commonly stranded on the British coasts in the autumn, when on their Southward migration; the individuals recorded being either young specimens of either sex or adult females, often accompanied by a calf. The occurrence of the species, as shown by the British Museum records, is in general agreement with this statement, except that the sex of the majority of the specimens is not definitely known and there are no records of females with calves. There is one record for each of the months July (1917) and August (1916), both from Scotland; four for each of the months September and October; and one from the South of England (Somerset) in November, 1914. The only others of which evidence has been obtained are two in March (Northumberland, 1914; Caithness, 1915), and one near Nairn, in May, 1914.

A remarkable alteration is known to occur in the male Bottle-nosed Whale, with increasing age, both in external form and in cranial characters. The changes in the skull are principally due to the immense increase in the height and thickness of the maxillary crests which are so characteristic a feature of this species, the adult males having formerly been described as a distinct species, *H. latifrons* Gray. With this increase in the maxillary crests is associated a corresponding change in the profile of the head; the "forehead" becoming more and more prominent until in old age its anterior outline is quite vertical. The old males appear to have a migration-route which is further from the land than that of the adult females; with the result that they are hardly ever recorded on the British coasts (Turner, 1886, p. 45).

According to Southwell (1883, p. 480) the young Bottle-nose is black, the colour becoming lighter with age; old specimens being almost yellow, with a greyish white ventral surface, while the beak and front of the head are quite white. The oldest males may become white all over (Millais, 1906, p. 298).

This species is provided with a pair, or sometimes two pairs, of

large teeth, which may reach a length of 40 mm. (Collett, 1906, p. 11), at the extreme front end of the lower jaw. According to most authorities these teeth remain concealed throughout life in females, but they pierce the gum in the oldest males, and are then commonly provided with a tuft of the Stalked Barnacle, *Conchoderma auritum*. Vestigial teeth, in addition to these, have frequently been described in both jaws (figured by Turner, 1912, p. 82); and traces of them have been found in one or two of the individuals here recorded. The male in this species reaches a length of at least 30 feet, while the female is said not to grow much beyond 24 or 25 feet (Munsterhjelm, 1915, p. 9). Collett (1906) states that the Bottle-nosed Whale is believed to be able to remain under water at least two hours, and that, although it feeds principally on Cephalopods, it also eats Herring or Cod, or even pelagic Crustacea. Newly-born young have been observed in June, while other females possess a small fœtus at this season.

(6) CUVIER'S WHALE (*Ziphius cavirostris* Cuv.)\*.

Before these records were instituted, this species was known as British on the evidence of a single skull, obtained by Sir William Turner from the Shetland Islands. One of the most interesting results of the system inaugurated by the British Museum has been the demonstration that Cuvier's Whale is not the extreme rarity it had been supposed to be. Three individuals have been definitely determined, from Cork (Feb., 1913), North Cornwall (June, 1916), and Wexford (July, 1915). It is by no means unlikely that some of the older records of "Bottle-nosed Whales" may have belonged to this species. Two of these specimens have already been recorded by me in a communication to this Society (Harmer, 1915, p. 559).

True (1910, p. 54) has given reasons for believing that the adults of the two sexes of this species are distinguished by marked differences in cranial characters and in the teeth. In adult males, according to this authority, the mesistrostral ossification is enormously developed and there is a deep "prenarial basin" in the skull. The teeth, of which one pair are present at the front end of the lower jaw, as in *Hyperoodon*, are fusiform and reach a diameter of 25 to 30 mm. In adult females, the mesistrostral ossification is only slightly developed and a prenarial basin is not formed. The teeth are slender, with a diameter of 10 to 14 mm.

Although the skulls of the specimens here recorded are not yet all available for study, they appear to confirm True's statements. The largest individual (Co. Cork) measured 26 feet in length,

\* [In my Annual Report for 1917, specimen No. 7, recorded on June 9 from Co. Clare, was described as a *Ziphius*. The examination of its skeleton, which has just been cleaned, proves that it belongs to a species of *Mesoplodon*, having its two teeth at the extreme anterior end of the lower jaw. It is proposed to publish a further account of this highly interesting specimen in due course.—S. F. H., July 16, 1918.]

and its cranial characters agree with those regarded by True as belonging to adult females. The teeth are slender, with a diameter of about 13 mm., and were completely concealed beneath the gum. Although the sex was not ascertained from observations made on the entire specimen, there can be little doubt that the animal was an adult female. The Cornish specimen was incomplete, the part recorded measuring 15 feet in length. Its teeth were uncut, and it was presumably a young male or female. The other specimen, 18 ft. 2 in. long, was definitely known to be of the male sex. Its teeth were large and massive, with a diameter of 35-37 mm., and they projected beyond the gum. It thus appears probable that the teeth remain uncut in the female Cuvier's Whale throughout life, unless they become external in old age, while in the male they are probably cut relatively early.

The coloration of this species appears to be variable. Certain individuals have been recorded in which the upper part of the head was white; and the Wexford specimen possessed this type of coloration. In other cases the colour has been described as dark above and light below.

#### (7) SOWERBY'S WHALE (*Mesoplodon bidens* Sowb.).

This rare species is represented by three records, from Inverness (Aug., 1915), Lincolnshire (Sept., 1916), and Wexford (Sept., 1914), respectively.

The male Sowerby's Whale is provided with a pair of large triangular teeth in the lower jaw, at about the middle of the length of the mouth, on either side. Females have a pair of similar teeth in the same position, but, so far as is known, always beneath the gum. The three specimens here recorded had their teeth concealed by the gum, and were presumably females. The Wexford individual was, however, definitely known to be of this sex. The Skegness specimen was reported to have been 18 feet in length, which is unusually long for this species; and it was white below—a type of coloration which has been reported by other observers, although Sowerby's Whale is often completely black. A list containing 33 records of this species has been given by Kükenthal (1914, pp. 98, 99).

The Ziphioid Whales are said to feed principally on Cuttlefish; and it is not impossible that the reduction of their teeth may be associated with this diet. Piscivorous animals, such as the Delphinidae and Crocodiles, seem to require a number of sharp teeth adapted for holding their prey. In the Ziphioids, teeth of this character are obviously not required; and it may be suggested that the absence of teeth is an advantage to them, since the suckers of the Cuttlefish would probably attach themselves to such convenient pegs, were these present, and the operation of swallowing the prey might thus be rendered more difficult. It must not be forgotten, however, that the Sperm Whale, which is

also "teuthophagous," has a specially strong series of teeth in its lower jaw.

(8) KILLER OR GRAMPUS (*Orcinus orca* L.).

A single record, May 1916, from the Solway Firth. The specimen, a male, was unfortunately incomplete, but the part remaining was 25 ft. 6 in. long; and the animal must have been at least 30 feet long when alive. The species is very common on the Norwegian coast (Hjort, 1902, p. 120).

It has been pointed out by Lütken (1887, p. 367) that a very remarkable alteration in the proportions of the fins takes place during growth in male Killers. While in young males, and in females throughout life, the fins are relatively small and weak, in the males all the fins—pectoral, dorsal and caudal—become disproportionately larger as the animal grows older. The difference between the small pectoral fins of the young male and those of the old male is described by this author as being "perfectly astonishing." These alterations in the fins have more recently been described and figured by Grieg (1906, p. 9; see especially his figs. 2-6, showing alterations in form and size of the dorsal, caudal, and pectoral fins).

The specimen from the Solway Firth was an excellent illustration of these statements. The dorsal fin was about 5 ft. 6 in. in height, while the pectoral limbs were 6 ft. 8 in. long and 3 ft. 7 in. broad; thus greatly exceeding in absolute size those of a large Sperm Whale. While the pectoral limbs of young animals and of females generally measure about one ninth of the total length of the animal, those of the old males are as much as one fifth of the entire length. Assuming the correctness of this statement of Lütken's, the total length of the old male here recorded would have been well over 31 ft. It seems probable that the female of this species hardly exceeds half the length of the largest males. The failure to recognize the occurrence of these changes in the males has resulted in the introduction of more than one specific name for the Killer.

Grieg (1906) has given an account of a school of about 47 Killers which were observed on the Norwegian coast at the middle of January, 1904. Four of the females were ascertained to be pregnant, and others were accompanied by a calf. The young of 2.5 m. in length were regarded as not more than 2 months old, and those measuring 3.5 m. as being probably 1 year old. Birth and pairing are believed by Grieg to take place during the later months of the year.

*O. orca* may be easily recognized by its very large teeth, which have a basal diameter of as much as  $1\frac{1}{4}$  or even  $1\frac{1}{2}$  in. and are 10 to 13 in number on each side of each jaw, as well as by its strikingly marked black and white (or yellowish) coloration. A white patch behind the eye is characteristic, and the white area of the ventral surface, although variable in extent, typically



sends up a lateral extension backwards on each side, behind the region of the dorsal fin.

(9) BLACKFISH OR PILOT-WHALE (*Globicephala melana* Traill).

Three records in the five years: Hampshire, 1913; Northumberland, 1914; and Cork, 1915; all in March; besides a school of about 50 individuals which were stranded at Penzance on July 1, 1911.

The Pilot-Whale reaches a length of at least 26 ft. and is usually completely black. It possesses about 10 large teeth, about  $\frac{7}{16}$  in. in basal diameter, on each side, in the front half of each jaw. The "forehead" is enormously swollen, and the pectoral limbs are very long and narrow, reaching a length of about 4 ft. 6 in. It is well known to associate in large schools, which are hunted in the Orkneys, the Færoe Islands, and elsewhere. As many as 2000-3000 individuals have been driven ashore at one time on the coast of Norway (Hjørt, 1902, p. 119); and a record of 1000 specimens observed at the Lofoten Islands, on Sept. 4, 1890, has been given by Grieg (1897, p. 8).

(10) RISSO'S GRAMPUS (*Grampus griseus* Cuv.).

Four records: Jersey, Aug, 1913; S. Devon, Aug., 1917; and S. Devon, Nov., 1913; the last record consisting of two individuals, presumably mother and calf, although the sexes were not definitely ascertained. It will be observed that all these records belong to the S.W. extremity of the British Islands; and there is little doubt that this is a more Southern species which only just reaches our seas.

Risso's Grampus is recognizable by its blunt head, without beak; and by the considerable reduction of the number of its teeth. Of these, none are present in the upper jaw, while the lower jaw possesses 4 or 5, of considerable size, with a basal diameter of as much as  $\frac{3}{4}$  in., at the front extremity. Adult individuals reach a length of about 12 ft. Flower's Memoir (1874) may be consulted for information regarding this species.

(11) BOTTLE-NOSED DOLPHIN (*Tursiops truncatus* Mont.).

Ten records: one in February (Scilly Islands, 1915), one in May (Merioneth, 1916), and the remainder during the period June-August. With the exception of one individual (Essex, 1914), the determination of which was not quite certain, all were from the Southern coast of England, or from the Welsh or Lancashire coast.

The Bottle-nosed Dolphin reaches a length of about 12 ft., and possesses about 25 teeth on each side of each jaw. As in some other Dolphins, about two of these, at the front end of the series, are very small and usually remain concealed beneath the gum; while the remainder are relatively large, with a basal

diameter of as much as  $\frac{7}{16}$  in. As indicated by its name, the head has a well-marked beak, about 3 in. long.

(12) WHITE-BEAKED DOLPHIN (*Lagenorhynchus albirostris* Gray).

Eight records: one from the North coast of Ireland (March, 1917), one from the Island of Islay (Oct., 1913), and the remainder from the Eastern coast, from Caithness to Lincolnshire—to which may be added three specimens stranded in Suffolk and Kent in February, 1918. Although the two species are known to overlap in their distribution, it is noteworthy that in this series of observations the distribution of the White-beaked Dolphin and of the Bottle-nosed Dolphin have not overlapped and are complementary to one another.

The White-beaked Dolphin is characterized, as indicated by its popular name, by possessing a well-marked short beak, which is white in colour. It reaches a length of rather more than 9 ft. Its teeth are about 25 on each side of each jaw, but are distinctly smaller than those of the Bottle-nosed Dolphin, their basal diameter being about  $\frac{1}{16}$ – $\frac{5}{16}$  in.

(13) WHITE-SIDED DOLPHIN (*Lagenorhynchus acutus* Gray).

Three records: Fair Island, between the Orkneys and the Shetlands (March, 1913); Lincolnshire (May, 1917); Co. Mayo (June, 1916).

This species, which is said to be one of the commonest of the Cetacea off the Norwegian coast, where it may occur in schools of as many as 1000 individuals (cf. Hjort, 1902, p. 118), may be regarded as a boreal species which does not often occur in our seas. Most of the specimens previously found have been from the Orkneys and other parts of Scotland; and one or two have been noticed from Ireland. So far as I am aware, the Lincolnshire specimen here recorded is the first to have been obtained on the English coast.

The White-sided Dolphin has a characteristic longitudinal whitish area on each side, in the middle and posterior half of its body. Its teeth are smaller (basal diameter about  $\frac{3}{16}$  in.) and more numerous (about 30 to 35 visible during life on each side of each jaw) than in the White-beaked Dolphin, from which it differs in certain other respects, the following of which may be noticed. The beak, which resembles that of *L. albirostris*, is black. The pectoral fins are falcate, with a very convex lower border; those of the other species being blunter and broader, and less convex below. These fins, moreover, originate from the white part of the body, being connected with the black part of the head by a narrow dark streak; while in *L. albirostris* the black of the dorsal surface extends as far as the base of the flipper (cf. Lütken, 1887, pp. 377, 386, 395). *L. acutus* is said to reach a length of about 12 feet (Hjort, 1902, p. 117).

(14) COMMON DOLPHIN (*Delphinus delphis* L.).

About 20 records, one or two of which have been not quite certain, though probable. Three individuals have been recorded from the Northern part of Ireland (Mayo, Donegal); two from the North-Eastern coast of Scotland (Inverness, Kincardine); one, somewhat doubtful, from East Anglia (Suffolk); and the remainder, either from the English Channel, from Kent to the Scilly Islands, or from the entrance to St. George's Channel, on both sides, from Cork (1918) to Wexford on the Irish side, and on the Welsh coast on the opposite side. None have been recorded in the North Sea area, from Forfar to Norfolk; and none on the West coast of Scotland; which, however, has provided a curiously small number of records during the whole of these observations. The distribution thus indicated is in agreement with the supposition that this is an oceanic species which is frequently stranded on the more exposed parts of the coast-lines, but comparatively seldom makes its way into the North Sea. The three records from the S. coast of Ireland (including one for 1918) were obtained in February, that from Inverness in April, and the remainder from August to December.

The Common Dolphin reaches a length of about 7 ft. 6 in.; and is distinguishable by its very long beak and numerous conical teeth, of relatively small size, with a basal diameter of about  $\frac{3}{16}$  in. The teeth are more numerous than in any of the other species here considered, being about 45 in each half of each jaw.

(15) COMMON PORPOISE (*Phocena phocena* L.).

Numerous records, indicating, as generally supposed, that this is the commonest species in British waters. Of those which were certainly determined, the great majority were recorded from the East coast of England, and most of them during the period May to August. Evidence has been obtained in support of the belief that the Common Porpoise gives birth to its young in the early summer, and that the length at birth is from 2 ft. to 2 ft. 6 in. According to Prof. Meek (1918, p. 197), the occurrence of Porpoises near the coast during July and August may be regarded as an inshore migration for parturition and pairing.

This species differs from all others found on the British coasts in the form of its teeth, which instead of being conical, as in the majority of the species, are broadened at the free end ("spade-shaped"), although the exact form of the broadened part is variable. The teeth undergo a considerable amount of thickening as growth proceeds, and the broadened blade is not infrequently worn away in some of the teeth. About 25, or rather more, are present on each side of each jaw; though usually two, at the anterior end of the series, remain small and are concealed below the gum. The length of the adult is about 5 ft. 6 in.—and this is distinctly the smallest of the British Cetacea. The head is not provided with a beak.

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8. On the Variation of the Pit-Viper, *Lachesis atrox*.

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The distinction of the forms, whether they be regarded as species or as varieties, which cluster around the tropical American Pit-Viper, *Lachesis atrox* L., and of which the principal are *L. lanceolatus* Lacepède, *L. jararaca* Wied, and *L. jararacussu* Lacerda, is a subject which needs renewed investigation, especially in view of Dr. Vital Brazil's recent publications\*, in which he claims specific rank not only for *L. lanceolatus* but also for *L. jararacussu*, which has generally been regarded as a mere colour variety.

Mr. G. A. Boulenger, who has kindly helped me with advice in my study of reptiles, suggested to me that I should take up this investigation, and he has given me not only access to the collection in the British Museum, of which he is in charge, but the benefit of his experience, especially as regards the bibliography of the subject. My best thanks are due to him for these favours.

## I. HISTORICAL.

The number of names which Mr. Boulenger has quoted under the synonymies of *L. atrox* and *L. lanceolatus* is very great, but for my present purpose it will be sufficient to discuss only the principal, such as have had more general currency, or which are accompanied by figures enabling me to form an opinion on the forms for which they are intended.

The earliest name is that of *Coluber atrox* Linnaeus, Mus. Ad. Frid. (1754) pl. xii. fig. 2. The specimens are described as having—centrals 200 and 196, subcaudals 70 and 67 pairs, and scales with “*carina elevata*.” However, Mr. L. G. Andersson, Cat. Lin. type-spec. Sn. (Bih. Sv. Vet.-Ak. Handl. xxiv. iv. No. 6) p. 19, has been able to supplement this definition, as he has had access to the type-specimens in the Stockholm Museum, and he finds that the keels on the scales “are low and extend nearly to the tip of the scales,” thus agreeing with Mr. Boulenger's *L. lanceolatus*,

\* La Défense contre l'Ophidisme. São Paulo, 1911, 8vo. 2nd edition, 1914.

not with his *L. atrox*. He counts 204 and 200 ventrals (v.), 67 and 70 subcaudals (c.). Both descriptions appear to correspond with two specimens in the British Museum collection, from Martinique (Cat. Snakes, iii. p. 536, spec. r & s).

*Coluber lanceolatus* Lacepède, Hist. des Serp. (1789) p. 121, is based on specimens in the Paris Museum: 228, 225 v., 61, 59 c. Habitat Martinique and perhaps Dominica and Cayenne. Figure worthless, probably from a bleached specimen. Duméril and Bibron (Erp. Gén. vii. 1854, p. 1505), under *Bothrops lanceolatus*, do not give us any particulars concerning the type-specimen, which they must have examined, but the fact that the "Vipère jaune de la Martinique," also found in St. Lucia and Dominica, is the form intended. There can be no question as to the application of the name *lanceolatus*, the Fer-de-lance, which must be regarded as a strict synonym of *L. atrox* of Linnæus according to Andersson.

*Cophias jararaca* Wied, Abbild. Nat. Bras. (1825), from E. Brazil, 193-201 v., 59-68 c. The description and figure indicate a snake similar to *L. atrox*, but with markings consisting of dark brown, darker-edged transverse bands, narrower on the back than on the sides, such as is figured by Jan, in Icon. Oph. 47me livr. pl. iii., and corresponding to several examples in the British Museum collection from Rio Janeiro and Para (Cat. Sn. iii. p. 537, spec. i, p. 539, spec. v). This variety must be the prevalent form in the Province of Bahia, as the following descriptions and figures of Wagler in Spix's Serp. Bras. (1824) are evidently referable to it. *Bothrops megera*, p. 50, pl. xix.: 195 v., 53 c. This figure shows dark olive upper parts with dark, darker-edged transverse bands and immaculate ventrals. *B. furia*, p. 52, pl. xx.: 201 v., 65 c. A uniformly coloured specimen which may be taken to have lost its markings. *B. leucostigma*, p. 53, pl. xxi. fig. 1: ? v., 66 c. Brownish, with darker transverse bands, ventrals powdered with grey. *B. tessellatus*, p. 54, pl. xxi. fig. 2: 190 v., ? c. Dorsal markings as in *B. leucostigma*, ventrals checkered with brown. *B. taniatus*, p. 55, pl. xxi. fig. 3. Colours lighter than the above, transverse bands always double.

*Bothrops jararacussu* Lacerda, Leç. sur le ven. des Serp. (1884) p. 9. From the province of Rio de Janeiro. An adequate description of the striking markings of the Jararacussu is given (black above with yellow markings, longitudinal on the head, and obliquely pronged forks on the sides, yellow beneath spotted with black). Similar to the *B. atrox* figured in Jan, Icon. Oph. (47me livr. pl. ii. fig. 3), and to two specimens in the British Museum collection from Sao Paulo, presented by Dr. Brazil.

Having thus indicated the sources to which I have referred in order to fix the exact meaning of the principal names which have had currency in the past, I will review the various opinions which have been expressed in the principal works on Ophidia.



Schlegel (Phys. serp. (1837) pp. 532, 535, 537) recognises three species:—1. *Trigonocephalus jararaca*, from São Paulo, Sta. Catharina I., Sta. Cruz de la Sierra: 172–204 v., 44–62 c. From the description, this snake is the true Jararaca of Wied. 2. *T. atrox*: 190, 196 v., 60, 68 c. Scales surmounted by a strong keel with tubercular tendency, in which respect it does not agree with the Linnean type specimen. Habitat N. Brazil, Dutch and French Guianas. 3. *T. lanceolatus*: 271, 220 v., 60, 60 c. Martinique and St. Lucia. Scales surmounted by a simple keel. Colour of ventrals a clear greenish yellow. The description corresponds to the type-specimen of *L. atrox* as described by Andersson. Schlegel maintains that *T. lanceolatus* has a higher number of ventrals than the two preceding, but the number 271 is probably due to some mistake.

Duméril and Bibron (Erp. Gén. (1854) pp. 1505, 1507, 1509) describe three species:—*Bothrops atrox*, *B. lanceolatus*, *B. jararaca*. The only differentiation made between the first two in the "Tableau Synoptique des Espèces du Genre *Bothrops*" (p. 1504), is that the ventrals of *B. atrox* are spotted, and those of *B. lanceolatus* unicoloured. In describing *B. atrox*, however, they mention that the scales are more strongly keeled. *B. jararaca* is distinguished from the preceding by a relatively obtuse canthus rostralis and larger scales on the snout. The description corresponds with that of the Jararaca of Wied.

*B. atrox*. 29–32 scales. Habitat Dutch and French Guianas.

*B. lanceolatus*. 271, 240, 220 v., 68, 64, 60 c.; from Martinique, Dominica, St. Lucia.

*B. jararaca*. 172, 195, 204 v., 44, 62, 65 c.; from São Paulo, Sta. Catharina I., never in Surinam.

The number of ventrals given by Duméril and Bibron do not seem very reliable, and 271 for *B. lanceolatus* is probably copied from Schlegel's statement, which there is good reason to question.

Jan, Icon. Oph. 47me livr. Pl. i.: *Bothrops lanceolatus* (Merr.). Antilles? Geneva Museum. The specimen figured has 29 rows of scales. Markings irregular, but similar to those of two specimens in the British Museum collection from Martinique (Cat. Sn. p. 536, spec. r, s).—Pl. ii.: *B. atrox* L., var. *dirus* Jan, from Buenos Ayres. Turin Museum. 25–27 rows of scales, with keels similar to those figured for *B. lanceolatus*. The markings represented in fig. 3 *nnn.* are matched by two specimens in the British Museum collection, from São Paulo (presented by Dr. Brazil), and, as before mentioned, agreeing with those of the Jararacussu of Lacerda.—Pl. ii. fig. 4: var. *tesselatus* Neuw. Milan Museum. Another form of dorsal markings, similar to a specimen in the British Museum collection, from St. Lucia (Cat. Sn. p. 536, spec. v).—Pl. iii.: *B. jararaca* Neuw. Freyburg Museum. An excellent figure of the typical Jararaca; 25 rows of scales.

A. E. Brown, in a paper in the Proc. Acad. Philad. 1893 (pp. 435-6), describes three species, but adds that he doubts their right to more than a varietal distinction:—1. *Bothrops atrox*, described from two specimens from British Guiana; 196, 195 v., 42, 59 c., 27, 27 rows of scales, which are broad, with a high short keel not extending to the tip. Abdomen unspotted. 2. *B. lanceolatus*, described from two specimens from Martinique; 199, 200 v., 69, 69 c., 25, 25 sc. Scales longer than in *B. atrox*, and bearing a simple keel to the tip. 3. *B. jararaca*, described from one specimen from Brazil; 206 v., 57 c., 27 sc.; besides the annulated markings, Mr. Brown notes that the canthus rostralis is less sharp and the scales on the snout are larger than in the preceding species, a fact which was also observed by Duméril and Bibron.

G. A. Boulenger, Cat. Sn. vol. iii. 1896, pp. 535-537.

*Lachesis atrox*. 161-216 v., 47-73 c.

*L. lanceolatus*. 180-240 v., 46-70 c.

Mr. Boulenger finds that the only distinctive character between these species is that of scale-structure. In the former the scales are "strongly keeled, the keels on the posterior part of the back very high, swollen in the middle, and much shorter than the scale." In the latter the scales are merely "sharply keeled," the keel extending nearly to their extremity. He also describes the ventrals of *L. lanceolatus* as yellowish, uniform, or powdered, or spotted with brown, and in this respect many of the specimens in the British Museum collection certainly disprove the statement made by other authors, that the ventrals of this snake are constantly immaculate. He adds that these species may have to be united, as some specimens of *L. lanceolatus* "approach *L. atrox* in the swelling of the scales at the base of the keels, and are thus intermediate between the two species." *Cophias jararaca* and *Bothrops jararacussu* are placed in the synonymy of *L. lanceolatus*.

V. Brazil, Déf. contre l'Ophidisme (2nd ed. 1914), pp. 78, 84, 88.

*L. lanceolatus*. 195-200 v., 50-53 c. Tropical America.

*L. atrox*. 202 v., 55 c. Tropical America, less abundant than the above in the southern states of Brazil.

*L. jararacuçu*. 170-176 v. Brazil (São Paulo and Rio).

In describing the first two species Dr. Brazil maintains that one of the main points of difference between these snakes lies in the "système de coloration" of *L. atrox*, of which he says: "La coloration du fond, sur lequel se dessinent des figures pareilles à celles constatées dans l'espèce précédente (*L. lanceolatus*) est d'un gris rougeâtre, parfois un ton gris cendré. Cette combinaison de couleurs donne un aspect velouté à l'animal, ce qui permet de le reconnaître à première vue." The ground-colour of *L. lanceolatus* is described as "vert très foncé, gris et quelquefois jaunâtre," and the abdomen "vert foncé, parsemé de taches jaunes," whilst

that of *L. atrox* is of a "très beau jaune clair marqueté sur les bords de noir ou de gris foncé" \*.

In examining a large number of these snakes I have found the ground-colour to be equally variable in both; the ventrals may be yellow, yellow checkered with black, or of that greenish colour produced by a powdering of black over yellow, in either *L. atrox* or *L. lanceolatus*. It was therefore not quite clear to me why Dr. Brazil considers the general aspect and coloration such striking points, or how the latter should produce a velvety appearance in *L. atrox*. Mr. Boulenger has looked into this matter with me, using specimens of *L. atrox* and *L. lanceolatus* named and sent to him by Dr. Brazil himself. There certainly is a difference in the appearance of these specimens, but this is not due in any way to the markings, which are strikingly similar. The specimen marked "*atrox*" has, however, the very prominently keeled scales mentioned before, and Mr. Boulenger has pointed out to me that the "velvety" appearance of this snake is entirely due to the consequently greater breaking up of light upon its dorsal surface. Dr. Brazil's *L. atrox* is therefore the same as Mr. Boulenger's.

*L. jararacussu*.—Dr. Brazil maintains the specific rank assigned to the Jararacussu by Lacerda: first, on account of its striking black and yellow markings; secondly, because of the comparatively low number of its ventrals; and, thirdly, because of its much more triangular head. With regard to the first point, there are specimens in the British Museum collection which can be graded to form a transition series from the typical *L. atrox* to the Jararacussu, a specimen from W. Ecuador being exactly intermediate between the two types of markings. With regard to the second point, the ventrals of the Jararacussu are as a rule fewer than those of *L. atrox*. Dr. Brazil mentions 170–176, but two specimens received from him have 180 and 184. 180–240 ventrals is, however, the range given for *L. lanceolatus* in Mr. Boulenger's Catalogue of Snakes, and, as I have failed to detect any structural differences in the shape of the head or in the scaling, I think that the Jararacussu cannot be regarded as more than a colour variety of *L. atrox* L.

## II. FORM AND LEPIDOSIS.

As I think I have shown in the annexed table that there is no correspondence between variations in markings and the number of ventrals and caudals, I will describe the differences in form and lepidosis which have led to the distinction of species.

The most important is that of the two types of scaling found in *L. atrox*. It has been generally accepted that the high short

\* The coloured plates which accompany Dr. V. Brazil's descriptions do not convey these supposed differences, and it is well to point out that but little care has been bestowed on the rendering of the markings. I think a *L. lanceolatus* with only about 10 markings on the body, as figured, to be an impossibility.

keel is proper to *L. atrox* and the low long keel to *L. lanceolatus*. Dr. Andersson has shown, however, that the latter form is really the *Coluber atrox* of Linnaeus, so that if the former is maintained as a distinct species on account of its scale-structure, it will be necessary to alter the name which has usually been given to it. I suggest that of *L. affinis* Gray, as the specimens of *Bothrops affinis* (Catalogue of Snakes (1849), p. 7, specimens *l* & *o*), which I have examined, answer the definition, and this appears to be the earliest name which can be applied to it.

The dorsal scale of the typical *L. atrox* *L.* is of a long narrow diamond shape, usually about twice as long as broad, and bearing a simple keel extending to the apical pits in the tip of the scale. That of *L. affinis* is broader in proportion, more rounded, and sometimes truncate behind; it bears a short keel, supported upon an extremely convex area, leaving only a narrow margin of flat scale. This convexity of the scales is so pronounced in some specimens that they can be distinguished from the preceding form by touch alone. The scales of other specimens, however, are intermediate in type; they may be of the narrow form with the long keel distinctly swollen at the base, or, while maintaining the long keel of *atrox*, they may be both broad and convex as in *affinis*. Other individuals present scales of both the extreme types. On examining the middle third of the body in one of these, I find that the median dorsal scales are of the high short type, and the lateral dorsals of the long low type. Further examination shows that, in every case, the anterior part of the snake is of the *atrox* type and the posterior of the *affinis* type. The evolution of the scale-structure is thus clearly shown. The long low-keeled scale gradually broadens, whilst its keel swells along its base and shortens, until it becomes completely transformed into the *affinis* type. This transformation is, as described above, completed upon the median dorsal scales sooner than upon the laterals.

As regards the snout of *L. jararaca*, its shape is very slightly different from that of *L. atrox*, in that the canthus rostralis is somewhat more obtuse, and the scales of the upper surface are slightly larger than those on the vertex.

These characters are not very distinct, as several specimens of the typical *L. atrox* present snouts of a similar form; in fact, one specimen (Cat. Sn. iii. p. 536, spec. *v*) is indistinguishable from *L. jararaca* (spec. *g*, Cat. Col. Sn. [1858] p. 226) in this respect. Duméril & Bibron, and A. E. Brown, both mention this point as one of the distinguishing features between the two forms; and Schlegel (Phys. Serp.), in his figure (pl. xix. fig. 1) of the dorsal view of the head of the Jararaca, represents the difference between the scales on the snout and those on the rest of the head as very considerable. This is certainly a point of variation which I cannot consider proper to the Jararaca alone, having found no fewer than six young specimens of *L. atrox* with this characteristic.

The different types of form and lepidosis described above are

therefore so inconstant, and so completely connected by intermediate forms, that they cannot in themselves be considered sufficient for the distinction of species.

### III. SYSTEM OF MARKINGS.

Before discussing the evolution of markings and their individual variation, I will outline the general system of arrangement of markings common to all colour varieties of *L. atrox*. As a working hypothesis on this subject, Mr. Boulenger drew my attention to Dr. Zenneck's paper "Die Zeichnung der Boiden"\*<sup>†</sup>, and I have found that his theory—that the dorsal and lateral markings of Boids are made up of four paired longitudinal series †—is equally applicable in the case of *L. atrox*. Of these, only three are usually present, but in some specimens the fourth is present upon the head. It is the constant relationship between the spots of the series of one side of the snake which forms the regular pattern, but those of one side are quite independent of those on the other, thus accounting for the asymmetrical appearance of the markings on the median dorsal line, which is sometimes very marked ‡.

When present on the head, the first or dorsal series commences as a streak, or a few broken spots. Occasionally it forms a Λ-shaped marking with its fellow. On the body this series is usually the broadest and most marked, and, in individuals where it tends to disappear, it is always the last to go. The dorso-lateral or second series, when present on the head, may either consist of an oblique narrow streak or of broken spots of this streak, originating above the ocular shield, or of a cross-bar or blotch in front of the eyes. This second series is rather unstable on the body, for though it may be of equal development to the dorsal, it is more often hardly discernible and certain spots frequently become confluent with their neighbours of the first series. In some forms the markings of these two paired series form a single dark triangular area on the head, but are more often irregular and indistinct.

The lateral series is always present on the head of those snakes exhibiting dorsal markings. It forms a broad black streak from the posterior border of the eye to the commissure of the jaws, usually passing through the sixth and seventh labials. Rays proceeding from it may be present on the other upper labials, or may take the form of isolated spots. The post-ocular streak is always separated from the superciliary streak by a narrow area of the lighter ground-colour, and is sometimes also outlined in

\* Tübingen Zool. Arb. iii. (1898).

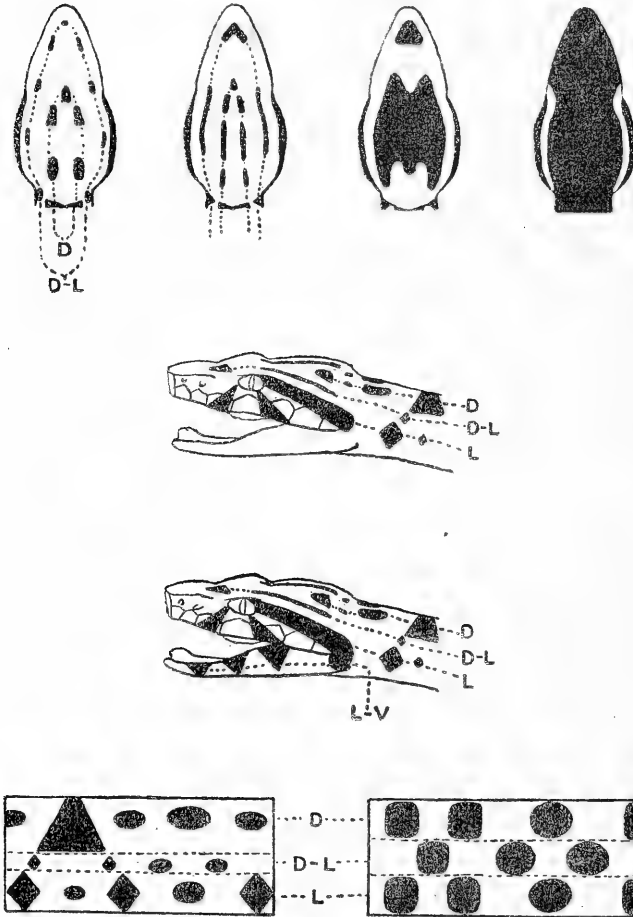
† These four series are termed Dorsal (D.), Dorso-lateral (D.L.), Lateral (L.), and Vento-lateral (V.L.) by Mr. Boulenger, 'Snakes of Europe' (1913), p. 30. This lettering is followed in my text-fig. 1.

‡ Mr. Boulenger has drawn attention to this bi-lateral asymmetry in his *op. cit.* p. 33, and he mentions a specimen of *Lachesis alternatus* with 24 markings on the left side and 27 on the right.

cream-colour, which brings it out very sharply. On the body this series is well defined.

The fourth or latero-ventral series is never present on the body, and not always upon the head. It is evidently a most primitive character, which has disappeared in many specimens. In the

Text-figure 1.



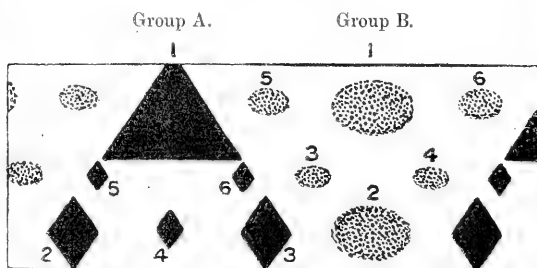
most marked form this series only consists of three or four black spots on the lower labials, and one larger spot which has become confluent with the post-ocular streak. This latter spot is the last of the series to disappear, and is entirely the cause of the apparent broadening and lengthening of the post-ocular streak in

many snakes. This series must not be confounded with the outer ventral series, which commences on the chin-shields and is usually distinctly marked throughout the body.

The markings develop upon regular lines, and the degree of this development varies on different regions of the body. That on the anterior end of the body is the most primitive, as I shall endeavour to show later on, but markings immediately behind the head are always irregular.

In *Lachesis atrox* the spots of the series on each side of the body form themselves into distinct alternating groups, which I shall call A and B. Group B is less stable than A, and frequently disappears altogether, either temporarily in the evolution of the markings or permanently.

Text-figure 2.



On one snake the relative development of groups A and B is not always constant, but it is always alike on both sides of the body.

Since group A is usually the best developed, it is this group which I have counted in giving the numbers of markings in the table of statistics. This number is not the same for the two sides of many snakes—another reason for the faulted appearance in the general dorsal pattern.

The dorsal markings of *L. atrox* are therefore made up on each side of three longitudinal series of spots, which in turn form themselves into alternating groups A and B. Each of these consists of six primitive spots, which, according to their presence, absence, or confluence, determine the variety of marking produced. In order to follow their evolution and variation, I have numbered those of each group in order of their stability (see text-fig. 2), so that each may be referred to by a definite formula.

The ground-colour appears to be formed by the varying proportions of a black (or dark brown) and a yellow pigment, the black being the more superficial. When the shade is greyish, there is a smaller proportion of yellow pigment. The usual brown tints are composed of a very fine powdering of the dark pigment over the yellow. Quite apart from the regular markings, the scales

often each show a delicate arrangement of black pigment standing out from the ground-colour and having the same pattern effect as the fine dendritic marks seen in many rocks. This arrangement is often exactly repeated from one scale to another. When this style of markings is present on the clear yellow of the ventral shields, it produces a dark green effect, merging, when seen at a distance, into the ground-colour.

#### IV. INDIVIDUAL VARIATION AND EVOLUTION OF MARKINGS.

##### *Individual Variation.*

As a starting-point in the study of the markings and colour varieties of *L. atrox*, it was suggested to me by Mr. Boulenger that I should make an examination of a female and her 26 young from Trinidad (received from Mr. Urich) in order to ascertain the amount of individual variation among specimens unquestionably pertaining to one form only.

The young snakes range from 160 to 300 mm. in length, and are more brightly marked than their mother. Their ground-colour is a soft shade of brown, except the tip of the tail, which is a pale yellowish. Particulars as to the number of ventrals and subcaudals etc. will be found in the annexed table. In the majority of cases, the pattern on each side is made up in the following way, as shown on text-fig. 3:—

Group A consists of the six primitive spots arranged in a pyramid (see text-fig. 2, p. 171). A large triangular or rather trapezoid spot (A 1, dorsal series) forms the apex, and rests upon two small rhombic spots (A 5, 6, dorso-lateral series), which are sometimes confluent with it. These rest upon three similar spots, the outer ones being somewhat the larger (A 2, 4, 3, lateral series). This triangular marking is margined in cream-colour, and encloses an area darker than the surrounding ground-colour, a state of things which seems to suggest a centripetal aggregation of pigment. Group A, though equal in size to group B, is in every case darker and more marked.

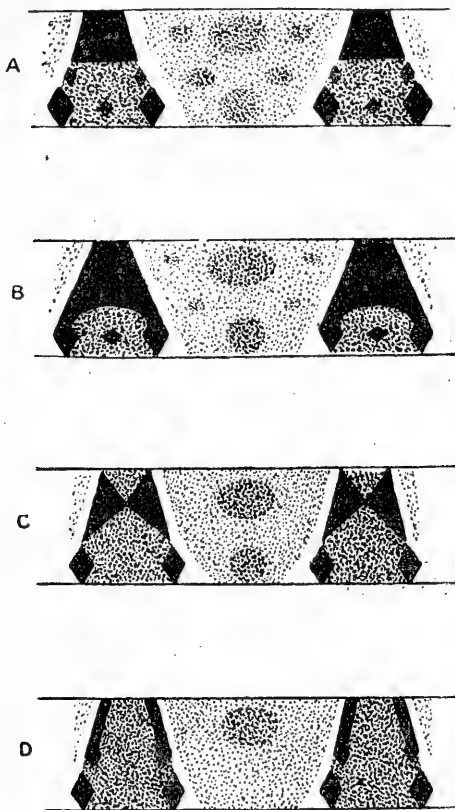
Group B is also triangular in form, but the base coincides with the mid-dorsal line, instead of the apex as in group A. The said base is composed of three oval spots (B 5, 1, 6, dorsal series), the middle one being much the largest. Three more small oval spots enter the remainder of this triangle, the largest at the apex (B 3, 4, dorso-lateral, B 2, lateral). (Text-fig. 3, A.)

When the markings of the two sides of the snake correspond exactly, the general dorsal design is a single string of light-spotted ovals on a dark ground; this is formed by the paired groups B having their bases applied together. They appear oval rather than diamond-shape, on account of the curved border of the ground-colour of these groups. If the markings should alternate with each other, a light wavy band on a dark ground is the general result. Usually, however, a single specimen exhibits



many different combinations of these forms, owing to the different number of markings on the two sides. In most specimens markings of one or more series are present on the head, and in several the latero-ventral series is very marked.

Text-figure 3.



Many specimens do not possess all the primitive spots described, especially upon the posterior part of the body, where the pattern becomes modified. In the first stage of this modification A 5 and 6 become confluent with A 1, which tends to divide into two triangular spots; the spots of group B, with the exception of B 1 and 2, merge into the background (text-fig. 3, c). Some specimens are of the more primitive type anteriorly only, whilst others have the markings of the greater part of the body of the slightly modified type, and become still further altered on their

posterior parts. One specimen, however (see Table, Trinidad 1 *h*), is inclined towards the Jararaca type of marking. Anteriorly A 1 is divided, each spot being confluent with A 5 and 6; A 4 is absent, and of group B only an occasional B 1 is present (text-fig. 3, D). At about the middle of the snake the twin spots A 1, 1, have become some distance apart, and are in sufficiently close proximity to A 2 and 3 to give the appearance at a distance of paired transverse bands, or, since the intermediate space is darker than the surrounding ground-colour, of a single dark-edged band; these bands, which may pair with those of the opposite side or not, are very little more than their own width apart.

In all specimens the pattern tends to break up into a spotted type just before the tail, all the spots being more or less equal in size and distribution. It consists of A 1, 1, 4, 2, 3, and B 1, 3, 4, and 2.

In the markings of the mother, A 1, 2, 3, 5, and 6 are confluent, forming a somewhat truncate chevron, in the middle of which A 4 is sometimes situated. Group B is made up of the six primitive spots, all except B 1, 2, however, being indistinct (text-fig. 3, B). On the whole, the individual variation shown by these 27 specimens is very slight; the most apparent differences between them are due not to variation of the actual markings, but to the inconstant relationship of those of the two sides of the snake.

I have since examined another mother and young, from Andagoya, Colombia (received from Dr. Spurrell), and in this case there is no variation at all among the young.

The markings of both families are of the most primitive type occurring in *L. atrox*, all other forms being evolved from it, as will be shown presently.

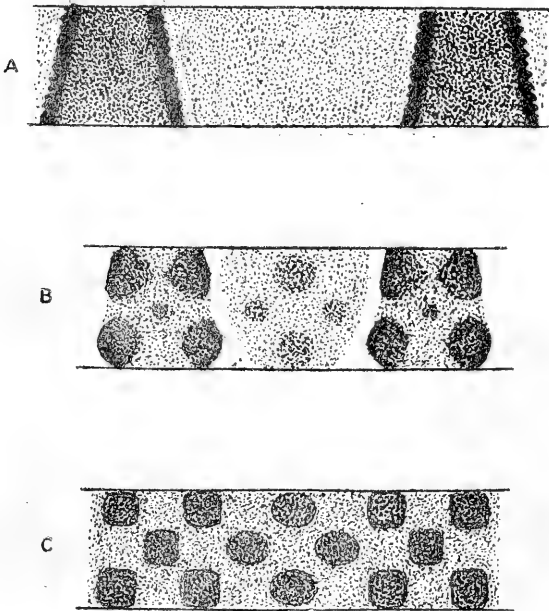
#### *Evolution.*

In the course of evolution, these primitive markings become modified in the following way, which is the same for all forms of *L. atrox*.

A 1 tends to divide transversely to the axis of the body, and A 5 and 6 become confluent with it. B 5 and 6 merge into the ground-colour, A 4 and B 3 and 4 disappear (this stage has already been described in the variations of the young snakes), A 1 then divides completely, but is still distinct from A 2 and 3, A 4 disappears, and the whole of group B tends to merge into the background. The spots A 1, 1 then become a considerable distance apart, narrow, and in close proximity with A 2 and 3, which, since the interspace is darker than in group B, thus produce the effect of a dark, darker-bordered, transverse band. Except for an occasional B 1, this group is pale and quite indistinct. At this point the bands, which may or may not pair with those of the opposite side, are slightly more than their own

width apart. A 1, 1 and A 2, 3 now become confluent, forming the dark unbroken marginal lines of the transverse band which constitutes group A (text-fig. 4, A). These lines may be nearer together on the back than on the sides, and are sometimes much serrated. The bands, *i. e.* groups A, gradually become further apart from each other, with the result that the markings are slightly fewer in number than in the primitive type. For the present I shall call this annulated form of marking Type II. It constitutes a distinct branch in the direct evolution of markings (text-fig. 3, A). Type III. evolves directly from the primitive

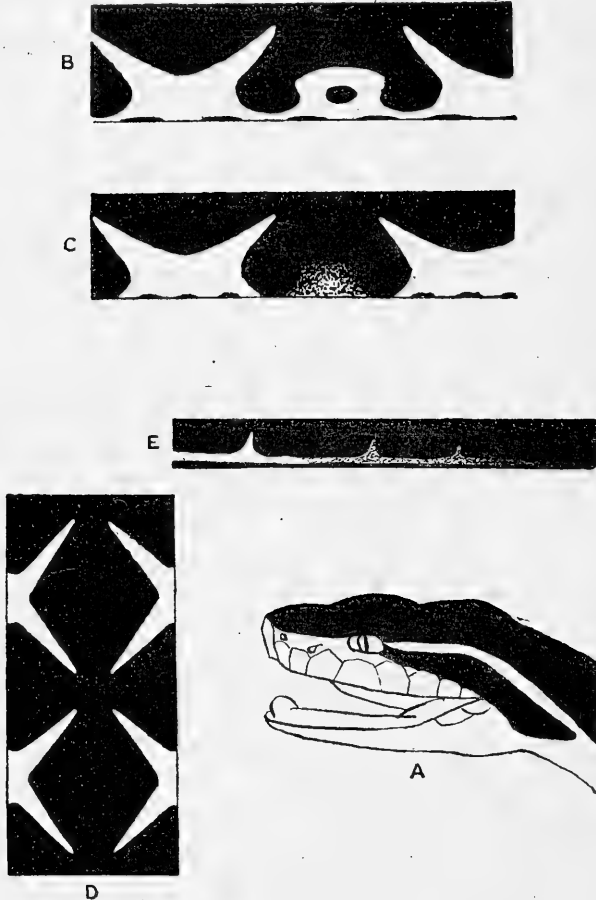
Text-figure 4.



arrangement, in exactly the same way as Type II. up to the point where A 1 is completely divided, but distinct from A 2 and 3. A 1, 1 are, however, squarish, and form a square group with A 2 and 3, which they equal in size. In the course of evolution A 4, B 2, 3, and 4 reappear (text-fig. 4, B), and are also all of equal size. In this type A 4 belongs to the dorso-lateral series, being situated immediately above its position in the lateral series in Type I. In the evolution from Type I. to Type III. the series equalise, the dorsal narrowing and the dorso-lateral broadening. The general pattern is formed, therefore, of three series of equal

and alternating spots (text-fig. 4, c). Group A can only be distinguished from B by the fact that these spots are more square than those of the latter. In this type the ground-colour is not usually darker at A, as is the case in the preceding types.

Text-figure 5.



Further development of this type is shown on a specimen from St. Lucia (Cat. p. 536, spec. *v*). On this snake both the dorso-lateral and lateral series are absent, or but faintly marked, the markings thus consisting of two squarish spots—A 1, 1—followed by one roundish spot—B 1—all of which are for the most part confluent with those of the opposite side.

The fourth type—*L. jararacussu* (text-fig. 5)—constitutes the third branch in the evolution of the markings. A 1, 5, 2, 6, and 3 become confluent, forming a subcrescentic marking, in the middle of which A 4 may be present or not. All the primitive spots of group B unite together to form a dark triangular area, which in the course of evolution becomes confluent with group A—*i. e.*, the apex of A with the base of B—along the dorsal line. At this point the markings darken, and the usual brownish, greyish, or olive ground-colour becomes a bright clear yellow. Finally, more and more black pigment becomes deposited at A and B, until the markings have usurped the place of the ground-colour, even the crescentic marking (A) being partially filled in with black. The general effect of Type IV. is therefore a black snake, with yellow forked markings issuing transversely from the yellow ventrals, which are checkered with black. The dorsal surface of the head is completely black, owing to the development and confluence between the streaks of the dorsal and dorso-lateral series. The post-ocular streak is separated from this area by a narrow stripe of the clear yellow ground-colour, which continues slightly below the commissure of the jaws.

The most striking feature about this type of marking is the clear yellow of the interspaces in the dorsal pattern; in other types this is only found on the ventral surface of the snake, the dorsal ground-colour always exhibiting a superficial powdering of dark pigment. It therefore seems probable that in the course of evolution this pigment has all aggregated in the spots of Groups A and B, and, as more and more becomes deposited, these areas further encroached upon the yellow ground-colour.

#### V. PHYLOGENETIC RELATIONS BETWEEN THE TYPES.

In tracing the evolution of markings from one type to another, I have assumed that the anterior parts represent the primitive pattern, as in lizards and many mammals (ex. *Lacerta muralis*, *Equus quagga*). It might appear, however, that in *L. atrox* this is not the case, the more regularly spotted type, characteristic of the West Indies representing the original pattern, from which the clustered, annulated, and forked markings of C. and S. American forms were derived. On careful consideration I cannot adopt this view for the following reasons:—1. The manner in which the pattern of the Jararacussu develops from Type I. into the complicated design of Type IV., and develops on each individual posteriorly until the tail is a uniform black, cannot be looked upon as primitive, and if this elaborate pattern, become simplified, is a further development of the clustered type of marking, the other forms must also be more advanced. 2. I hold the greater number of spots to be the more primitive (and for this assumption there is much correlative evidence among other snakes and lizards). The clustered pattern is therefore less advanced than the more evenly spotted, for in the former groups A and B

TABLE OF PARTICULARS RELATING TO SOME SPECIMENS OF *L. ATROX*,

Viz.: Colour variety and form of marking. Form of scales, at the anterior (a), middle (m), posterior (p), of the body; either of the *affinis* (af), intermediate (in), or *atrox* (at) types; number of ventrals (v), pairs of subcaudals (c), and dorsal scales (s). Number of markings on the right (r) and left (l) sides of the snake. Locality.

Var. <i>affinis</i>	Colour Variety.	Scales.						Markings.				Locality.	
		Form of			Number of			Number of					
		a	m	p	v	c	s	r	l				
Almost black		af	af	af	211	66	27	obscure					Dominica.
Indistinct		in	af	af	225	67	27	22	21				St. Lucia.
Primitive		af	af	af	183	59	24	23	24				Atoyac, Mexico.
"		af	af	af	213	62	25	22	25				British Honduras.
"		at	in	af	202	66	23	15	17				Malagapan, Nicaragua.
"		at	at	af	197	61	23	16	19				Venezuela.
(♀ and yg.)		at	af	af	218	56	28	20	20				Trinidad.
Primitive		af	af	af	198	59	27	20	20				a
"		in	af	af	190	55	27	19	19				b
"		in	in	af	198	62	27	21	26				c
Very primitive		in	in	af	193	59	27	19	19				d
Primitive		af	af	af	191	57	27	21	19				e
"		af	af	af	192	50	27	17	18				f
"		in	in	af	192	50	27	20	20				g
"		in	af	af	199	60	25	22	22				h
"		in	af	af	197	57	27	20	22				i
"		in	af	af	195	49	27	21	21				j
"		af	af	af	191	56	25	21	21				k
"		in	af	af	216	50	25	19	19				l
Tendency to var. <i>javavaca</i>		af	af	af	200	55	25	21	20				m
Primitive		in	af	af	199	54	27	17	19				n
"		in	af	af	191	54	27	21	21				o
"		in	in	af	196	67	25	22	23				p
"		in	af	af	193	60	27	19	22				q
"		af	af	af	188	65	26	20	20				r
"		in	af	af	189	53	27	19	20				s
"		af	af	af	194	56	27	22	22				t
"		af	af	af	189	65	27	20	20				u
Very primitive		in	af	af	197	57	25	21	20				v
Primitive		in	in	in	194	59	25	19	18				w
Tendency to f. <i>gyptica</i> , primitive		in	in	in	212	59	27	19	20				x
Primitive		in	in	af	192	57	24	20	21				y
"		in	af	af	164	57	27	18	15				z
Very primitive (deformed specimen)		af	af	af	200	63	24	19	20				Trinidad.
Primitive		af	af	af	200	65	27	18	18				33
Very primitive		af	af	af	200	65	27	18	18				"

Primitive .....	af	af	181	57	27	19	21	Berbice. 1
" .....	af	af	195	60	26	19	19	" 2
Tendency to var. <i>jararaca</i> .....	af	af	209	78	25	18	19	Rosario de Cacueta, Colombia.
" .....	af	af	190	65	25	17	15	Cayaria.
" .....	at	in	175	61	26	15	15	W. Ecuador.
" .....	at	at	202	63	27	21	18	Sao Paulo. 1
" .....	at	in	195	55	26	19	18	" 2
" .....	af	af	185	56	25	19	21	" 3
" .....	af	af	195	63	25	18	16	" 4
Intermediate between <i>affinis</i> and <i>jararaca</i> .....	af	af	196	55	25	16	17	Berbice.
Var. <i>jararaca</i> .								
Indistinct .....	at	at	208	50	24	16	17	Martinique*.
Intermediate between var. <i>affinis</i> , <i>jararaca</i> , and {	af	af	185	63	27	19	18	Rosario de Cacueta.
f. <i>typica</i> .....	at	at	200	?	24	anterior	unmarked	Rio Janeiro.
Forma <i>typica</i> .	at	at	197	60	25	16	16	Brazil.
Indistinct .....	af	af	186	63	25	17	18	Berbice. 1
Intermediate between var. <i>affinis</i> and <i>jararaca</i> .....	af	af	189	64	24	14	16	" 2
Forma <i>typica</i> .								
Indistinct .....	at	at	228	62	30	22	21	Guadeloupe.
Dorsal series only .....	at	at	198	64	28	24	24	Martinique. 1
Modified .....	in	in	216	61	29	24	23	" 2
Indistinct .....	at	at	204	69	25	19?	22?	St. Lucia.
" .....	af	af	192	60	23	obscure	obscure	Venezuela.
Indistinct .....	af	af	179	69	24	19	19	Berbice. 1
" .....	af	af	178	68	25	16	16	" 2
Modified .....	af	af	194	71	25	obscure	obscure	Pampa del Sacramento.
Intermediate between var. <i>affinis</i> and <i>jararacensis</i> . {	in	in	195	70	25	obscure	obscure	Pozuzo, Peru.
Var. <i>jararacensis</i> .....	af	af	196	56	24	18	16	Sarayacu.
" .....	af	af	200	65	25	17	18	W. Ecuador. 1
" .....	af	af	195	59	25	19	18	" 2
Intermediate between var. <i>affinis</i> and <i>jararacensis</i> . {	at	in	180	58	25	20	20	Sao Paulo. 1
Var. <i>jararacensis</i> .....	at	in	184	53	25	19	19	" 2

\* Mr. Boulenger tells me that the locality of this specimen is not to be trusted, as it forms part of the old collection, and bears no register number. It was entered as *Craspedocephalus lanceolatus* in the appendix of Gray's Cat. Col. Sn. (1858) p. 226 (spec. g), and was referred to *Lachesis lanceolatus* by Mr. Boulenger.

consist of 6 spots each, whilst in the latter group A consists of 5 and B of 4. Besides these two points, I attach importance to the fact that the eight primary series of spots never extend beyond the head.

As we have already seen, Types II., III., and IV. are all directly evolved from Type I.; but their relative positions have yet to be discussed. Of the stages of development evinced between each of these three and the primitive type, many show a tendency for the markings to break up into the spotted type (Type III.) just before the tail. Nearly all specimens with markings ranging from Types I. to II. show this peculiarity, also all forms intermediate between Types I. and III. In the series from Types I. to IV. this is the case in intermediate forms, but Type IV. itself maintains its direct line of development, the black markings encroaching more and more upon the yellow ground-colour towards the posterior part of the snake, the end of the tail being black.

It will therefore be seen that phylogenetically the markings of Type III. are not to be regarded as so primitive as those of Type II., and that Type IV. is the most modified.

In the next chapter, on classification, varieties will be based on these types of markings in conjunction with their geographical distribution.

Having traced the markings of *L. atrox* from the most primitive onwards, it is of some interest to try to trace these markings back to the hypothetical four-paired streaks of primitive snakes.

The first stage towards this would be the equal development of group B with group A, and the commencement of the fourth or lower labial series on the body. The series would then become more equalised, until a pattern were reached of 4 rows of equal and alternating spots—independent from those on the opposite side—which would be but the result of the breaking up of the primitive streaks. But *L. atrox* is very far ahead of this prototype, and such cases as might appear at first to be an approximation to it, prove on careful consideration to be secondary, an instance of deceptive apparent reversion.

## VI. CLASSIFICATION.

It will be seen from the foregoing that no very definite boundaries can be traced between the varieties of *L. atrox*, whether based on structure or on coloration, so complete are the links connecting them. I can, however, recognize four principal forms based chiefly on markings, more or less in conjunction with geographical distribution, which I think afford on the whole a more satisfactory basis for classification than the characters of scale-structure, etc.

The first of these forms is *L. atrox*, var. *affinis*, which exhibits the more primitive type of marking (Type I.), viz., the



characteristic chevron, or triangle, which, however, varies slightly according to localities.

The most primitive type of marking is not found in the W. Indies proper, or south of Colombia and the Guianas, but prevails north as far as Mexico, and appears to be constant in Trinidad. Specimens of this form have scales with the high short keel. In the W. Indies proper a less primitive variation occurs, in which the elemental spots are more confluent and the pattern less distinct; the scales may either be of the short high-keeled or long low-keeled type. As this variety extends southwards the markings, though still undoubtedly of Type I., frequently approach those of the Jararaca, or Jararacussu in type, and the scaling may conform to either type. Thus the *L. atrox* and *L. lanceolatus* of Dr. Vital Brazil, which are marked simply with dark triangles on the sides, undoubtedly approach the Jararaca of Wied in pattern. A pattern of markings intermediate between the primitive type of this variety and that of the Jararacussu occurs in W. Ecuador. *L. atrox*, var. *affinis*, is the most widely ranging of the four varieties (Mexico to Southern Brazil and Peru). All forms of it are marked with triangles or chevrons, with their apex turned towards the mid-dorsal line. Group A is always darker than B, and encloses an area darker than the surrounding ground-colour. The ventrals may be uniform cream-colour or yellowish, or blotched or speckled with black. In the young the elemental spots, when present, are more distinct, a certain amount of confluence or fading taking place with age.

Form 2, *L. atrox*, var. *jararaca*, has been considered a distinct species since the time of Wied, but as it does not differ from the typical *L. atrox* in any appreciable way, save in the dorsal markings, I consider it to be a variety only. The Jararaca inhabits Brazil, and is especially prevalent in Bahia, São Paulo, and Rio. It is recognized by its annulated form of markings, previously described as Type II., consisting of dark, darker-edged bands, narrower on the mid-dorsal line than on the sides. These bands are more than their own width apart, the interspaces being lighter and unspotted. The ventrals may be uniform, spotted, or powdered with black.

Figures of the Jararaca are given in Wied, *Abbild. Nat. Bras.*, under the name of *Cophias atrox*; Wagler in *Serp. Bras.* pls. xix., xxi., under the names of *Bothrops megarera*, *B. leucostigma*, *B. tessellatus*, and *B. tæniatus*; and in Jan, *Icon. Oph.* xlvii. pl. iii. under *B. atrox*.

A typical specimen of this variety could not be confounded with the preceding, but in the British Museum collection there are some young specimens from Berbice (*Cat. Sn.* p. 539, spec. ε-κ), which are exactly intermediate between these three varieties.

Form 3, the typical *L. atrox* (*L. lanceolatus*) occurs principally in the West Indies, which is the acknowledged home of the Fer-de-lance, but also in the Guianas, Venezuela, and curiously in Peru, in a somewhat modified form. The markings of this

variety are of the spotted type, described as Type III., consisting of three longitudinal series of subequal and alternating dark spots, more or less uniformly distributed on a lighter ground-colour; the scales are usually of the low, long-keeled type. In the modified form from Venezuela, Berbice, and Peru the spots of group A are darker than those of group B, the whole pattern thus having a less even appearance. In some cases the markings are very indistinct, only the principal spots of group A (A 1, 1, 2, 3) being discernible. The scales may be of either type.

Form 4, *L. atrox*, var. *jararacussu*, is the distinct colour variety, which Lacerda regarded as a valid species in 1884, and which is still maintained as such by Dr. V. Brazil. There is, however, no difference between the Jararacussu and *L. atrox* except that of colour and markings.

The Jararacussu inhabits Brazil, São Paulo, and Rio, and is distinguished from the preceding forms by its peculiar markings described above as Type IV., and the fact that the interspaces in the black areas are bright yellow instead of the brown, grey, or olive shades of all the other varieties. The pattern appears to consist of transverse yellow forks issuing from the yellow ventrals, which are blotched with black. The tail is black. The head of the Jararacussu is extremely characteristic, the dorsal surface being of a uniform black, from which the black post-ocular streaks are separated by a narrow streak of yellow, continued obliquely from the yellow throat. A coloured plate of this variety is given in Dr. Brazil's 'Défense contre l'Ophidisme' (2nd edition), pl. 14, under the name of *Lachesis jararacussu*. It is also represented in Jan's Iconographie, 47me livr., pl. ii. fig. 3, as *Bothrops atrox*.

9. Report on Deaths of Animals in the Gardens in 1917.  
By J. A. MURRAY, M.D., B.Sc., F.Z.S., Director,  
Imperial Cancer Research Fund; Pathologist to the  
Society.

[Received April 23, 1918: Read April 23, 1918.]

The accompanying tabular statement of the numbers of deaths of mammals, birds, and reptiles (including amphibia and fishes) in 1917, shows only minor differences from the figures recorded in 1916 by Professor Plimmer or from the average numbers in the previous 5 years. In 1917 rather less than 25 per cent. of the animals dying had been less than 6 months in the Gardens.

TABLE I.

MAMMALS.	BIRDS.	REPTILES.	
613	1940	446	In Gardens, 1. i. 17.
215	745	368	Admitted in 1917.
828	2685	814	TOTAL.
$\frac{68}{167} = 235$	$\frac{93}{461} = 554$	$\frac{62}{80} = 142$	Under 6 months. Died.
			Over 6 months.
28.4	20.6	17.4	Per cent. of total.
28.3	23.4	28.6	„ in 1916.
27.0	23.3	31.2	„ in 1911-15.

As has been pointed out by Dr. Chalmers Mitchell, little statistical value attaches to such tabular statements of combined mortality of species with widely different liability to disease and duration of life. The only conclusion to be drawn is that there has been freedom from severe epidemics during the year.

Table II. summarises the results recorded under the more important causes of death for the chief mammalian orders, and for mammals, birds, and reptiles generally. These have been compiled from the careful records made by Professor Plimmer as regards the first 7 months of the year. There was an interval of nearly two months before I entered upon the duties of pathologist, and the incomplete data recorded in this interregnum

TABLE II.

	MAMMALS.						Total.	BIRDS.	REPTILES.
	Primates.	Carnivora.	Rodentia.	Ungulata.	Edentata.	Chiroptera.			
1. <i>General Diseases.</i>									
Tuberculosis .....	6	2	2	3	...	...	13	46	4
Mycosis .....	1	1	...	1	...	...	4	9	1
Septicæmia .....	1	...	...	...	...	...	1	...	9
Abscess .....	1	1	2	1	...	...	5	...	...
Peritonitis .....	1	1	...	2	1	...	6	3	...
Cestodes .....	...	...	...	...	...	...	...	1	...
Filariasis .....	1	...	...	...	...	...	1	...	...
Ascarides .....	...	...	...	...	...	...	...	2	2
Hæmogregarines .....	...	...	...	...	...	...	...	...	3
2. <i>Diseases of Respiratory Organs.</i>									
Atelectasis .....	...	...	...	1	...	...	1	...	...
Pneumonia .....	27	13	26	9	...	2	7	84	197
Pleurisy .....	...	2	...	...	...	...	...	2	...
3. <i>Diseases of Heart.</i>									
Degeneration of Heart-muscle.	...	1	...	...	...	...	...	1	5
Valvular disease .....	...	...	...	3	...	...	...	3	...
4. <i>Diseases of Liver.</i>									
Hepatitis .....	...	...	...	...	...	...	...	...	3
5. <i>Diseases of Alimentary Tract.</i>									
Gastro-enteritis .....	1	2	...	...	...	...	...	3	...
Gastric ulceration .....	1	3	1	1	...	...	1	7	...
Enteritis .....	4	8	9	...	1	...	...	22	88
Gastritis .....	...	...	...	1	...	...	...	1	7
Intestinal obstruction .....	1	...	...	2	...	...	...	3	2
Intussusception .....	...	1	...	...	...	...	1	2	...
Prolapse of Rectum .....	...	...	...	...	...	1	...	1	...
6. <i>Diseases of Urinary and Generative Organs.</i>									
Nephritis .....	4	8	2	3	...	...	...	17	58
Salpingitis .....	...	...	...	...	...	...	...	...	5
7. <i>Various.</i>									
Carcinoma .....	...	1	...	...	...	...	1	2	...
Sarcoma .....	...	...	...	...	...	...	...	...	2
Hæmorrhage .....	...	...	1	...	...	...	...	1	1
Injuries discovered <i>post-</i>	1	2	...	...	...	...	...	3	7
<i>mortem</i> .....									
Starvation and malnutrition .....	1	2	...	1	...	...	...	2	1
Killed by companions, rats, &c.	1	2	...	...	...	...	...	3	10
Killed by order .....	3	3	3	2	...	...	...	11	19
Not diagnosed .....	11	9	13	...	...	...	4	37	81

are partly responsible for swelling the totals under the heading "not diagnosed" in Table II.

*Protozoan Parasites.*—In addition to the three reptilian deaths in Table II. ascribed to Hæmogregarines, these parasites have been observed in a number of snakes dying from other causes.

They have revealed an apparently definite dimorphism of the schizonts in the circulating blood, a long slender form which produces great deformation of the red cell, the hæmoglobin being retained, and a short stout form which produces much less deformity but exhausts the hæmoglobin very rapidly. The significance of the two forms and their relation to the schizogony in the liver-cells remain to be determined by further study, for which a considerable material has been preserved.

*Malignant new Growths.*—In two mammals death was ascribed to carcinoma and in two birds to sarcoma. Of these one case of squamous-cell carcinoma of the fauces and palate of a Dingo, probably arising from the epithelial covering of the tonsil, has been examined personally. In addition a new growth was found on examination of a Leopard which died with bronchiectatic cavities in the lungs. The growth in this case proved to be an adeno-carcinoma lying on the ventral surface of the trachea in the thorax. The tissue of origin could not be determined.

(Two further cases have been observed in 1918: a carcinoma of the liver in a Marsh-Buck and a teratoma of the testis in a Golden Eagle.)

*Comparative Pathology of the Thyroid.*—The special value of the material occurring in the Prosectorium consists in the opportunity offered for a comparative study of pathological and physiological problems which are of general interest, and special attention has been directed to the thyroid gland. The thyroid occurs throughout the whole vertebrate series and, with the exception of the cyclostome fishes, presents the same histological picture in all. From studies in man and mammals in various pathological conditions an important rôle has been ascribed to it in the reaction of the body to a variety of intoxications. The results of physiological experiment indicate other important functions both in health and disease. It was therefore of interest to note the contrast in the appearance of the gland in cold- and warm-blooded animals respectively in severe infections. In warm-blooded animals dying under these conditions extreme congestion of the whole gland is practically constant. Nothing of the kind has been encountered in the reptiles examined, although a large proportion presented severe septicæmic conditions after death. This result is unfavourable to the view that the thyroid plays the part of a neutraliser of toxic substances in the body. It is in much better harmony with the view that the changes in the thyroid in these conditions are the expression of its participation in the heat-regulating mechanism of the body. In poikilothermic animals one would expect these changes to be absent.

*Effect of Diet on the Thyroid.*—Although attention has been drawn to the effect of a meat diet on the thyroid, no observations are recorded on the results of the natural experiment presented by the occurrence of meat-eating and plant-eating groups in birds and mammals. The analysis of the observations in birds presents

many difficulties, and will be undertaken later. In mammals, however, the comparison is much easier, and the preliminary survey which has been carried out shows that in Carnivora the thyroid is from two to three times as large as in Ungulata of corresponding body-weight. The key to the problem is probably furnished by Marine and Lenhart's work on thyroid enlargement in trout kept in hatcheries. These authors have shown that the goitrous condition, which so frequently supervenes, is due to the diet of horseflesh with which the fish are fed and that it can be obviated and even cured by supplying a ration of sea-fish. Their investigations have shown that the constituent deficient in the horseflesh diet is iodine. The necessity for fixing the inadequate amounts present in flesh is met by a hypertrophy of the gland. When adequate amounts of iodine are supplied either in the form of sea-fish or soluble iodides, the enlargement subsides.

## EXHIBITIONS AND NOTICES.

February 5th, 1918.

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

The SECRETARY read the following Report on the Additions made to the Society's Menagerie during the months of November and December, 1917 :—

## NOVEMBER.

The registered additions to the Society's Menagerie during the month of November were 38 in number. Of these 28 were acquired by presentation and 10 were received on deposit.

The number of departures during the same period, by death and removals, was 88.

Amongst the additions special attention may be directed to :—

1 Brindled Gnu (*Gorgon taurinus*) ♀, from South Africa, deposited on November 21st.

1 Wilson's Bird of Paradise (*Schlegelia wilsoni*), from Waigiou, and 2 Himalayan Goldfinches (*Carduelis caniceps*), presented by Alfred Ezra, F.Z.S.

1 Lesser Vasa Parrot (*Coracopsis nigra*), from Madagascar, presented by The Marquess of Tavistock, F.Z.S.

## DECEMBER.

The registered additions to the Society's Menagerie during the month of December were 17 in number. Of these 7 were acquired by presentation and 10 were received on deposit.

The number of departures during the same period, by death and removals, was 81.

Amongst the additions special attention may be directed to :—

1 Grey Seal (*Halchaerus grypus*), from the North Sea, presented by T. Witherwick on December 24th.

1 European Flamingo (*Phaenicopterus roseus*), from S. Europe ;  
2 South-American Flamingoes (*Ph. chilensis*), from S. America ;  
2 Black-necked Swans (*Cygnus melanocephalus*) and 2 Coscoroba Swans (*Coscoroba coscoroba*), from S. America : deposited on December 31st.

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Mr. D. SETH SMITH, F.Z.S., Curator of Birds, exhibited and remarked on a series of lantern-slides made from photographs

of Reptiles taken in the Gardens, directing special attention to those showing feeding habits of the Black Cribo (*Oxyrhopus clelia*), which attacks and devours poisonous snakes.

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*The Wild Dingo (Canis familiaris, var.).*

The SECRETARY read the following letter from Mr. Thomas E. Whitehead:—

“During a recent visit to England, I spent a delightful day at the Zoological Gardens, but was rather surprised at the animals exhibited as Dingos. Now, Sir, I spent a great many years as a stockman and drover in the back country of South Australia, New South Wales, Queensland, and Northern Territory, besides travelling and prospecting over a large part of Western Australia during the past 23 years, but I have never met with a Dingo anything like those I saw at the London Zoo.

“I have enquired from my friends if they could tell me what part of Australia they could have come from, and I am told that many years ago a Mastiff got away with the Dingos about Mount Kosciusko and crossed the breed in that district. So probably that is where your Dingos came from. They are too tall, too long, too thick muzzled, and too short-haired to be true Dingos. The true Dingo resembles the fox a great deal, but is larger, his nose is pointed, forehead fairly broad, has longish hair, and a tail almost as bushy as the fox. There are two colours, according to the colour of the country he inhabits. Those in the Tableland and Mountainous districts are usually of a sandy brown colour, while those in the yellow sand-hill country are usually sandy yellow, and have longer hair than those on the Tablelands. I once saw a pack of about a dozen of the darker kind in the forenoon on the south side of Lake Yandandaninna, and towards evening I saw a pack of the lighter colour on the north side of the lake; they had come for a drink from the sandhills to the northward.

“Dingos never bark, neither do they learn to bark when tamed. The Bushman can always distinguish between the howl of a Dingo and that of a Domestic Dog. Like the fox, he is very partial to poultry, and is a terror to poultry-owners in the new townships. He will kill sheep by the dozen just for the fun of doing so. If hungry, he will rip a hole in the flank and eat his fill of the liver and leave the rest. I once heard sheep rushing on a bright moonlight night. On going to investigate I saw our Overseer's prize Kelpie rounding up about 300 sheep, while in the centre was a Dingo slut enjoying herself by killing sheep wholesale. I fired my rifle at the Kelpie but missed, then fired at the slut, and next morning tracked her up by blood marks and found her nearly dead, so quickly despatched her.



She had killed 11 sheep and had bitten many more, some of them dying during the next few days.

“THOS. E. WHITEHEAD,  
262 Bulwer Street,  
North Perth,  
Western Australia.”

—————

*On a New and a Rare Species of the Golden Mole*  
(*Bematiscus*).

Dr. R. BROOM, C.M.Z.S., exhibited specimens of two rare South-African Golden Moles, and made the following remarks:—

Hitherto the giant moles from the eastern part of Cape Colony have been referred to *Bematiscus trevelyani*, but it is quite manifest that there are at least two species. The specimen which I make the type of this new species was sent to me by Miss Ivy Lesch from St. Cuthberts, Isolo, and as it differs very markedly from *Bematiscus trevelyani* of the Pirie Bush or any of the hitherto described species, I have much pleasure in naming it after the discoverer, to whose interest in natural history we also owe *Bematiscus transvaalensis*.

*Bematiscus leschæ* is a moderately large mole, probably about 180 mm. in length, but as I have only the dried skin, it is impossible to be quite sure of the length. It is manifestly considerably smaller than *B. trevelyani*. The fur is of a fairly uniform dark brown—lighter on the abdomen. On the lips the short fur is somewhat reddish brown. On the upper side of the head the fur is also rather lighter than further back, owing to the short under-fur being pale reddish brown. On the back and greater part of the body the fur is about 18 mm. in length—a dark slaty very fine under-fur with coarse-tipped hairs whose tips of 7 mm. overlap the under-fur. The tips have the last 2 or 3 mm. dark brown and the more proximal  $\frac{2}{3}$  light brown.

The following are the measurements of the claws of the front foot:—1st 2·5 mm., 2nd 6 mm., 3rd 11 mm., 4th 1·5 mm.

The following are the principal measurements of the skull:—

	mm.
Greatest length .....	35·6
Greatest width.....	21·4
Greatest height .....	17
Width between orbits.....	7·5
Dental series .....	14
Molar series .....	8
Width across the premolars .....	10·8
Width between last premolars .....	4·6

The skull has the large bulla for the malleus well projecting as in *B. villosa* and *B. transvaalensis*, and the affinities are much closer with these two species than with *B. trevelyani*. The mole

from Maritzburg described by Dobson, and doubtfully referred by him to *B. villosa* is, I think, undoubtedly a distinct species, and may be called *Bemataiscus dobsoni*.

To the genus *Bemataiscus* there would thus be referred five known species—*B. villosa* and *B. dobsoni* from Natal, *B. transvaalensis* from the Transvaal, and *B. trevelyani* and *B. leschae* from Eastern Cape Colony.

The second exhibit is a specimen of the rare Golden Mole—*Chrysochloris sclateri*. Originally discovered in the Nieuwveld, north of Beaufort West, and named in honour of Mr. W. L. Selater, it was next discovered at Morija in Basutoland, 350 miles from the original locality. In an unexplored country a species occurring at two such remote localities would not excite any wonder, but in South Africa our researches on the fauna have gone so far that we can say not only that the species has never been found in the intermediate area, but that no Golden Moles inhabit the northern part of Cape Colony. Six years ago I discovered tracks of *Chrysochloris* on Compass Berg, and I have since been fortunate, through the kindness of Miss K. Jansen, of Wilgebosch, New Bethesda, in getting a specimen which proves to be also *C. sclateri*. This discovery brings the known localities 130 miles nearer, and suggests that the species may originally have extended to Basutoland by the Winterberg and Stormberg. Possibly it may yet occur in these localities. The black mole of the south coast, which I named *C. duthieae*, is an extremely closely allied species. It occurs at Knysna, and possibly extends eastwards to Port Elizabeth. *C. sclateri* with its 40 teeth is probably near the ancestral form from which *C. hottentota* and allied forms with 36 teeth are derived.

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February 19th, 1918.

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

The SECRETARY read the following Report on the Additions made to the Society's Menagerie during the month of January 1918:—

The registered additions to the Society's Menagerie during the month of January were 26 in number. Of these 16 were acquired by presentation, 8 were received on deposit, and 2 by purchase.

The number of departures during the same period, by death and removals, was 80.

Amongst the additions special attention may be directed to:—

1 White-nosed Coati (*Nasua narica*), from Tampico, presented by H. C. Banbury on January 19th.

1 Otter (*Lutra lutra*), from Hampton Court, presented by H. Tagg on January 18th.

2 Straw-necked Ibises (*Carphibis spinicollis*), from Australia ; 1 Scarlet Ibis (*Eudocimus ruber*), from Para ; 1 Himalayan Monaul (*Lophophorus impeyanus*) ♂, from Himalayas ; 1 Peacock Pheasant (*Polyplectrum chinquis*) ♂, from Burmah ; 2 Swinhoe's Pheasants (*Genuæus swinhoi*) ♂ ♀, from Formosa, presented by Major The Hon. Waldorf Astor, F.Z.S.

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Dr. SMITH WOODWARD, F.R.S., V.P.Z.S., exhibited a copy of an incised drawing of a hunted deer, pierced by arrows, made by Palæolithic man in the cave of La Peña, San Roman de Candamo, Asturias, Spain. It was lately published by Dr. Hernández-Pacheco in no. 17 of the memoirs of the Spanish commission on prehistoric investigations.

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*An African Civet attacking Human Beings.*

The following letter, communicated by Professor POULTON, F.R.S., F.Z.S., was read from Captain G. D. Hale Carpenter, M.D., giving an account of a case which had come under his personal observation in which an African Civet attacked human beings.

"On the night of Dec. 10-11th, 1917, an Indian and an African, employées of the railway, were sleeping in the verandah of the station building when the latter was awakened by a bite on his toe, and found to his alarm what he thought was a young leopard—it was a very dark night and without a moon. It viciously attacked the two men, but they managed to catch it and throw it down a well, as they had no stick or other weapons handy: they both came to hospital in the morning to have their wounds dressed—the African had a contused and punctured wound on the ball of the great toe: the forearm of the Indian was superficially lacerated. When they brought up the body of the culprit, which I had decided in my mind would prove to be a Serval cat, as I thought it unlikely the two men would without weapons have overpowered a Leopard cub. But to my astonishment the draggled carcase was that of a rather small, old, *Civet* !

"The men said there had been two of them.

"I should think undoubted instances of unprovoked assault by a Civet on mankind must be rare.

"G. D. HALE CARPENTER, M.D.,  
*Capt. Uganda Med. Service.*"

"On the Central Railway of ex-German East Africa,  
17 miles W. of Tabora,  
December 12, 1917."

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Professor E. W. MACBRIDE, M.A., D.Sc., F.R.S., F.Z.S., gave an account, illustrated by lantern-slides, of his recent investigations into the development of the Sea-Urchin (*Echinocardium cordatum*).

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March 5th, 1918.

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

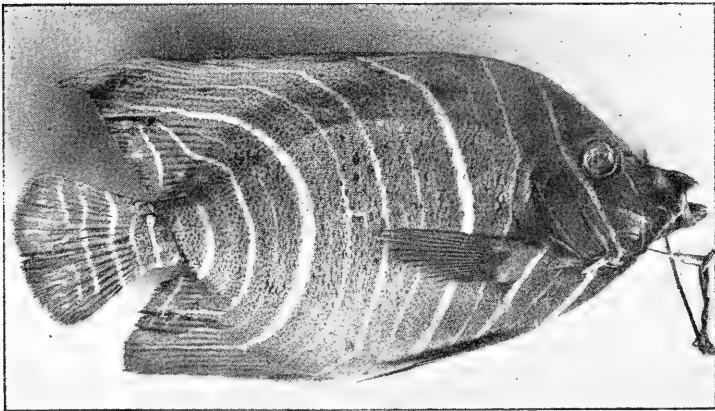
Mr. D. SETH SMITH, F.Z.S., exhibited skins of the Hoatzin (*Opisthocomus cristatus*), and described the habits and distribution of the species, illustrating his remarks with lantern-slides.

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*A Chætodont Fish with Markings resembling Arabic Characters.*

Mr. C. TATE REGAN, M.A., F.R.S., F.Z.S., exhibited photographs of an Indo-Pacific Chætodont Fish (*Holacanthus semicirculatus* Cuv. et Val.). Two of these had been sent to him by Major H. R. Cartwright, Commandant of Police, Zanzibar;

Text-figure 1.



they were of a specimen that had been sold in the fish-market for a penny; the man who bought it was going to eat it and cut off the tail and threw it on the ground; another man picked it up and called out that it had writing on it, and, indeed, on one side of the caudal fin was written in old Arabic characters "Laillaha Illalah" (There is no God but Allah) and on the other side "Shani-Allah" (A warning sent from Allah). The

news caused great excitement in the market place; the fish changed hands at rapidly increasing prices until 5000 rupees was offered; the fish was regarded as sacred and Major Cartwright, who put it in formalin for the owner and had it photographed, thought it might become the object of pilgrimages.

The other photographs exhibited by Mr. Regan were of examples of this species in the collection of the British Museum (Natural History), and illustrated the changes in coloration that take place during growth. In young specimens the ground-colour is almost black, the body is crossed by a few curved white stripes, and the posterior half of the caudal fin is clear. In larger fish 3 or 4 inches long the general ground-colour is paler, but is dark-spotted; the stripes have increased in number by the addition of narrow ones between the original ones, and still narrower ones between these, so that there may be as many as 24 stripes instead of the original 6; also the posterior part of the tail is now darkened and is crossed by 3 pale stripes, of which the posterior 2 may be discontinuous or connected or replaced by longitudinal bars; it is these which may simulate Arabic characters. This stage was described as *Holacanthus alternans* Cuv. & Val., and from now onwards the ground-colour becomes paler and the dark spots better defined, the pale stripes disappear anteriorly, and posteriorly still increase in number but break up into spots and vermiculations, so that a fish of seven inches long has quite a different appearance, and indeed was described by Bleeker as a distinct species, *H. lepidolepis*.

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### March 19th, 1918.

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

The SECRETARY read the following report on the Additions made to the Society's Menagerie during the month of February 1918:—

The registered additions to the Society's Menagerie during the month of February were 19 in number. Of these 14 were acquired by presentation, and 5 were received on deposit.

The number of departures during the same period, by death and removals, was 71.

Amongst the additions special attention may be directed to:—

2 Stanley Cranes (*Tetrapteryx paradisea*), from South Africa, and one Black-necked Crowned Crane (*Balearica pavonina*), from West Africa, presented by W. H. St. Quintin, F.Z.S., on February 21st.

1 American Bison (*Bison americanus*), from N. America, deposited on February 15th.

April 9th, 1918.

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

The SECRETARY read the following Report on the Additions made to the Society's Menagerie during the month of March 1918:—

The registered additions to the Society's Menagerie during the month of March were 31 in number. Of these 23 were acquired by presentation, 6 were received on deposit, 1 by purchase, and 1 in exchange.

The number of departures during the same period, by death and removals, was 93.

Amongst the additions special attention may be directed to:—

1 Jungle-Cat (*Felis chaus*) ♀, from India, purchased on March 9th.

2 Hog-Deer (*Axis porcinus*), ♂ ♀, from India, deposited on March 5th.

1 King Penguin (*Aptenodytes patagonica*), from South Georgia, received in exchange on March 19th.

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Miss L. E. CHEESMAN, Assistant Curator of Insects, exhibited specimens of an East-African homopterous insect, *Ityræa nigro-cincta*, sent by the Curator of the Museum at Nairobi.

Special interest is attached to these insects by reason of their habit of clustering in colonies on a plant-stem in imitation of the inflorescence. There is a coloured form and a green form of the adult insect, and when the latter are found clustering on the apex of the flower-spike, they bear an extraordinary resemblance to unopened buds.

An interesting account of a similar species was published by Dr. Gregory in his book 'The Great Rift Valley,' with a sketch of the insects. They have also been figured in a paper read by Mr. Hinde before the Entomological Society in 1902.

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Dr. A. SMITH WOODWARD, V.P.Z.S., exhibited fossil rostral teeth of *Eopristis* and *Pristis*, and referred to the progressive changes in the rostral teeth of the Pristidæ, or saw-fishes, during geological time. In the Cretaceous genus, *Sclerorhynchus*, these teeth only differ from the ordinary shagreen in their enlargement and the elongation of their apical portion. Their pulp-cavity is restricted to the basal half, and the distal portion is traversed by several very irregular large vascular canals, mainly longitudinal in direction. In the genus *Eopristis*, not known later than the

Eocene period, the teeth are still loosely ranged along the edge of the rostrum, not in deep sockets; but their structure is nearly that of *Pristis*, the vascular canals being only much more irregular and not yet clearly the centres of well-marked hexagonal prisms. *Pristis* itself, with the rostral teeth in deep sockets, and with the well-known prismatic structure, ranges from the Eocene period onwards.

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Mr. G. A. BOULENGER, F.R.S., exhibited the head of a *Hydrocyon goliath* Blgr., from the Congo, a fish attaining a length of four feet, the largest and most formidable representative of a genus of the family Characinidæ inhabiting the principal rivers of Africa. The Nile species is known as the *Kelp-el-Bahr*, or River-dog, of the Arabs, and a third species, common in the Zambesi and Limpopo systems, is called Tiger-fish by the colonists.

The object of this exhibition was to show the enormous shark-like teeth to which special interest attaches owing to a recent publication by Dr. Eastman, who has pointed out their close similarity to the fossils known as *Onchosaurus* Gervais (originally referred to the Mosasaurs), *Ischyrrhiza* Leidy, and *Gigantichthys* Dames, which appears to indicate the existence of the Characinidæ as far back as the Upper Cretaceous, a range in time which Mr. Boulenger had predicted as probable thirteen years ago, and which is of special importance in explaining the present distribution of this family\*.

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April 23rd, 1918.

A. EZRA, Esq., Vice-President, in the Chair.

Mr. D. SETH SMITH, Curator of Birds, exhibited and made remarks on a Zulu Head-dress made of the plumes of the male Long-tailed Whydah, *Chere progne*.

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The SECRETARY called attention to an advertisement that had recently appeared in the London Press, announcing Fur Sales by Public Auction about to take place in the United States. The sales in question were only examples of what took place annually in London and other important commercial centres. The numbers advertised were smaller than usual, no doubt on account of the War, but they included very large quantities of animals the

\* Cf. C. R. Ac. Sci. Paris, clxvi. 1918, p. 197.

extinction of which could not be far distant, unless measures were carried out to protect them. In the opinion of the speaker, which was confirmed by the Meeting, there was urgent need for drastic measures to protect Mammals. The protection of Birds appealed to popular sentiment, and was zealously advocated by many influential organisations. The danger that threatened Mammals was even greater, and, on account of their higher intelligence and more sensitive nervous organisation, the cruelty involved in the methods of hunting, trapping, and killing them was incomparably greater.

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Professor WOOD-JONES, F.Z.S., Honorary Acting Prosector, exhibited and made remarks on specimens from the Prosectorium illustrating the effects of Rickets. He also exhibited a set of anatomical preparations useful for teaching purposes, made from material obtained from the Society's Collection.

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ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

February 5th, 1918.

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

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Menagerie in the months of November and December, 1917.

Mr. D. SETH SMITH, F.Z.S., Curator of Birds, exhibited and made remarks on a series of lantern-slides made from photographs of Reptiles taken in the Gardens, directing special attention to those showing feeding habits of the Black Cribb (*Oxyrhopus cloelia*), which attacks and devours poisonous snakes.

The SECRETARY read a letter from Mr. THOS. E. WHITEHEAD containing observations on the wild Dingo of Australia.

A paper by Professor B. L. BHATIA and BAINI PRASHAD (communicated by Lieut.-Colonel J. STEPHENSON, D.Sc., I.M.S., F.Z.S.), entitled the "Skull of *Rana tigrina* Daud., was read.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., presented his paper entitled "Description of a new Snake of the genus *Oligodon*, from Upper Burma."

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Dr. R. Broom, C.M.Z.S., exhibited specimens of two rare South African Golden Moles. The one was described as a new species of *Bemataiscus*, *B. leschæ*. Hitherto the Giant Moles of the Eastern Cape Colony have been referred to *B. trevelyani*, but the present type from St. Outhberts, Isolo, differs from *B. trevelyani* and agrees with *B. transvaalensis* and *B. villosa* in having the temporal bulla markedly projecting from the side of the skull. The skull measures 35·6 mm. in length and 21·4 mm. in width, being thus very appreciably smaller than *B. trevelyani*.

The other specimen exhibited was one of the rare mole *Chrysochloris sclateri*. Hitherto it has been only known from the Nieuwveld and from Basutoland—localities 350 miles apart. The present specimen was from New Bethesda, 130 miles nearer to Basutoland than the original locality.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, February 19th, 1918, at 5.30 P.M., when the following communications will be made:—

Professor E. W. MACBRIDE, M.A., D.Sc., F.R.S., F.Z.S.

The development of *Echinocardium cordatum*.

Captain G. D. HALE CARPENTER, M.D.

An African Civet attacking Human Beings. (Communicated by Professor Poulton, F.R.S.)

L. A. LANTZ (Moscow).

Reptiles from the River Tajan. (Communicated by G. A. Boulenger, F.R.S., F.Z.S.)

The following papers have been received:—

Miss MAUDE L. W. CLEGHORN, F.Z.S., F.L.S., F.E.S.

First Report on the Inheritance of Visible and Invisible Characters in Silkworms.

R. I. Pocock, F.R.S., F.Z.S.

On the External Characters of the Lemurs and *Tarsius*.

Dr. R. W. Shufeldt, C.M.Z.S.

Notes on the Osteology of the Young of the Hoatzin  
(*Opisthocomus cristatus*) and other points on its Morphology.

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Communications intended for the Scientific Meetings should  
be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,

· REGENT'S PARK, LONDON, N.W. 8.

*February 12th, 1918.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

February 19th, 1918.

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

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Menagerie in the month of January, 1918.

Dr. SMITH WOODWARD, F.R.S., V.P.Z.S., exhibited a copy of an incised drawing of a hunted deer, pierced by arrows, made by Palæolithic man in the cave of La Peña, San Roman de Candamo, Asturias, Spain. It was lately published by Dr. Hernández-Pacheco in no. 17 of the memoirs of the Spanish commission on prehistoric investigations.

A letter, communicated by Professor POULTON, F.R.S., F.Z.S., was read from Captain G. D. Hale Carpenter, M.D., giving an account of a case which had come under his personal observation in which an African Civet attacked human beings.

A paper by L. A. LANTZ of Moscow, communicated by Mr. G. A. BOULENGER, F.R.S., F.Z.S., describing a collection of reptiles made in Transcaspia and now in the Zoological Museum of Moscow University, was read.

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Professor E. W. MACBRIDE, M.A., D.Sc., F.R.S., F.Z.S., gave an account, illustrated by lantern-slides, of his recent investigations into the development of the Sea-Urchin (*Echinocardium cordatum*).

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The next Meeting of the Society for Scientific Business will be held on Tuesday, March 5th, 1918, at 5.30 P.M., when the following communications will be made:—

R. J. Pocock, F.R.S., F.Z.S.

On the External Characters of the Lemurs and *Tarsius*.  
(Illustrated by lantern-slides.)

Sir GEORGE F. HAMPSON, Bt., F.Z.S.

A Classification of the *Pyralidae*, Subfamily *Hypsotropinae*.

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The following Paper has been received:—

Miss MAUDE L. W. CLEGHORN, F.Z.S., F.L.S., F.E.S.

First Report on the Inheritance of Visible and Invisible Characters in Silkworms.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,  
*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*February 26th, 1918.*

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

March 5th, 1918.

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

---

The Minutes of the last Scientific Meeting were confirmed.

Mr. D. SETH SMITH, F.Z.S., exhibited skins of the Hoatzin (*Opisthocomus cristatus*), and described the habits and distribution of the species, illustrating his remarks with lantern-slides.

Mr. R. I. POCKOCK, F.R.S., F.Z.S., gave an account of his communication entitled "On the External Characters of the Lemurs and *Tarsius*." The observations recorded were based, except in the case of *Tarsius*, upon specimens that had lived in the Society's Gardens. They related chiefly to the muzzle, the ear, vibrissæ, hands and feet, and the perineal organs. The author, in conclusion, stated his opinion that *Tarsius* should be removed from the Lemuroid Primates and classified with the Monkeys. He proposed to divide the Primates into two primary groups, the Strepsirhini for the Lemurs and the Haplorhini for *Tarsius* and the rest, the Haplorhini being further divided into the Tarsiodea for *Tarsius* and the Pithecoidea for Monkeys, Apes, and Man.

A communication from Sir GEORGE F. HAMPSON, Bt., F.Z.S., contained a classification of the *Hyppotropinæ* which the Author described as a rather obscure group of the *Pyralidæ*, of very uniform appearance and differing chiefly in structure.

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Mr. C. TATE REGAN, M.A., F.R.S., F.Z.S., exhibited photographs of an Indo-Pacific Chaetodont Fish (*Holacanthus semicirculatus* Cuv. et Val.). Two of these had been sent to him by Major H. R. Cartwright, Commandant of Police, Zanzibar; they were of a specimen that had been sold in the fish-market for a penny; the man who bought it was going to eat it and cut off the tail and threw it on the ground; another man picked it up and called out that it had writing on it, and indeed on one side of the caudal fin was written in old Arabic characters "Laillaha Illalah"—There is no God but Allah—and on the other side "Shani-Allah"—A warning sent from Allah. The news caused great excitement in the market place; the fish changed hands at rapidly increasing prices until 5000 rupees was offered; the fish was regarded as sacred and Major Cartwright, who put it in formalin for the owner and had it photographed, thought it might become the object of pilgrimages.

The other photographs exhibited by Mr. Regan were of examples of this species in the collection of the British Museum (Natural History), and illustrated the changes in coloration that take place during growth. In young specimens the ground-colour is almost black, the body is crossed by a few curved white stripes, and the posterior half of the caudal fin is clear. In larger fish 3 or 4 inches long the general ground-colour is paler, but is dark-spotted; the stripes have increased in number by the addition of narrow ones between the original ones, and still narrower ones between these, so that there may be as many as 24 stripes instead of the original 6; also the posterior part of the tail is now darkened and is crossed by 3 pale stripes, of which the posterior 2 may be discontinuous or connected or replaced by longitudinal bars; it is these which may simulate Arabic characters. This stage was described as *Holacanthus alternans* Cuv. & Val., and from now onwards the ground-colour becomes paler and the dark spots better defined, the pale stripes disappear anteriorly, and posteriorly still increase in number but break up into spots and verniculations, so that a fish of seven inches long has quite a different appearance, and indeed was described by Bleeker as a distinct species, *H. lepidolepis*.



The next Meeting of the Society for Scientific Business will be held on Tuesday, March 19th, 1918, at 5.30 p.m., when the following communications will be made :—

Dr. S. F. HARMER, M.A., Sc.D., F.R.S., F.Z.S.

Notes on Cetacea stranded on the British Coasts during the last Five Years.

Miss MAUDE L. W. CLEGHORN, F.Z.S., F.L.S., F.E.S.

First Report on the Inheritance of Visible and Invisible Characters in Silkworms.

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The following Paper has been received :—

Dr. BRANISLAV PETRONIEVICS.

Comparison between the Lower Jaws of the Cynodont Reptiles *Gomphognathus* and *Cynognathus*.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,  
*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
March 12th, 1918.



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ZOOLOGICAL SOCIETY OF LONDON.\*

March 19th, 1918.

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

---

The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Menagerie in the month of February, 1918.

Dr. S. F. HARMER, F.R.S., V.P., gave an account, illustrated by lantern-slides, on observations made on Cetacea stranded on the British Coast during the last five years.

A paper by Miss MAUDE L. W. CLEGHORN, F.Z.S., entitled "First Report on the Inheritance of Visible and Invisible Characters in Silkworms," was communicated.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, April 9th, 1918, at 5.30 P.M., when the following communications will be made:—

G. A. BOULENGER, LL.D., F.R.S., F.Z.S.

Exhibition of a head of the Charasinid Fish, *Hydrocyon gobiath*.

Miss J. B. PROCTER, F.Z.S.

On the Variation of the Pit-Viper, *Lachesis atrox*.

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The following Paper has been received:—

Dr. BRANISLAV PETRONIEVICS.

Comparison between the Lower Jaws of the Cynodont Reptiles *Gomphognathus* and *Cynognathus*.

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Communications intended for the Scientific Meetings should be addressed to

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*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W. 8.

March 26th, 1918.

ABSTRACT OF THE PROCEEDINGS  
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April 9th, 1918.

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

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions to the Menagerie in the month of March, 1918.

Miss CHEESMAN, Acting Curator of Insects, exhibited and made remarks on examples of the East African Plant-bug, *Itymæa nigrocincta*, sent from the Nairobi Museum.

DR. A. SMITH WOODWARD, F.R.S., V.P.Z.S., exhibited fossil rostral teeth of the Sawfishes *Eophristis* and *Pristis*, and referred to the progressive changes in the rostral teeth of the Pristidæ during geological time.

MR. G. A. BOULENGER, F.R.S., exhibited the head of an example of *Hydrocyon goliath*, Blgr., from the Congo, a fish attaining the length of four feet. The object of the exhibition was to show the enormous shark-like teeth, to which special interest attaches, owing to a similarity, recently pointed out by Dr. Eastman, to fossil teeth occurring in the Upper Cretaceous, which would appear to indicate the existence of Characinidæ in that geological epoch, a range in time which Mr. Boulenger had predicted as probable thirteen years ago.

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\* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

Mr. G. A. BOULENGER also, in the absence of the author, gave an account of a communication by Miss J. PROCTOR, F.Z.S., entitled "On the Variation of the Pit-Viper, *Lachesis atrox*." The paper dealt with the variation of the principal characters of the Central and South American Pit-Viper, *Lachesis atrox* L., of which she regarded *L. lanceolatus* Lacep. as a synonym, and *L. affinis* Gray, *jararaca* Wied, and *jararacussu* Lacerda, as varieties. She laid special stress on the different patterns of markings, discussing their evolution and regarding that shown by the more northern form, *L. affinis*, as the most primitive, from which all others could be derived.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, April 23rd, 1918, at 5.30 P.M., when the following communications will be made:—

Dr. J. A. MURRAY, F.Z.S., Acting Honorary Pathologist.

Report on the Deaths in the Gardens during the Year 1917.

Prof. WOOD-JONES, F.Z.S., Acting Honorary Prosector.

Exhibition of specimens illustrating the effects of Rickets.

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The following Papers have been received:—

Dr. BRANISLAV PETRONIEVICS.

Comparison between the Lower Jaws of the Cynodont Reptiles *Gomphognathus* and *Cynognathus*.

Miss DOROTHEA M. A. BATE.

On a new Genus of extinct Muscardine Rodent from the Balearic Islands. (Communicated by Dr. A. Smith Woodward, F.R.S., V.P.Z.S.)

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Communications intended for the Scientific Meetings should  
be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*April 16th, 1918.*





ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

April 23rd, 1918.

A. EZRA, Esq., Vice-President, in the Chair.

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The Minutes of the last Scientific Meeting were confirmed.

Mr. D. SETH SMITH, Curator of Birds, exhibited and made remarks on a Zulu Head-dress made of the plumes of the male Long-tailed Whydah, *Chere progne*.

The SECRETARY (Dr. P. CHALMERS MITCHELL, D.Sc., LL.D., F.R.S.) called attention to an advertisement that had recently appeared in the London Press, announcing Fur Sales by Public Auction about to take place in the United States. The sales in question were only examples of what took place annually in London and other important commercial centres. The numbers advertised were smaller than usual, no doubt on account of the War, but they included very large quantities of animals the extinction of which could not be far distant, unless measures were carried out to protect them. In the opinion of the speaker, which was confirmed by the Meeting, there was urgent need for drastic measures to protect Mammals. The protection of Birds appealed to popular sentiment, and was zealously advocated by many influential organisations. The danger that threatened Mammals were even greater, and, on account of their higher intelligence and more sensitive nervous organisation, the cruelty involved in the methods of hunting, trapping, and killing them was incomparably greater.

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Professor WOOD-JONES, F.Z.S., Honorary Acting Prosector, exhibited and made remarks on specimens from the Prosectorium illustrating the effects of Rickets. He also exhibited a set of anatomical preparations useful for teaching purposes, made from material obtained from the Society's Collection.

Dr. A. J. MURRAY, F.Z.S., Acting Honorary Pathologist to the Society, gave a Report, illustrated by lantern-slides, of the causes of deaths in the Gardens during the year 1917.

A vote of thanks was passed to Professor WOOD-JONES and Dr. MURRAY for their very valuable services to the Society.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, May 7th, 1918, at 5.30 p.m., when the following communications will be made:—

E. HERON-ALLEN, F.L.S., F.R.M.S., F.Z.S.

Lantern exhibition of the Arenaceous Foraminifera of the Genus *Thurammina*.

Dr. BRANISLAV PETRONIEVICS.

Comparison between the Lower Jaws of the Cynodont Reptiles *Gomphognathus* and *Cynognathus*.

Miss DOROTHEA M. A. BATE.

On a new Genus of extinct Muscardine Rodent from the Balearic Islands. (Communicated by Dr. A. Smith Woodward, F.R.S., V.P.Z.S.)

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List of Papers in hand:—

C. TATE REGAN, M.A., F.Z.S., F.R.S.

“Freshwater Fish as Food,” to be taken at the Meeting on May 28.

NOEL TAYLOR, B.Sc. London.

A Case of Hermaphroditism in a Lizard, *Lacerta viridis*.  
(Communicated by Prof. J. P. Hill, F.Z.S., F.R.S.)

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Communications intended for the Scientific Meetings should  
be addressed to

P. CHALMERS MITCHELL,  
*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*April 30th, 1918.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

May 7th, 1918.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,  
in the Chair.

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The Minutes of the last Scientific Meeting were confirmed.

Mr. R. I. Pocock, F.R.S., F.Z.S., Curator of Mammals, exhibited and remarked on a number of molar teeth of Elephants, either shed by animals in the Society's menagerie or removed after death.

Mr. E. Heron-Allen, F.L.S., F.R.M.S., F.Z.S., gave a lantern exhibition of Arenaceous Foraminifera of the genus *Thurammina*.

Dr. A. Smith Woodward, F.R.S., V.P.Z.S., in the absence of the authors, gave an account of the two following Papers:—

Dr. Branislav Petronievics.

Comparison between the Lower Jaws of the Cynodont Reptiles *Gomphognathus* and *Cynognathus*. (Communicated by C. W. Andrews, D.Sc., F.R.S., F.Z.S.)

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Miss DOROTHEA M. A. BATE.

On a new Genus of extinct Muscardine Rodent from the Balearic Islands. (Communicated by Dr. A. Smith Woodward, F.R.S., V.P.Z.S.)

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The next Meeting of the Society for Scientific Business will be held on Tuesday, May 28th, 1918, at 5.30 P.M., when the following communications will be made:—

NOEL TAYLOR, B.Sc. London.

A Case of Hermaphroditism in a Lizard, *Lacerta viridis*. (Communicated by Prof. J. P. Hill, F.Z.S., F.R.S.)

C. TATE REGAN, M.A., F.Z.S., F.R.S.

“ Freshwater Fish as Food,” illustrated by lantern-slides.

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The following Paper has been received:—

MORLEY ROBERTS.

The Function of Pathology in Evolution. (Communicated by the Secretary.)

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W. 8.

May 14th, 1918.

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

May 28th, 1918.

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

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The Minutes of the last Scientific Meeting were confirmed.

The Secretary read a list of additions to the Menagerie in the month of April 1918.

Professor J. P. HILL, F.R.S., communicated a memoir in which the author, Mr. NOEL TAYLOR, B.Sc., described a case of hermaphroditism in the Green Lizard, *Lacerta viridis*.

Mr. C. TATE RYGAN, M.A., F.R.S., F.Z.S., gave an account, illustrated by lantern-slides, of the Freshwater Fishes of Great Britain, with special reference to their value as food, and to the possibilities of increasing their economic use.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, June 11th, 1918, at 5.30 p.m., when the following communications will be made:—

A. SMITH WOODWARD, LL.D., F.R.S., V.P.Z.S.

On Two new Elasmobranch Fishes from the Upper Jurassic Lithographic Stone of Bavaria.

MORLEY ROBERTS.

The Function of Pathology in Evolution. (Communicated by the Secretary.)

---

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W. 8.

*June 4th, 1918.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

June 11th, 1918.

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

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a list of additions to the Menagerie in the month of May, 1918.

Lt.-Col. S. MONCKTON COPEMAN, M.D., F.R.S., F.Z.S., described observations he had made in Primrose Hill, London, N.W., on a colony of Burrowing Bees (*Andrena fulva*).

Lt. A. SMITH WOODWARD, LL.D., F.R.S., V.P.Z.S., gave an account of his memoir entitled "On Two new Elasmobranch Fishes from the Upper Jurassic Lithographic Stone of Bavaria."

Mr. MORLEY ROBERTS read a paper entitled "The Function of Pathological States in Evolution."

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\* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 5th, 1918, at 5.30 P.M. An announcement of the Papers to be taken will be issued at the end of October.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*June 18th, 1918.*

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## NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1917, p. . . . The Distribution is usually as follows, but on account of war conditions Parts I. & II. are published simultaneously and Parts III. & IV. will probably be similarly issued:—

Part I. issued in March.  
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" III. " September.  
" IV. " December.

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'Proceedings,' 1917, Parts III. & IV. (pp. 217-338), were published together on February 19th, 1918.

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# PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

# ZOOLOGICAL SOCIETY

OF LONDON.

1918, pp. 197-310,

WITH 2 PLATES and 30 TEXT-FIGURES.

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PRINTED FOR THE SOCIETY,  
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LONDON:  
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PATERNOSTER ROW.



L I S T  
OF THE  
COUNCIL AND OFFICERS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.  
1918.

---

Patron.

HIS MAJESTY THE KING.

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

<p>THE HON. CECIL BARING, M.A. RICHARD H. BURNE, Esq., M.A. LT.-COL. S. MONCKTON COPE- MAN, M.D., F.R.S. CHARLES DRUMMOND, Esq., <i>Treasurer.</i> ALFRED EZRA, Esq., <i>Vice-</i> <i>President.</i> CAPT. HAROLD S. FERGUSON. CAPT. HUGH S. GLADSTONE, M.A. SIDNEY F. HARMER, Esq., M.A., Sc.D., F.R.S., <i>Vice-President.</i> PROF. JAMES P. HILL, D.Sc., F.R.S. WILLIAM HUNTSMAN, Esq. SIR EDMUND G. LODER, Bt., <i>Vice-President.</i></p>	<p>PROF. ERNEST W. MACBRIDE, D.Sc., LL.D., F.R.S., <i>Vice-</i> <i>President.</i> COL. SIR A. HENRY McMAHON, G.C.M.G., K.C.I.E., G.C.V.O., C.S.I. P. CHALMERS MITCHELL, Esq., C.B.E., M.A., D.Sc., LL.D., F.R.S., <i>Secretary.</i> ADRIAN D. W. POLLOCK, Esq. THE LORD QUEENBOROUGH. THE MARQUESS OF SLIGO, F.S.A., <i>Vice-President.</i> AUBYN TREVOR-BATTYE, Esq., M.A. ANTHONY H. WINGFIELD, Esq. A. SMITH WOODWARD, Esq., LL.D., F.R.S., <i>Vice-Pre-</i> <i>sident.</i></p>
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PRINCIPAL OFFICERS.

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*Secretary.*  
R. I. POCKOCK, F.R.S., F.L.S., *Curator of Mammals and*  
*Resident Superintendent of the Gardens.*  
D. SETH-SMITH, *Curator of Birds and Inspector of Works.*  
LIEUT. EDWARD G. BOULENGER, *Curator of Reptiles.*  
Prof. H. MAXWELL LEFROY, *Curator of Insects.*  
JOHN BARROW, *Accountant.*  
W. H. COLE, *Chief Clerk.*

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PROCEEDINGS  
OF THE  
GENERAL MEETINGS FOR SCIENTIFIC BUSINESS  
OF THE  
ZOOLOGICAL SOCIETY  
OF LONDON.  
1918.

PARTS III. & IV.  
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MARCH 1919.

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# ZOOLOGICAL SOCIETY OF LONDON.

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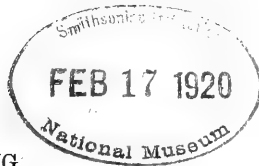
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FOR

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# ZOOLOGICAL SOCIETY OF LONDON.

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The "Proceedings" for each year are issued in four parts, paged consecutively, during the months of March, June, September, and December\*. From January 1901 they have been issued as two half-yearly volumes, indexed separately.

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\* On account of War conditions, the Parts I. & II. and Parts III. & IV. have been issued together, but it is hoped that normal publication will soon be restored.

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**ZOOLOGICAL RECORD.**—Vol. 53, containing literature relating chiefly to the year 1916, was delayed owing to the War, but is nearly ready. Vol. 54, for the year 1917, is being prepared as usual.

P. CHALMERS MITCHELL,

*Secretary.*

Regent's Park, London, N.W. 8.  
March, 1919.

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## PAPERS.

10. Comparison between the Lower Jaws of the Cynodont Reptiles *Gomphognathus* and *Cynognathus*. By Dr. BRANISLAV PETRONIEVICS\*.

[Received March 6, 1918 : Read May 7, 1918.]

(Text-figures 1-8.)

Being occupied at the end of last year (1917), when in London, with the problem of the double articulation of the lower jaw, which is to be expected in the direct reptilian ancestors of the Mammals, I was led to examine the lower jaws in the specimens of the Theriodont Reptiles that are preserved in the Natural History Museum. One of the skulls in question, that described by Seeley in 1895 as one of the two specimens of *Gomphognathus* from Lady Frere (S. Africa), struck me on account of the strange appearance of its lower jaw. On comparing carefully this latter with the lower jaw in *Cynognathus crateronotus*, described by Seeley in 1895, I have arrived at the conclusion that the difference between them is a very considerable one, and that in the lower jaw of *Gomphognathus* we have the greatest known development of the dentary bone in any theriodont reptile, a development representing the initial state of the double articulation, if not the actual double articulation itself.

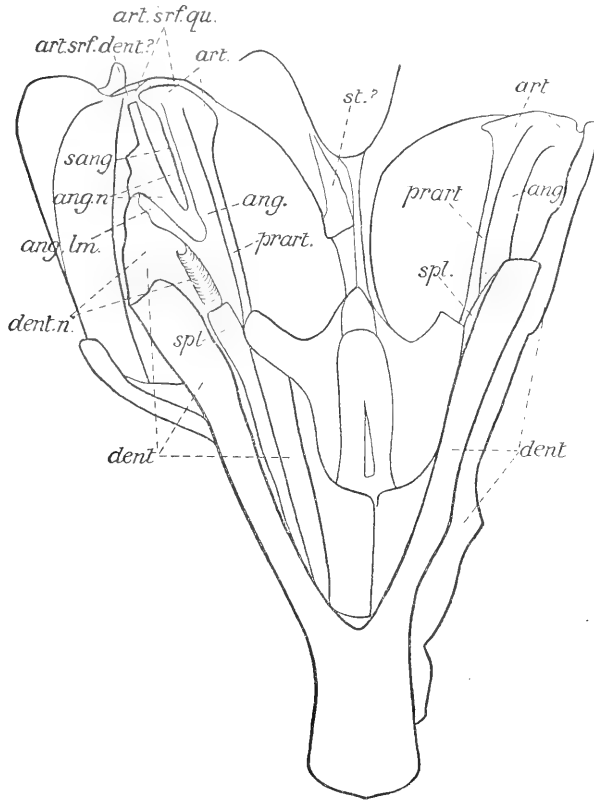
The main points of difference in the lower jaws of *Gomphognathus* and *Cynognathus* are the following:—

1. In *Gomphognathus* the articular bones are placed inside and laterally at some distance from the dentary bone, whilst in

\* Communicated by Dr. C. W. ANDREWS, F.R.S., F.Z.S.

*Cynognathus* they are attached closely to the dentary bone (comp. the right ramus of the lower jaw of *Gomphognathus* in text-fig. 1 with the right ramus of *Cynognathus* in text-fig. 7).

Text-figure 1.



*Gomphognathus*: inferior surface of skull and mandibles.  $\times \frac{1}{2}$ .

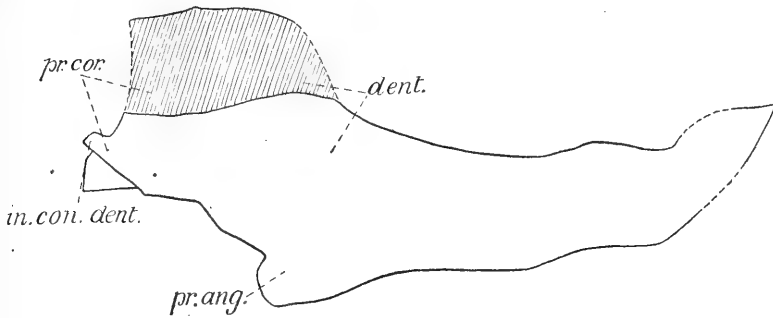
ang.; angular.  
 ang.lm.; angular lamina.  
 ang.n.; angular notch.  
 art.; articular.  
 art.srf.dent.?  
 art.srf.qu.; articular surface of quadrate.  
 dent.; dentary.  
 dent.n.; dental notch.  
 prart.; prearticular.  
 sang.; supra-angular.  
 spl.; splenial.  
 st.?  
 stapes.

2. In *Gomphognathus* the posterior end of the dentary bone goes almost as far back as the articular bones (comp. text-figs. 2

and 4), whilst in *Cynognathus* the articular goes farther back than the dentary\* (and it does this more externally than internally—comp. text-fig. 5 and text-fig. 6, in which the length of these portions of the dentary bone is the same).

3. In *Gomphognathus* the posterior edge of the dentary bone covers externally the articular bones almost entirely (comp. text-figs. 2 and 4), whilst in *Cynognathus* the hind part of the articular bones is clearly visible and considerably external to the dentary bone (text-fig. 5).

Text-figure 2.



*Gomphognathus*: right ramus of lower jaw, external view.  $\times \frac{1}{2}$ .  
Shaded part covered with matrix.

*dent.*; dentary.  
*in.con.dent.*; incipient condyle of dentary.  
*pr.cor.*; coronoid process of dentary.  
*pr.ang.*; processus angularis.

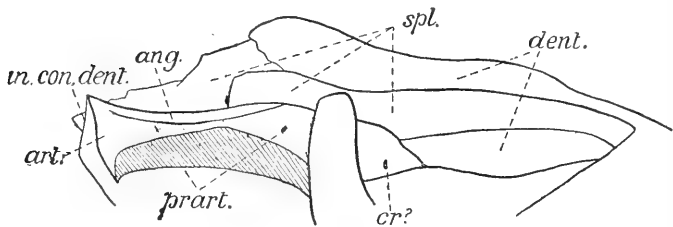
In connexion with the first point we must add that Seeley's contention (comp. Seeley (1), 1895, p. 26), that the articular bones of *Gomphognathus* were "somewhat displaced, being drawn away laterally from the edge of the dentary bones," must be wholly rejected, because the lateral distance of these bones from the dentaries is exactly the same on both sides (comp. text-fig. 1), and the bony connexion of the almost horizontally situated reflected angular lamina, which is well preserved on the left side, is such (comp. text-fig. 1) that no doubt about the naturalness of its position can be entertained. The angular notch limited by this lamina is a large one, and comparatively large, also, is the notch lying in front of it, between the dentary on the one side, and angular and splenial on the other (comp. text-fig. 1; the hind part of the splenial is preserved only on the right side). In *Cynognathus* the reflected angular lamina, whose position is almost a vertical one, is preserved only partially (comp. text-fig. 6

\* In *Cynognathus platyceps* the hind end of the dentary is more prolonged backwards than in *Cynognathus crateronotus*, but it did not reach the squamosal. Comp. Seeley (2), 1895, fig. 29, p. 135, and Broom, 1904, text-fig. 100, p. 496.

and text-fig. 7), but it must have been relatively smaller than in *Gomphognathus* (comp. text-fig. 6).

In *Gomphognathus* there is a bony connexion between the articular bones and the dentary (whose thickness could not be established, but which probably is not a considerable one), this bony connexion, forming the roof of the angular notch, being well preserved and visible on the left side (comp. text-fig. 1). The

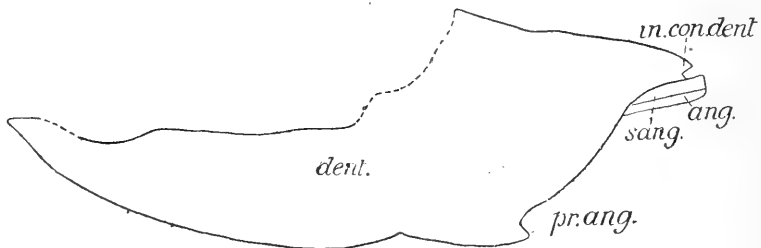
Text-figure 3.



*Gomphognathus*: right ramus of lower jaw, internal view.  $\times \frac{1}{2}$ .  
Shaded part covered with matrix.

*ang.*; angular.  
*art.*; articular.  
*cr.?*; coronoid.  
*dent.*; dentary.  
*in. con. dent.*; incipient condyle of dentary.  
*prart.*; prearticular.  
*spl.*; splenial.

Text-figure 4.



*Gomphognathus*: left ramus of lower jaw, external view.  $\times \frac{1}{2}$ .

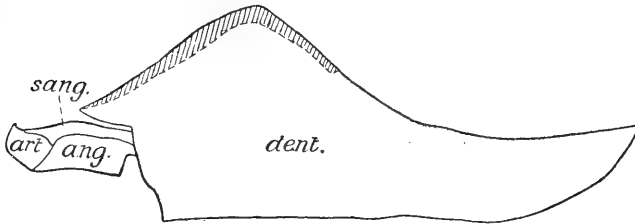
*ang.*; angular.  
*dent.*; dentary.  
*in. con. dent.*; incipient condyle of dentary.  
*pr. ang.*; processus angularis.  
*sang.*; supra-angular.

sutures between the articular bones are not to be traced in their whole length in *Gomphognathus* (comp. text-figs. 3 and 4), while they are clearly visible in *Cynognathus* (comp. text-figs. 5, 6,

and 7): it is probable that the mutual limits of these bones are in both cases the same. The suture between the articular and prearticular is obliterated in both cases.

As to the second point. The coronoid process of the left dentary in *Gomphognathus* is only partially preserved (text-fig. 4),

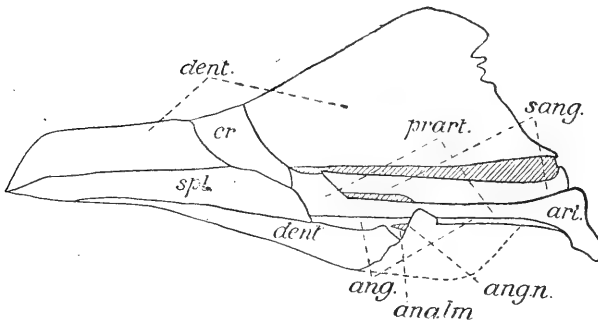
Text-figure 5.



*Cynognathus crateronotus*: right ramus of lower jaw, external view.  $\times \frac{1}{4}$ .  
Shaded part covered with matrix.

ang.; angular.  
art.; articular.  
dent.; dentary.  
sang.; supra-angular.

Text-figure 6.



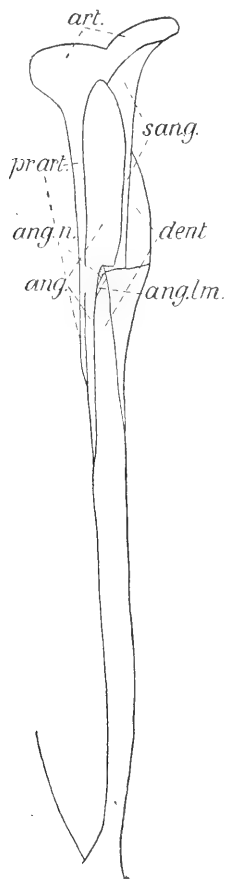
*Cynognathus crateronotus*: right ramus of lower jaw, internal view.  $\times \frac{1}{4}$ .  
Shaded part covered with matrix.

ang.; angular.  
ang.lm.; angular lamina.  
ang.n.; angular notch.  
art.; articular.  
cr.; coronoid.  
dent.; dentary.  
prart.; pre-articular.  
sang.; surangular.  
spl.; splenial.

whilst the right dentary shows this process in its entirety, and although the upper part of it is covered with matrix, its upper edge is clearly visible from above (comp. text-fig. 2). As the hind

end of this edge lies in direct prolongation of the lower part of the posterior edge of the coronoid process uncovered by the new

Text-figure 7.



*Cymognathus crateronotus*: right ramus of lower jaw,  
inferior surface.  $\times \frac{3}{2}$ .

*ang.*; angular.  
*ang.lm.*; angular lamina.  
*ang.n.*; angular notch.  
*art.*; articular.

*dent.*; dentary.  
*prart.*; pre-articular.  
*sang.*; surangular.

preparation, so the naturalness of this posterior edge and consequently of the prominent backward condylar prolongation of the right dentary (text-fig. 2) cannot possibly be doubted. As this



condylar prolongation is damaged beneath and at its posterior end, whose transverse section shows a triangular shape, the articular surface of the condyle cannot be certainly established. On the left side (text-fig. 4) only a part of the prominent backward condylar prolongation is preserved, so that on the outer side of the left jaw the hind end of the articular bones seems to go farther back than the hind end of the dentary, while on the right side the reverse seems to take place. But the hind end of the articular bones on the right side is evidently damaged, so that it is not impossible that the dentary reached its far back as the articular bones, and that a double articulation really did take place in *Gomphognathus*\*.

The possibility of the double articulation in *Gomphognathus* follows also from the fact of two different articular surfaces preserved in our specimen on the left side (comp. text-fig. 8). A comparison with the corresponding region in the type skull of *Diademodon* described by Watson (comp. fig. 3 in Watson 1911) shows (comp. also fig. 8 in Watson 1911 representing the quadrate in *Gomphognathus polyphagus*) that only the triangular hollow on the front face of the squamosal, in which the missing quadrate was received, is preserved in our specimen on the left side together with the two notches which received the two processes of the quadrate (these notches being filled with matrix). As there is in our specimen on the left of these notches and in a more forward position another flat surface on the squamosal, which lies in the same direction as the hind end of the dentary (comp. text-figs. 1 and 8), it is quite possible that into this flat surface was received the hind end of the condylar prolongation of the dentary. Indeed, as the articular end in our specimen did not reach the squamosal on the external side of the dentary as in *Gomphognathus kannemeyeri* (comp. fig. 1 in Seeley (1) 1895, p. 5, and especially fig. 2 in Broom, 1904, pl. xxxv.), or as in *Cynognathus* (comp. fig. 8 in Seeley (2) 1895, p. 81, and fig. 1 in Broom, 1904, pl. xxxv.), so the flat surface in question could be reached in our specimen only by the hind end of the dentary (supposing that it was reached by the lower jaw at all).

The third point is a corollary of the second. As the posterior edge of the left dentary of *Gomphognathus*, extending from the angle up to the condylar prolongation, is almost undamaged (comp. text-fig. 4), whilst the corresponding posterior edge of the right dentary is not inconsiderably damaged, the difference in the extent of the covering of the articular bones by the dentary from outside in *Gomphognathus* and *Cynognathus* is strikingly shown

\* The length of the two dentaries of *Gomphognathus*, as they are preserved, is almost the same (149 mm.), when measured from the hind point of their symphysis. But a certain asymmetry of them is not improbable, because when we compare the length of the upper edge of the left dentary with the corresponding line in the coronoid process of the right dentary, we find the first to be 63 and the second 66 mm:

when text-fig. 4 is compared with text-fig. 5. So that, although the hind end of the dentary in *Cynognathus* goes farther back on the inner than on the outer side, it is clear from this comparison that it did not reach the squamosal and that the possibility of an incipient condyle of the dentary in *Cynognathus* is excluded.

Text-figure 8.



*Gomphognathus*: articular surface of the left squamosal. Nat. size.

*art.*; articular.

*art.sf.dent?*; probable articular surface of dentary.

*art.srf.qu.*; articular surface of left quadrate.

*dent.*; dentary.

The inner side of the jaws shows the same bones in both cases (comp. text-fig. 3 with text-fig. 6). The comparison shows that the splenial goes farther back in *Gomphognathus* than in *Cynognathus*.

The essential difference above mentioned that exists in respect to the relation of the articular bones and the hind end of the dentary to the squamosal between the *Gomphognathus*-skull of our specimen and the other specimens known under the names of *Gomphognathus* and *Diademodon* (a general survey of which has been given by Watson, 1911, p. 327 seq.) suggests the well-founded supposition that our specimen is *generically* different from all the other specimens of the same kind, which are all essentially similar in the above point. Beyond that, a comparison between the lower jaw of *Gomphognathus kannemeyeri* (figured by Seeley (1) 1895, fig. 2, p. 8) and of *Diademodon mastacus* (figured by Broom, 1905, fig. 1, pl. x.) shows that they are similar in shape, while the shape of the lower jaw of our specimen (comp. text-fig. 2), especially the shape of its coronoid process, is very different. So that I agree with Watson in his identification of *Gomphognathus* and *Diademodon* for all the other specimens

except the one in question, which alone has to retain the old generic name of *Gomphognathus*\*.

Having finished the comparison between the lower jaws of *Gomphognathus* and *Cynognathus*, I will add here some general remarks concerning the origin of the mandibular articulation and the origin of the Ossicula auditus in Mammals, inasmuch as these two very closely connected problems receive new light from our comparison.

That the mandibular articulation in the most primitive mammals (the hypothetical order Promammalia of Gregory—comp. its definition in Gregory, 1908, p. 164) was a double one, our *Gomphognathus*-skull puts this point beyond question, as it shows that in this advanced Theriodont the dentary almost if not actually reached the squamosal. That the dentary articulation was situated in the same plane with the articular articulation, and *not in front*, is also a point put beyond question. That the two articulations have worked closely together and practically as *one* articulation, is also very probable (on these three points in primitive Mammals comp. Gregory, 1908, pp. 135–138).

Our *Gomphognathus*-skull shows also the way in which the cotylus and condylus of the dentary articulation in Mammals have probably arisen. As the articular surface of the dentary situated on the squamosal is a smooth plane surface in our specimen, so we have to suppose that also the corresponding surface on the condylar prolongation of the dentary was a smooth plane surface. Consequently we may suppose that this latter surface was a mechanical result of the lateral movements of the lower jaw, through which the hind end of the dentary (*i. e.* the condylar prolongation of its ascending process) was brought in contact with the squamosal. The primitive condition of the dentary articulation in Mammals would, according to this supposition, be a simple syndesmosis, as we find such a syndesmosis secondarily in *Tatusia hybrida* among living forms. The different forms of the mandibular articulation in higher Mammals would then be considered as further mechanical results of jaw-movements according to the mechanical theory of normal articulations of Fick †, Tornier ‡, and Cope §.

Still greater is the importance of our specimen in respect to

\* Between the skulls of *Cynognathus* on the one side and the skulls of *Diademodon* (and perhaps also of *Gomphognathus*) on the other, I find an essential difference in a separate ossification that exists in front of the epipterygoid and below the postfrontal bone in the British Museum specimen R 3587 of *Diademodon*-skull (described by Watson, 1911, who has not recognized its separate nature), an ossification that I suppose to be an incipient orbitosphenoid. The front edge of the epipterygoid bone in *Cynognathus crateronotus* is damaged, but the under surface of the postfrontal bone is so smooth, that a corresponding separate orbitosphenoidal ossification is a very improbable one (comp. fig. 5 in Watson, 1911, p. 300, with fig. 6, p. 76, in Seeley (2), 1895).

† Comp. R. Fick, "Ueber die Form der Gelenkflächen" in 'Archiv für Anatomie und Physiologie,' 1890, p. 391.

‡ Comp. J. Tornier, "Das Entstehen der Gelenkformen" in 'Archiv für Entwicklungsmechanik,' 1897, pp. 124–158, 224–268, 307–346.

§ Comp. E. Cope, 'Primary Factors of Organic Evolution,' 1904, p. 283 seq.

the question of the origin of the Ossicula auditus in Mammals. Our specimen shows the beginning of the separation of the articular bones from the dentary, a state of things that the classical theory of the origin of Mammalian ossicula auditus necessarily presupposes. As we have seen, the bony connexion between the articular bones and the dentary is a relatively much reduced one, especially in the hind part (comp. text-fig. 1). The fact that the quadrate has been lost in our specimen on the left side, where it might have been preserved, shows that it was probably only insufficiently fixed in the corresponding groove of the squamosal. The movable condition of the quadrate, that the classical theory presupposes, is here, as it seems, also in its beginning. And finally we find in our specimen on the left side a displaced bone (comp. text-fig. 1, *st.*), that is, according to another specimen, to be considered as the bone connecting the region of the fenestra vestibuli with the quadrate, consequently as the stapes or the columella (on this bone comp. Seeley (1 1895, p. 25, Broom 1904, p. 491, who considers it in *Cynognathus platyceps* wrongly as a tympanic ring, and especially Watson, 1911, p. 324).

From the above it follows that we have in *Gomphognathus* realized all the elements that constitute the morphologically initial state in the evolution of the mammalian ossicula auditus, and we have only to suppose that in the descendants of the corresponding relatives of *Gomphognathus* (the direct ancestors of Mammals) this state of things increased in the direction of a further separation of the stapes-quadrate-articular bone chain from the squamosal and dentary bones, in order to reach the final state, when in true Mammals the former were transformed into the ossicula auditus. Into the question how this transformation took place, and into the corresponding question of the homologies, I cannot enter here (comp. the Literature, Nos. 7-11). I mention only that the tympanic membrane of the Mammals is most probably a neomorph (and I agree in this point with Gaupp—comp. Gaupp, 1911, p. 641 seq. and p. 659, while in many other conclusions reached by Gaupp—comp. p. 633 and p. 656—I must disagree), and that the manubrium mallei in Mammals cannot be homologized with the extra-columella of the Reptiles, as Kingsley does (comp. Kingsley, 1900, p. 232 seq.).

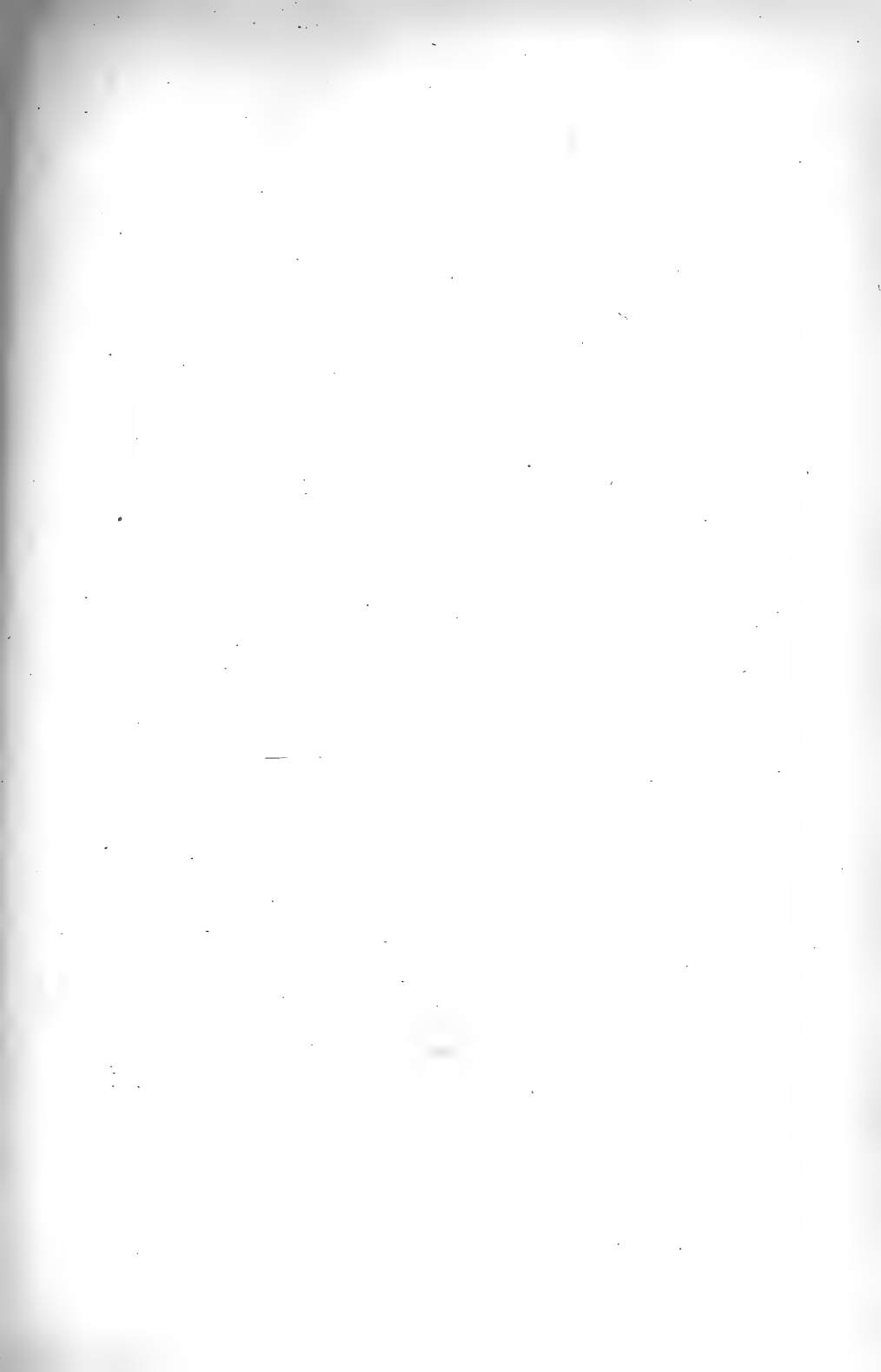
In finishing this paper I desire to express my thanks to Dr. Smith Woodward and Dr. Andrews, of the British Museum (Natural History), for the loan of the new preparations (executed by Mr. Hall), and to Dr. Andrews for some valuable help.

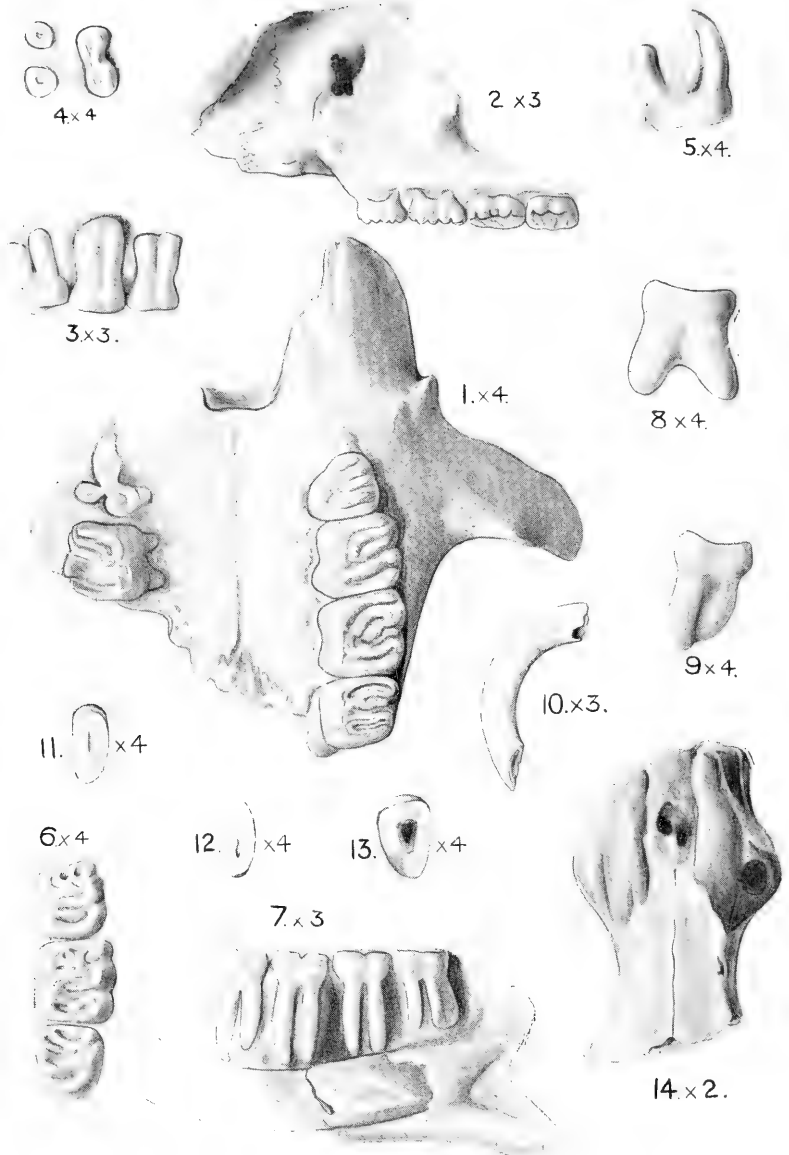
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HYPNOMYS, gen. nov. et LEITHIA.



11. On a new Genus of Extinct Muscardine Rodent from the Balearic Islands. By DOROTHEA M. A. BATE\*, Hon. M.B.O.U.

[Received April 9, 1918: Read May 7, 1918.]

(Plate I.† and Text-figs. 1, 2.)

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<i>H. mahonensis</i> , sp. n. ....		218
<i>H. morpheus</i> , sp. n. ....		219

During a second visit to Mallorca in 1910 in search of ossiferous deposits a few rodent remains were obtained; the following year further researches were carried out in Menorca by means of a grant from the Trustees of the Percy Sladen Memorial Fund, and here similar remains were found to be somewhat more plentiful, occurring in several fissures in the Miocene limestone. A description of the deposits from which the collection was obtained has already been published‡. A first cursory examination of the specimens led me to suppose that they represented large forms of *Eliomys* § or *Leithia* ||. Since then a number of specimens from Menorca have been developed from the hard matrix in which they were embedded, and all have been carefully examined, with the result that it is found that they cannot be included in any genus with which I have been able to compare them. The examples from the two islands differ considerably in size, those from Menorca being the larger, and they are probably specifically distinct: in this connection it is interesting to remember that, after the examination of a very large quantity of material, a similar variation in size was found to obtain in *Myotragus* ¶. This seems to point to a longer period of isolation in Menorca, the most easterly and probably the first of the group to be separated from the mainland.

All the remains obtained are now in the collection of the British Museum (Natural History). No complete skulls and only a few limb-bones were procured, but it will be seen from the descriptions of the specimens given below that the Balearic genus should undoubtedly be included in the Muscardinidae. The specimens to be described are intermediate in size between the largest recent forms and the extinct *Leithia* from Malta, and show a number of points of resemblance both to the recent *Eliomys* and to the Maltese *Leithia*, but at the same time differ to an equal extent from both these genera. The

\* Communicated by Dr. A. SMITH WOODWARD, F.R.S., F.Z.S.

† For explanation of the Plate see p. 222.

‡ Geol. Mag. [6] vol. i. 1914, pp. 337-45.

§ *Ibid.* p. 100.

|| Proc. Zool. Soc. 1916, p. 424.

¶ See Andrews, Phil. Trans. Roy. Soc. ser. B, vol. 206, 1915, p. 301.

range of species in neighbouring islands is always of interest, which may perhaps make it worth mentioning here the present-day distribution of *Eliomys* in the Balearics. Mr. Oldfield Thomas has described *E. gymnesicus*\* from Menorca, a species smaller than, though similar in coloration to, *E. quercinus*, which, in spite of this, he believes to be most nearly allied to the Southern forms. In an earlier paper † the same author mentions that this animal is also well known in Mallorca but is said not to occur in Ibiza. Unfortunately I have not seen one from the larger island, but in the British Museum there are now several specimens from the small island of Formentera to the south-west of Ibiza, which prove to belong to the large form *E. lusitanicus* which is found on the neighbouring mainland of Spain.

Remains of Muscardinidæ are known only from European deposits, and occur from Miocene times. *Eliomys* itself is represented by *E. pomeli* in the Lower Miocene of Allier, and by *E. hamadryas* in the Middle Miocene of La Grive St. Alban and Steinheim. Both species are of small size, and from the mandible do not show any close affinity to the remains which form the subject of this note, than which they would both appear to be already more highly specialised. In the British Museum there are two mandibular rami supposed to represent an *Eliomys* from the Pleistocene of Malta (B.M. 49342c and 49351)‡. These are considerably more robust than in any recent member of the genus, and are found to resemble in shape the Mallorean specimens and to be only slightly inferior in size, although the length of the alveolar area is considerably less. Unfortunately none of the cheek teeth are preserved, and the formation of the roots cannot always be satisfactorily deduced from an examination of the alveolar cavities, though in one of these specimens (B.M. 49351) it seems that in the first and second molars the posterior roots had become confluent as in the genus now to be described. These specimens seem worth mentioning as suggesting a possible extension of the known distribution of the Balearic dormouse. So far as I am aware, no other rodent remains have been described from the Balearics, although so long ago as 1855 De la Marmora wrote § that he had observed indications of an ossiferous breccia in the hill of Belver near Palma, in which he had seen a bone which seemed to belong to a *Lagomys* or to a rabbit.

The following description of the most important specimens obtained may be taken as applying to the genus so far as known at present. It is proposed that the genus be known as

#### HYPNOMYS, gen. nov.

Skull, mandible, and limb-bones as in *Eliomys* but more robust; interorbital region wide and anterior portions of frontals greatly

\* Ann. Mag. Nat. Hist. ser. 7, vol. xi. 1903, p. 494.

† Proc. Zool. Soc. 1901, p. 41.

‡ Cat. Foss. Mamm. Brit. Mus. Pt. i. p. 225 (1885) (as *Myoxus* sp.).

§ Mem. Accad. Sc. Torino (ser. 1), vol. xxxvii. 1855, p. 59.

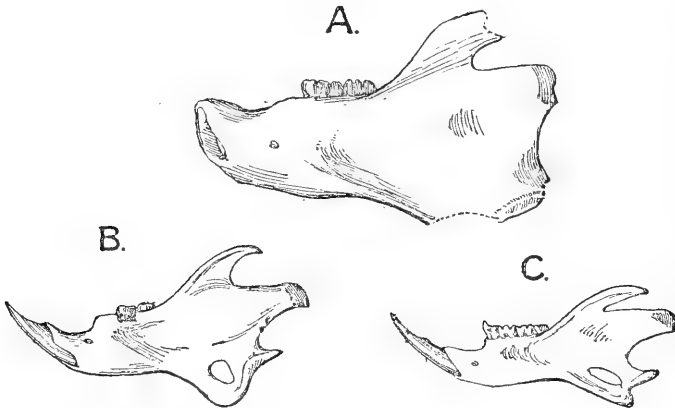
expanded. The infraorbital foramen opens anteriorly and the outer wall of the infraorbital canal is very robust with a wide base. The anterior palatine foramina penetrate for some distance the palatal plate of the maxillæ which forms the greater portion of the palate. The angle of the mandible is perforated. Dental formula i.  $\frac{1}{1}$ , pm.  $\frac{1}{1}$ , m.  $\frac{3}{3}$ , molariform premolars and molar crowns sub-quadrate in shape with low transverse ridges. Upper molars with one large wide internal and two smaller external roots. In the first and second lower molars the two posterior roots may be confluent for the greater part of, or for their entire length; the last molar has two anterior and one large posterior root. Tibia and fibula joined.

*Skull.*—The skull is represented only by some few fragmentary specimens none of which show the posterior portion, that is to say behind the frontals. An isolated and imperfect auditory bulla (B.M. M 1167I) was obtained which agrees in form and in the shape and position of the meatus with the corresponding bone in *Dyromys*. So far as available specimens show, the skull in general resembles and may be compared with that of *Eliomys*, which for our present purpose will be taken in a broad sense and to include *Dyromys*. Even the smaller examples (those from Mallorca) are larger and comparatively, as well as actually, more robust than *E. lusitanicus*, which is the largest of the recent species of that genus. Viewed from above, the nasals are seen to be practically flat and about the same width throughout their length. The interorbital portion of the frontals is wide and smoothly flattened and is defined by sharp lateral edges; a measurement taken at the narrowest point is nearly half the antero-posterior length of the nasals in *Hypnomys*, whereas in *E. lusitanicus* it is not quite a third. Anteriorly the frontals expand rapidly by a smooth swelling and attain to a great width—about twice that of the interorbital region—where they are joined by the nasals and the nasal processes of the maxillæ. This expansion is caused by the very large size of the olfactory cavities (Pl. I. fig. 14). There is a fine but distinct ridge on the dorsal aspect of the maxilla at the upper root of the zygoma from where the skull narrows rapidly to form the snout. The premaxillæ are robust, slightly inflated dorso-anteriorly as in *Eliomys*, and deep dorso-ventrally, the rostrum being stouter than in *E. lusitanicus*. The infraorbital region is not very well preserved in any of the Balearic specimens, but sufficient is shown by two or three examples to demonstrate that in this respect *Hypnomys* shows no close resemblance whatever to either a typical Murine such as *Rattus* or to typical Sciurines such as *Sciurus* or *Xerus*. Though showing more general resemblance, this portion of the skull in the Balearic genus still differs somewhat from that of any other of the Muscardinidæ with which I have been able to compare it; in some respects it seems to agree with that of *Leithia*, though unfortunately all the anterior portions of skulls of this last in

the British Museum are either very imperfect or else considerably crushed and distorted. The infraorbital foramen opens anteriorly and, as well as can be seen in the type specimen of *Hypnomys mahonensis* (Pl. I. fig. 2), it has a greatest length of about 3 mm. and occupies a median position between the two roots of the zygomatic process of the maxilla. The lachrymal foramen shows an extension of similar length, but ovoid in form, in front of the infraorbital foramen much as in *Muscardinus*, and without the lower lateral expansion seen in *Eliomys*. The outer wall of the infraorbital canal is very robust, broadly concave anteriorly, with a distinct outstanding point in front of its base, which is wide owing to the hinder border being produced outwards from above the first molar.

The anterior palatine foramina start a short distance behind the incisors and penetrate the palatal plate of the maxillæ for some distance, their extent being comparable with that obtaining in *Eliomys*. The palate (Pl. I. fig. 1) is not completely preserved in any of the specimens, but can be seen to be wide and gently concave and chiefly composed of the palatal plate of the maxillæ, which extends posteriorly about as far as the hinder border of the second molar. The palatal plate of the palatines is hardly shown but can certainly have formed only an insignificant portion of the palate.

Text-figure 1.



Left mandibular rami of:—

- A. *Leithia melitensis* (B.M. 49342 D),
- B. *Hypnomys morpheus* (B.M. M 11697),
- C. *Eliomys lusitanicus* (recent specimen).  $\times 1\frac{1}{2}$ .

*Mandible*.—In general plan the mandible (text-fig. 1, B) is essentially as in *Eliomys* (text-fig. 1, C), from which it yet differs strikingly, although this difference is easier to observe than to describe. That of *Eliomys* may be said to have an aspect of

attenuation, its posterior portion particularly being very slight and the cheek-teeth closely crowded together. This applies also to the skull, though perhaps to a lesser degree. The mandible of the Balearic genus is altogether more robust, and gives the impression of being possibly less highly specialised. The angle of the jaw is perforated, and also resembles in shape that of *Eliomys*, but compared with this last the coronoid process originates further forward and rises more abruptly; it tapers to a slender point but is comparatively shorter and the space between it and the condyle less deeply excavated: this last also applies to the region between the condyle and the highest point of the angle, causing the hinder portion of the jaw to be more solid owing to this comparatively greater extent of bone. The articulating surface of the condyle is strongly marked. The symphyseal region and that between it and the cheek-teeth are likewise robust. The incisor extends considerably behind and rises above the cheek-teeth row, causing a marked protuberance on the outside of the jaw at the base of the coronoid process, and the inferior dental foramen occupies a correspondingly high and backward position.

*Teeth.*—The dental formula is the same as that of other of the Muscardinidæ, that is to say, i.  $\frac{1}{1}$ , pm.  $\frac{1}{1}$ , m.  $\frac{3}{3}$ . The incisors are of medium size, with the anterior band of enamel smooth and stained the characteristic orange-yellow colour. The upper incisor originates above and just in front of the premolar; its inner surface (Pl. I. fig. 10) is flat and the outer gently rounded, this being also the case in the corresponding tooth of the lower jaw. Both are considerably compressed laterally with the antero-posterior thickness much greater than the lateral width, this being nearly double in the lower teeth. Their transverse sections (Pl. I. figs. 11 & 12) are more or less elliptical in shape, thus differing from those for instance of *Eliomys*, *Glis*, and *Leithia*, in which the section forms practically an isosceles triangle with the anterior face as the shorter base (Pl. I. fig. 13). There is naturally a corresponding difference in the shape of the worn surfaces of the teeth. As Mr. Hinton has pointed out to me, these differences in the form and proportions of the incisors are of importance as indicating probable differences in the modes of life in these various genera.

It is interesting to find that an examination of the microscopic structure of the enamel in the incisors of *Hypnomys* seems to bear out the conclusions independently arrived at from a general study of its remains. Mr. Thornton Carter very kindly undertook the task of making this examination, and allows me to include his report of his investigations, which is as follows:—

“The structure of the enamel of the incisors in the specimens from Menorca and Mallorca is identical with that of *Leithia melitensis*.

“The ‘pattern’ is distinctive and presents characters which would seem to place it between Sciuridæ and Myoxidæ. In

longitudinal sections the enamel rods (or fibres, as Sir John Tomes designates them in his classical memoir) leave the surface of the dentine with a slight curve and then proceed outwards, slightly flexuous, at an angle of about  $70^{\circ}$  with the dentinal surface for about half the thickness of the enamel, where they bend sharply and abruptly to proceed in a straight course to the surface.

“There is appearance of serrations of the margins such as is usually seen in the Dormice.

“Thus the course of the rods is as in *Myoxidæ*, whilst their form is as in *Sciuridæ*.

“In transverse section alternate groups of rods cross one another at an angle of about  $120^{\circ}$ , and when half-way through turn sharply outwards and run parallel out to the enamel surface which they reach at right angles, the pattern assumed resembling, though not identical with, that seen in a transverse section of the incisor of *Eliomys*.”

While the palate is almost uniform in width, the rows of cheek-teeth appear curved owing to their inner borders being practically in a straight line, so that all the differences in the sizes of the teeth, especially that of the premolar, affect only the outer border of the rows, which thus have a curved outline. The plane of wear of the premolar is almost horizontal, while that of the molars lies at a considerable angle, the inner border being the higher; this character will be referred to again later. Some scarcely worn upper molars are slightly concave and their enamel ridges incline towards being cuspidate, but in most of the specimens obtained the worn surfaces of the crowns are nearly flat. The molariform upper premolar is bluntly triangular in outline and the molars subquadrate in shape, the second being very little larger and the third not much smaller than the first. In the above characters these teeth somewhat resemble those of *Leithia*, those of *Eliomys* differing markedly in the concavity and greater comparative width of their crowns.

In the Balearic molars the ridges are low, and in those of aged individuals, of which a number were obtained, these become almost entirely worn away. In little-worn specimens (Pl. I. fig. 1) it can be seen that in each of the upper cheek-teeth the crown is crossed by four complete and one incomplete transverse ridges, with the addition of one or more further incomplete ridges in the second and third molars. The second complete ridge in the first and second molars runs from the inner border in an anterior direction for more than half its distance before turning to reach the outer margin. The two posterior complete ridges run more or less parallel with the hinder border of the teeth, and it is in the space left between the complete ridges that the incomplete ones occur. The inner edge of the crown surface almost invariably remains unbroken, while the outer border is cut by the valleys between the ridges. In much worn teeth there is found a confluent valley alongside the inner enamel border of

the tooth for the whole of its distance; this condition of wear is also seen for instance in *Leithia*, *Eliomys*, and *Xerus*. Apart from size, the upper molars of *Leithia* chiefly differ from those of *Hypnomys* in their transverse ridges being considerably higher and more sharply defined, and in the complete ones in the first and second molars originating at the postero-internal border of the crown as already described and figured by Mr. Lydekker\*.

Of the lower cheek-teeth the premolar is the smallest and is obtusely triangular in shape; the third molar is somewhat larger with a rounded posterior margin, although the crown has a tendency to become squarer in outline when much worn. The first and second molars are the largest of the series, almost equal in size and in shape quadrate, or with the antero-posterior length slightly greater than the width. The number of ridges appears to be much the same as in the upper cheek-teeth, though they become broken up earlier and into a greater number of incomplete ridges. In a moderately worn specimen (B.M. M 11674, Pl. I. fig. 6) the first and second molars seem to have three complete ridges, two distinct incomplete ones running half-way across the crown from opposite sides and a shorter one coming in from the antero-external corner, while the antero-internal area is broken up into several rather indistinct loops. The third molar shows four complete ridges and two small accessory ones. In the case of aged individuals the confluent worn surface is of course along the external border of the crown, it being on the internal side in the upper cheek-teeth. In less worn specimens this external enamel border is interrupted at two points, and the enamel between and on either side of these channels, owing to its being slightly folded over, is at this stage of wear more massive than in other parts of the ridges.

The number, position, and conformation of the roots of the cheek-teeth in rodents form a subject of considerable interest and importance, and it is one that has received a good deal of attention from investigators, notably Schlosser † and, later, Dr. Forsyth Major ‡. The specimens under discussion are no exception in this respect, for their molar roots are unlike those of any Pleistocene or recent genus with which I have been able to compare them with the single exception of *Leithia*, and that only in the case of the upper molars. It may be mentioned that I have not found this character previously noted in the descriptions of the Maltese genus. The alveolar formula can be most easily realised by reference to the accompanying text-figure (text-fig. 2), but at the same time it should be borne in mind that such a formula alone is of very little value for purposes of comparison. The present examples are a case in point, as, for instance, the first and second upper molars of *Eliomys* and *Glis* are three-rooted, as in

\* Proc. Zool. Soc. 1895, pp. 861-3, text-fig. 1.

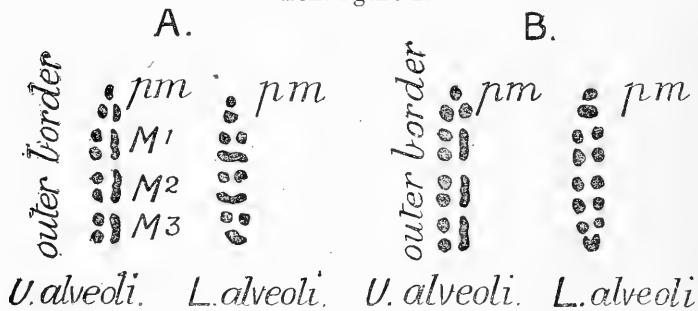
† 'Palaeontographica,' Band xxxi. 1885.

‡ See, for instance, the following: "On Fossil Dormice," Geol. Mag. Nov. 1899, p. 492, and "On some Miocene Squirrels," Proc. Zool. Soc. 1893, pp. 179-214.

*Hypnomys* and *Leithia*, but an examination of the roots themselves show them to be essentially different.

In *Hypnomys* the upper premolar has three long and rather stout roots, which terminate in blunt rounded ends (B.M. M 11658, Pl. I. fig. 3). The anterior one takes a forward direction and is the shortest of the three, the other two project in a parallel direction from the hinder border of the tooth and may be confluent for a varying distance, but apparently not for more than half their length. This description is based on examples of *Hypnomys mahonensis*, but the alveolus in a Mallorcan specimen indicates a similar formation. Unfortunately there has been no opportunity of examining any milk-teeth in the case of either this genus or *Leithia*.

Text-figure 2.

Diagram of alveoli of cheek-teeth of A. *Hypnomys* and B. *Leithia*.

The upper molars each have three roots, one large internal and two small external ones, a number commonly found in many rodents. The distinctive feature of the Balearic teeth lies in the construction of the large internal roots: in *Eliomys*, *Glis*, and also in other forms such as *Xerus* and *Sciurus*, which have the same alveolar formula, these are single, rather flattened conical roots projecting from the centre of the border of the crown which they support. In *Hypnomys* the internal root is quite different, this being clearly portrayed in the accompanying illustrations. Fig. 3 (Pl. I.) shows the latero-internal view of the first and second molars of *H. mahonensis*: it will be seen that there is a slight constriction at the base of the crown where the enamel ends, and from there the confluent root continues practically of the same size for its whole length, which is a little less than twice the antero-posterior length of the crown-surface. In the figured specimen the first molar measures 4 mm. from the crown-surface to the tip of the root, while the antero-posterior length of the crown is very little more than 2 mm. In the second molar the root is very slightly shorter and not rounded at its apex, but this may perhaps be partly due to damage in developing the specimen. The internal root of the third molar is exposed in the type



specimen of *H. mahonensis* (B.M. M 11657), in which it is seen to be similar to that of the other two. In some specimens there is a slight groove along the centre, indicating the compound nature of the roots; the ends are closed in all examples examined. The slight intero-external width is well shown in the section (B.M. M 11661, Pl. I. fig. 4) and in the posterior view of the second upper molar (B.M. M 11660, Pl. I. fig. 5), in which it can also be seen that there is a certain amount of curvature in the direction of the compound roots. They are considerably longer than the external roots, although, owing to the slope of the crowns, they do not penetrate much deeper into the alveolar cavity.

As already mentioned, the upper molar roots of *Leithia* are similar to those of *Hypnomys*, the only other genus, among many examined, showing a closely similar condition of root structure is *Trechomys*. In the British Museum there are two fragments of the upper jaw of *T. platyceps* (B.M. M 1627) from the Phosphorites of Caylux, containing the premolar and first molar, the roots of the latter being as in *Hypnomys* except that the broad inner root is perhaps not quite so wide compared with the crown. It must be mentioned that in *Trechomys* the roots of the premolar are the same as in the molars, which is of course not the case in either *Leithia* or the Balearic genus. The molar roots of *Theridomys* are somewhat similar but are accompanied by much more hypsodont crowns.

The roots of the lower cheek-teeth of *Hypnomys* (B.M. M 11673, Pl. I. fig. 7) show a very considerable amount of variation both as regards their length and conformation. The premolar may perhaps be said to have two roots, but these are confluent for the greater part of their considerable length, diverging at a varying but never very great distance from their apices, the anterior of which is slightly the longer of the two. The upper, posterior portion of the root is wide and flattened, being very evidently the result of the fusion of two roots. In some specimens (as in B.M. M 11678) there are clearly three confluent roots.

In the first and second molars the two anterior roots are usually long, equal in size, and separate though not very widely divergent. In the posterior roots the length and antero-posterior thickness are about the same as in the anterior pair, so that viewed laterally little or no difference is observable (Pl. I. fig. 7). But viewed from behind they are seen to be confluent transversely for either the whole or three-fourths of their length (Pl. I. figs. 8, 9, B.M. M 11675-6); in the latter case the stout terminal portions of the roots may diverge considerably. The resemblance to *Hypnomys* seen in the roots of the upper molars of *Leithia* does not hold good for those of the lower jaw, for in the Maltese genus the first and second molars each have four roots, entirely separate from each other for their entire length. In *Trechomys*, however, the lower molar roots seem to agree with those of the Balearic genus with the possible exception of the

third molar. Schlosser gives the number of roots for this tooth as three, but judging from the alveolus of a specimen of *T. platyceps* in the British Museum (M1627) it appears that there may sometimes be two large, transverse roots only.

The last lower molar in *Hypnomys* has three roots, two anterior slender ones and a large, backwardly projecting posterior one. This condition is very similar to that obtaining in the corresponding tooth of *Leithia* and the recent *Eliomys*, though in the latter there is a more marked constriction immediately below the crown.

*Limb-bones*.—Very little of the skeleton was obtained, but a few femora, a tibia, and fragmentary portions of humeri and other bones, chiefly from a Mallorcan cave-deposit, show characters which also indicate that the genus should be included in the Muscardinidæ. The ulna is very similar to that of *Eliomys*, as is also the femur, except that the third trochanter seems to be slightly less prominent and less sharply separated from the great trochanter. As contrasted with the Hystricidæ, Sciuridæ, and Anomaluridæ, which have the tibia and fibula free, a characteristic of the Muridæ and Muscardinidæ is the joining of these two bones for a third or more of their distal portions. It may be worth noting that in *Rattus* (*Epimys*), for instance, the fibula at its distal extremity is once more separated though closely adpressed to the tibia. On the other hand, in *Eliomys quercinus* the tibia and fibula continue completely ankylosed at their distal ends, and it is with this latter that the Balearic specimens agree, as *Leithia* likewise does in this respect. These bones are joined for more than a third of their total length in the three last-mentioned genera. In *Hypnomys* the tibia is a straighter bone with a less well-developed enamel crest than in *Eliomys*.

The above are the chief characters of all the Balearic specimens, and it will only be necessary to add a brief note and a few measurements in the two species from the different islands.

The species from Menorca may be named

#### HYPNOMYS MAHONENSIS, sp. n.,

and regarded as the type species of the genus, distinguished from the Mallorcan species by its greater size and different habitat. Further differences would probably be apparent were a larger amount of material available. All the specimens were obtained from fissures in the Miocene limestone, and were in one or two instances associated with remains of *Myotragus* and *Testudo gymnesicus*. Some imperfect lacertilian jaws also occurred, and these have been very kindly examined by Mr. G. A. Boulenger, F.R.S.: they prove to be those of a *Lacerta* of the *viridis-ocellata* group and a species of *Chalcides*. Although representatives of both these occur commonly in the Mediterranean region, neither are found in Mallorca or Menorca at the present day.

Owing to the fragmentary state of the specimens not many

measurements can be given, but the following are a few. The length of the nasals is about 18 mm. in the single example in which these bones are completely preserved, and the interorbital width of the frontals is 8 mm. The base of the outer wall of the infraorbital canal measures 6 mm., and the incisive foramina are approximately 8 mm. in length. In the type specimen (Pl. I. fig. 1) the complete row of left upper cheek-teeth is almost 10 mm. in length, this measurement being 14 mm. in a corresponding example of *Leithia*, and barely 7 mm. in one of *Eliomys lusitanicus*. In *H. mahonensis* the width of the palate between the first molars is not quite 6 mm., in *Leithia* it is little more, being 6.5 mm.

The length of the lower cheek-teeth series is about 10 mm.; as already mentioned the length of their roots is very variable: in one specimen having teeth with moderately worn crowns (B.M. M 11673, Pl. I. fig. 7) the first molar has a crown-width of 2.5 mm. with a root-length (measured from the crown-surface to root-tip) of almost 5 mm. In the third molar in the same specimen the greatest length of root is 3 mm., the large posterior root attaining an antero-posterior width of 1.5 mm., while the antero-posterior length of the crown is 2.5 mm. In an example of a left lower second molar (B.M. M 11676, Pl. I. fig. 9) with a less worn crown than the above the crown-width is 2 mm., and the greatest root-length 3 mm.

It is proposed that the species from Mallorca be known as

HYPNOMYS MORPHEUS, sp. n.,

characterised by its smaller size and different habitat from *H. mahonensis*. The few specimens of jaws and limb-bones by which it is represented were obtained from cave-deposits in Mallorca, and were found associated with remains of *Myotragus*, and in one case with a few mandibular rami and limb-bones of *Apodemus*, which still occurs plentifully in the island. In size it appears to agree with the larger forms of *Glis*. The type specimens (B.M. M 11695), consisting of the anterior portion of the skull with the incisors and right molars and two mandibular rami, are believed to have been associated and fell apart on being separated from the earthy matrix in which they were preserved. The base of the outer wall of the infraorbital canal measures 5 mm., and the antero-posterior length of the molar row is 6 mm. The length of the lower cheek-teeth series is 8 mm. In the upper incisor (B.M. M 11696) shown in fig. 10 (Pl. I.) the antero-posterior width is 2.5 mm. while the thickness is 1.5 mm.; in a specimen of the lower incisor the antero-posterior width is 2 mm., with a thickness of barely more than 1 mm.

The greatest length of a right tibia, wanting its proximal epiphysis, is 41 mm., the distal 18 mm. of which are joined to the fibula. A femur has a total length of 55 mm., that of a right ulna being 36 mm.

*Summary and Conclusions.*

The above description may be very briefly summarised as follows. *Hypnomys* is represented by two species known by remains from the two largest islands of the Balearic group and is considered to belong to the Muscardinidae, though seeming to be a very distinct form not closely related to any other at present known. Its dental and osteological characters so far observed not only seem to show that *Hypnomys* belongs to the Muscardinidae but also appear to afford further support to the opinion, now very generally held, that this group cannot be included in either the so-called Sciuromorpha or Myomorpha and lending additional weight to the argument against employing these terms. This seems to hold good also for the modern representatives which have been briefly described by Mr. Miller\* as “. . . mostly arboreal animals with habits and aspect somewhat intermediate between mice and squirrels. . . .”

The Balearic genus may be compared with the recent *Eliomys* and the extinct *Leithia* from the Pleistocene of Malta. It agrees with the former in general plan of skull, lower jaw, and limb-bones, and it may be noted that there is also a perforation in the angle of the lower jaw. It differs in a number of points, among which the following may be cited:—In the pattern of the molar crowns, which are very slightly concave and lack the marginal cusps, both distinctive characteristics of *Eliomys*. In *Hypnomys* the worn surfaces of the molars are subquadrate in shape, whereas in the recent genus the width is distinctly greater than the antero-posterior length; the alveolar formula differs in the two genera, and the large inner root in the upper molars of *Hypnomys* is quite distinctive. This root-structure was evidently attained by a process of simply filling up the space between two parallel roots, whereas the single *conical* root seen in the Sciuridae and others would seem to be arrived at by the drawing together of the apices of the two roots with a similar filling up of the intervening space. It would be interesting could one arrive at a reasonable hypothesis to account for this root-formation in *Hypnomys* and *Leithia*, for presumably it must have been acquired to meet a special stress or strain consequent on some peculiarity of diet or mode of life.

*Hypnomys* agrees with *Leithia* in its squared molars and in the large, confluent and single inner roots of the upper molars, but differences are seen in the former having a perforation in the angle of the jaw, which is also of a different shape (see text-fig. 1), in the crown pattern of the molars, much lower enamel ridges, and in the roots of the lower molars.

It has also been noted that in the roots of both upper and lower molars, but *not* premolars, *Hypnomys* shows a striking resemblance to *Trechomys*. However, it is not for a moment

\* ‘Cat. Mammals of West. Europe,’ London 1912, p. 549.

suggested that this similarity, which is apparently unaccompanied by other points of resemblance, indicates any close affinity. On the contrary, it would seem that these three genera each exhibit in this character what would have been a stage, and that a very early one, in the history of the evolution from the low-crowned four-rooted towards the hypsodont and rootless or semi-rootless molar. The cheek-teeth of *Theridomys* also seem to suggest the possibility of this result being attained without the necessity of including a stage having a large conical inner root in the upper molars accompanied by a somewhat triangular-shaped crown, as seen in some of the Sciuridæ (*Xerus* for instance) and which Dr. Forsyth Major has fully described in his invaluable paper on the Miocene Squirrels\*.

*Hypnomys* is an interesting addition to the extinct fauna of the Balearics so far known by *Myotragus* and *Testudo gymnesicus*, both forms totally distinct from the present-day fauna of the islands. Owing to the small amount of material available, the question as to the precise age of these Balearic deposits and their contents seems a difficult, if not impossible, one to answer at present. Lately this matter has been the subject of some interesting remarks by Prof. M. Boule†, who seems inclined to consider the deposits of earlier age than Pleistocene. Seeming to support this view are the absence of human remains and the character of the chief remains found, *i. e.* *Myotragus*, *Hypnomys*, and a giant *Testudo*. The occurrence of remains of this last in the limestone fissures of Menorca certainly suggests that there must have been great changes of climate and vegetation, and that there have been considerable alterations in the land surface is indicated by extensive stretches of sheets of stalagmite now exposed on the weathered surface of the Miocene limestone in both Mallorca and Menorca.

On the other hand, it should be realised that not much weight should be placed on the absence of human remains owing to the fact that not a single one of the ossiferous deposits was found to be in an undisturbed condition, all the upper layers in which such remains might be expected to occur having been entirely destroyed. Another point to be borne in mind is that in the Mediterranean region several species now extinct have been proved to have persisted until the time of man's occupancy of these particular areas. The well-known *Prolagus*, remains of which were found in Neolithic settlements in Corsica by Dr. Forsyth Major, is a case in point. Another somewhat similar example is that of a small deer, *Anaglochis*, whose remains occur abundantly in some of the cave-deposits of Crete, while a number of its antlers were found by Sir Arthur Evans in a shrine in the famous Minoan Palace of Knossos.

I should like to take this opportunity of expressing my grateful thanks to the Trustees of the Percy Sladen Memorial Fund for

\* Proc. Zool. Soc. 1893, pp. 179-214.

† 'L'Anthropologie,' tome xxviii. (1917) pp. 160-3.

enabling me to visit Menorca. Also to Dr. A. Smith Woodward, F.R.S., for continued kindness in giving me every facility for working in the Geological Department of the British Museum (Nat. Hist.), to Mr. M. A. C. Hinton for kind advice and for looking over some of my material, and to Mr. J. Thornton Carter for his valuable investigations into the enamel structure in the teeth of *Hypnomys* and other genera.

## EXPLANATION OF PLATE I.

- Fig. 1. *Hypnomys mahonensis*. Type-specimen (B.M. M 11657). Palate showing the left premolar and molars and right M<sup>1</sup>. × 4.
2. Do. Side view of same specimen showing anteorbital region. × 3.
3. Do. Lateral view of right upper pre-molar and 1st and 2nd molars, showing the large confluent roots of the latter (B.M. M 11658). × 3.
4. Do. Transverse section of left M<sup>1</sup> (B.M. M 11661). × 4.
5. Do. Posterior view of right M<sup>2</sup> (B.M. M 11660). × 4.
6. Do. Crown view of right lower molars (B.M. M 11674). × 4.
7. Do. Lateral inner view of right lower cheek-teeth (B.M. M 11673). × 3.
8. Do. Right M<sub>2</sub> (B.M. M 11675) showing posterior roots. × 4.
9. Do. Left M<sub>2</sub> (B.M. M 11676) showing posterior roots. × 4.
10. *H. morpheus*. Right upper incisor (B.M. M 11696), inner view. × 3.
11. *H. mahonensis*. Transverse section of upper incisor (B.M. M 11662). × 4.
12. Do. Transverse section of lower incisor (B.M. M 11677). × 4.
13. *Leithia melitensis*. Transverse section of upper incisor (B.M. M 49345 a). × 4.
14. *H. mahonensis*. Dorsal view of interorbital region of skull (B.M. M 11659). × 2.

12. A Case of Hermaphroditism in a Lizard, *Lacerta viridis*.  
By NOEL TAYLER, B.Sc. (Lond.)\* (From the Zoological Department, University of London, University College.)

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(Text-figures 1-3.)

The specimen, the urogenital system of which is described in the following pages, was placed in my hands by Prof. J. P. Hill, F.R.S. It turned up in the course of class-work in the Senior Laboratory in the College, and its abnormal condition being observed, it was fixed in corrosive sublimate and preserved for detailed examination. The specimen presents certain features of interest which, it is believed, are worthy of being placed on record.

I wish to express my thanks to Prof. Hill for his advice and assistance in the preparation of these pages.

## I. DESCRIPTIVE.

### a. *General Morphology.*

When this specimen came into my hands, it was in a partly dissected condition, the greater portion of the abdominal viscera having been removed.

The Fat Bodies were present and well developed, the right being rather larger than the left. They are not represented, however, in text-fig. 1, which gives a general view of the urogenital system, since *in situ* they obscured the more anterior portions of the oviducts.

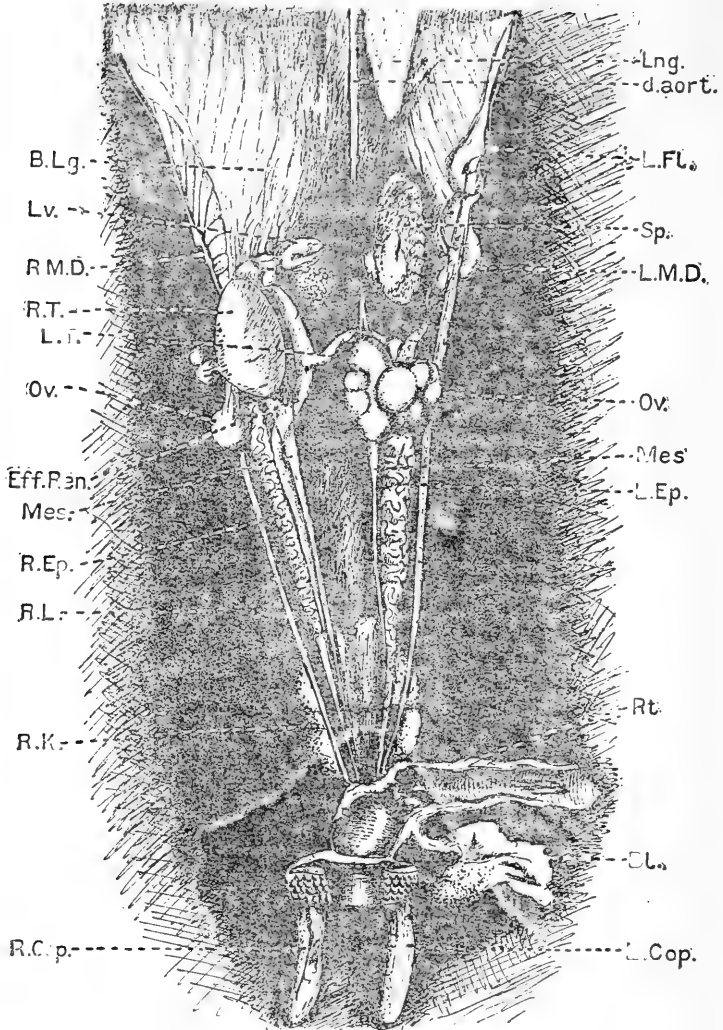
The testes (text-fig. 1, *R.T.* and *L.T.*) were well developed and suspended in the folds of the longitudinal mesorchia (*Mes.*). The right was placed somewhat more anteriorly and was rather larger than the left, the dimensions of the former being about .9 cm. × .4 cm., and of the latter .65 cm. × .3 cm.

Both gonads seem normal in shape apart from the remarkable stalked outgrowths on each (*Ov.*). These on section were found to contain ova, and the gonads may therefore properly be designated ovotestes. The right gonad, it will be seen, possessed two of these spherical ovarian appendages, each joined to the dorso-lateral border of the testicular portion of the organ by a well-marked stalk; the more anterior was further sub-divided into two by a median constriction.

The left gonad also possessed two outgrowths, the surface of the larger being subdivided into five or six hemispherical projections. The epididymes were well developed (*L.Ep.*, *R.Ep.*)

\* Communicated by Prof. J. P. HILL, D.Sc., F.R.S., F.Z.S.

Text-figure 1.

*Lacerta viridis*: dissection of a hermaphrodite animal.

## Explanation of the lettering.

<i>B.Lg.</i>	Broad Ligament.	<i>Mes.</i>	Mesorchium.
<i>Bl.</i>	Bladder.	<i>Ov.</i>	Ovary.
<i>d.aort.</i>	Doreal Aorta.	<i>R.Cop.</i>	Right Copulatory Organ.
<i>L.Cop.</i>	Left Copulatory Organ.	<i>R.Ep.</i>	Right Epididymis.
<i>L.Ep.</i>	Left Epididymis.	<i>R.K.</i>	Right Kidney.
<i>L.Fl.</i>	Left Fommel.	<i>R.L.</i>	Muscular Band.
<i>L.M.D.</i>	Left Oviduct.	<i>R.M.D.</i>	Right Oviduct.
<i>Lng.</i>	Lung.	<i>R.T.</i>	Right Testis.
<i>L.T.</i>	Left Testis.	<i>Rt.</i>	Rectum.
<i>L.v.</i>	Liver.	<i>Sp.</i>	Spleen.



and situated in the broad ligament parallel to but separate from the testes. They were not attached, as is normally the case, to the inner border of the testes, and vasa efferentia were consequently absent. Posteriorly, the epididymes passed into the vasa deferentia, and these, having united with the ureters, opened into the posterior division of the cloaca by the urogenital papillæ.

The two kidneys were apparently normal, each consisting of an anterior and posterior lobe (in the figure, only the right kidney, *R.K.*, is indicated by reference letters).

The copulatory organs (*R. Cop.*, *L. Cop.*) were present as in the normal male lizard.

The oviducts (*R.M.D.*, *L.M.D.*) were developed for about a third of their lengths. Each opened into the body-cavity by a well-developed funnel (only the left, *L.Fl.*, is indicated by reference letters in the figure), and behind that was continued into the duct, the plaited glandular walls of which are seen in the outer border of the broad ligament (*B.Lg.*). The right oviduct attained the greater complexity as in the normal female.

Passing down from the posterior tip of the cœlomic funnel on each side, on the extreme outer border of the broad ligament was a narrow but well defined ribbon-like muscular band which continued right back on each side to the cloaca. Similar bands, which were at first taken for the oviducts, were referred to by Howes (5) as the round ligaments, and he thus describes them in his specimen: "From this (the oviducal aperture) there passed back a ribbon-shaped muscular band which skirted the free edge of the broad ligament, remindful of the round ligament of mammalian anatomy. This structure was wholly absent on the side destitute of an oviducal vestige, as indeed it is in the normal male. Its development is correlative with that of the oviduct."

#### b. *Histology.*

Transverse sections were made of the gonads and stained with hæmatoxylin and eosin. The main body of each gonad was found to consist of normal testicular tissue, *i. e.* seminiferous tubules with an interstitial stroma, the lining cells being in active mitotic division (text-fig. 2, *s.t.*).

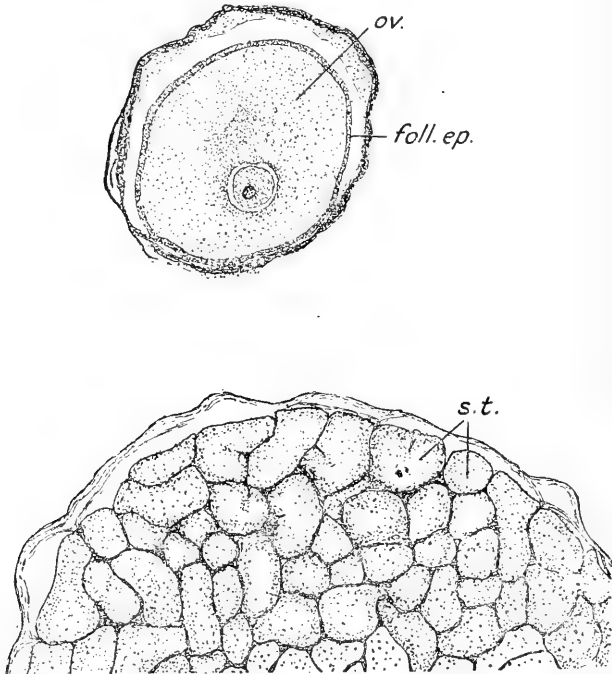
The stalked outgrowths were found to consist of ovarian tissue, the bulb-like extremities containing large and fully-grown ova. A section of the gonad through the nuclear plane of the most anterior ovum is somewhat diagrammatically represented in text-fig. 2.

The large yolk-laden ovum (*ov.*) is, it will be seen, surrounded by the relatively thin follicular epithelium (*fol. ep.*), outside this is a fibrous layer continuous with that sheathing the testicular portion of the gonad. In the stalk region all the normal histological elements of the ovary are represented. Outside is a layer of cubical epithelial cells continuous with the peritoneal epithelium, while the main mass of the stalk is formed of a loose stroma of connective tissue, contained in which

are numbers of young follicles of various ages, the youngest being nearest to the testis. The connective-tissue body of the stalk is confluent with the tunica albuginea of the testicular portion of the gonad, which is somewhat thickened in the region of junction.

The sections of the oviducts revealed in their anterior portions a typical structure. They are lined with a well developed ciliated and glandular epithelium, the lumen of the duct being filled with the coagulated secretion of the gland-cells. Spermatozoa were not detected.

Text-figure 2.



*Lacerta viridis*, hermaphrodite animal: sections through gonad.

*ov.*; ovum.

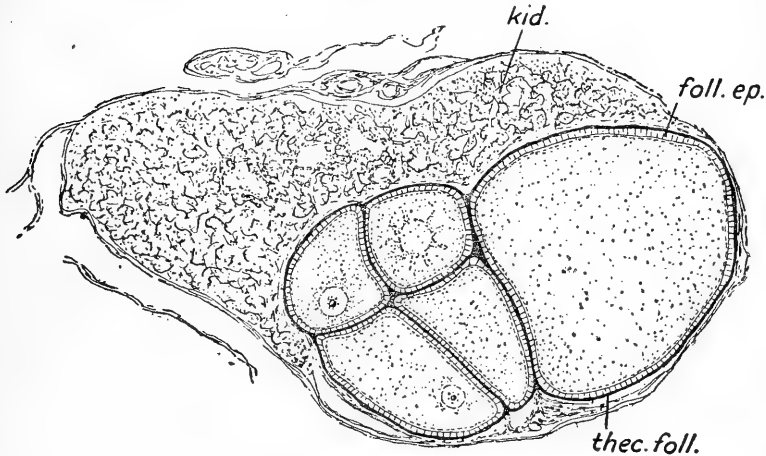
*foll. ep.*; follicular epithelium.

*s. t.*; testicular stroma.

The appearance of the epididymis was quite normal, but no spermatozoa were found in the lumen of the vas deferens, and examination of the sections failed to reveal the presence of vasa efferentia through which the spermatozoa normally pass from gonad to epididymis.

In the dissected specimen two or three fine tubule-like filaments were seen to pass from the posterior ends of the oviducts to the anterior extremities of the corresponding epididymes; these were best marked on the left-hand side (see text-fig. 1). These filaments were carefully examined in the sections. The epithelial lining of the oviduct was found to end posteriorly in a cul-de-sac, as did that of the epididymis anteriorly. The "filaments" in section appeared as actual tubular passages devoid of any epithelial lining and running in the substance of the broad ligament. They commenced at the extreme anterior tip of the epididymis, and while two of them ended blindly, the third ran up as far as the posterior extremity of the oviduct, its lumen being continuous with the spaces in the mesentery in which were contained the glandular portion of the oviduct.

Text-figure 3.



*Lacerta viridis*, hermaphrodite animal: section through kidney.

*kid.*; kidney tissue.  
*foll. ep.*; follicular epithelium.  
*thec. foll.*; theca folliculi.

The morphological interpretation of these spaces would seem a problem of some difficulty. Being devoid of epithelial lining and making no connection with the lumen of the epididymis, one would hardly seem justified in regarding them as rete tubules proper, while the close relationship of one of them with the oviduct also seems anomalous, on this view.

The condition which Howes (5) describes in one of his specimens seems of some interest in this connection. "In one instance," he says, "I discovered an interesting modification of the condition recorded by Leydig. There was buried up in the

peritoneum in a line with the head of the epididymis a delicate filament which, while it answered in every respect to the rudiment described by him, instead of ending abruptly and blindly became suddenly enlarged, opening into the body-cavity by a wide-mouthed funnel-shaped extremity, identical with that of the oviduct, and lined by a ciliated epithelium."

This without doubt seems the description of a vestigial oviduct, yet, posteriorly, according to his figure, it appears to arise from the anterior tip of the epididymis. Unfortunately he does not seem to have investigated the precise nature of its relations to this organ.

The sections through the kidneys reveal the presence on the dorsal portion of one of them of an embedded mass of almost fully grown ova. Text-fig. 3 is a semi-diagrammatic representation of one of the sections in which five ova occur. It will be seen that the mass of ova lies actually embedded within the kidney tissue (*kid.*). Each ovum is surrounded by a layer of follicular cells (*fol. ep.*), while externally to this and separating it from the kidney substance is a thin fibrous layer (*thec. foll.*) presumably representing the theca folliculi.

## II. DISCUSSION.

No instance of complete hermaphroditism in the Lacertilia seems yet to have been put upon record, though cases of the more or less complete development of the Müllerian Ducts in adult male lizards have been described.

Leydig in 1872 (7) described the persistence in the males of *Lacerta agilis* of the Müllerian Ducts as small blind and convoluted tubules, while Braum in 1877 (2) noted the development of rudimentary Müllerian Ducts in the young male of the same species, making no mention, however, of its presence in the adult form.

In 1887 Howes (5) published a brief but important paper, "On the vestigial structures of the reproductive apparatus in the male of the Green Lizard" (*Lacerta viridis*). One of his specimens was a male lizard in which both the oviducts were all but fully developed, while in another the oviduct was fully developed on one side.

In thirteen out of twenty-five specimens examined certain segments of the oviduct were well developed, the other portions being only represented as delicate filaments, thus giving a series of conditions analogous to those described by Matthews for the male toad.

In 1893, Hill (4) published an account of the persistence of vestigial Müllerian Ducts in the full-grown male of an Australian lizard, *Amphibolurus muricatus*; while two years later, in 1895, Jaquet (6) described the presence of Müllerian Ducts identical with those of the normal female in an adult individual of *Lacerta agilis*.

All the above mentioned cases are, it will be noted, predominantly male, indeed as far as their gonads are concerned wholly male, for in no case is any reference made to the presence of ova or ovarian tissue.

In this respect the specimen described in the present paper stands in striking contrast to previously described cases; moreover, while it is distinguished by the presence of well-marked ovotestes, it must have been physiologically sterile.

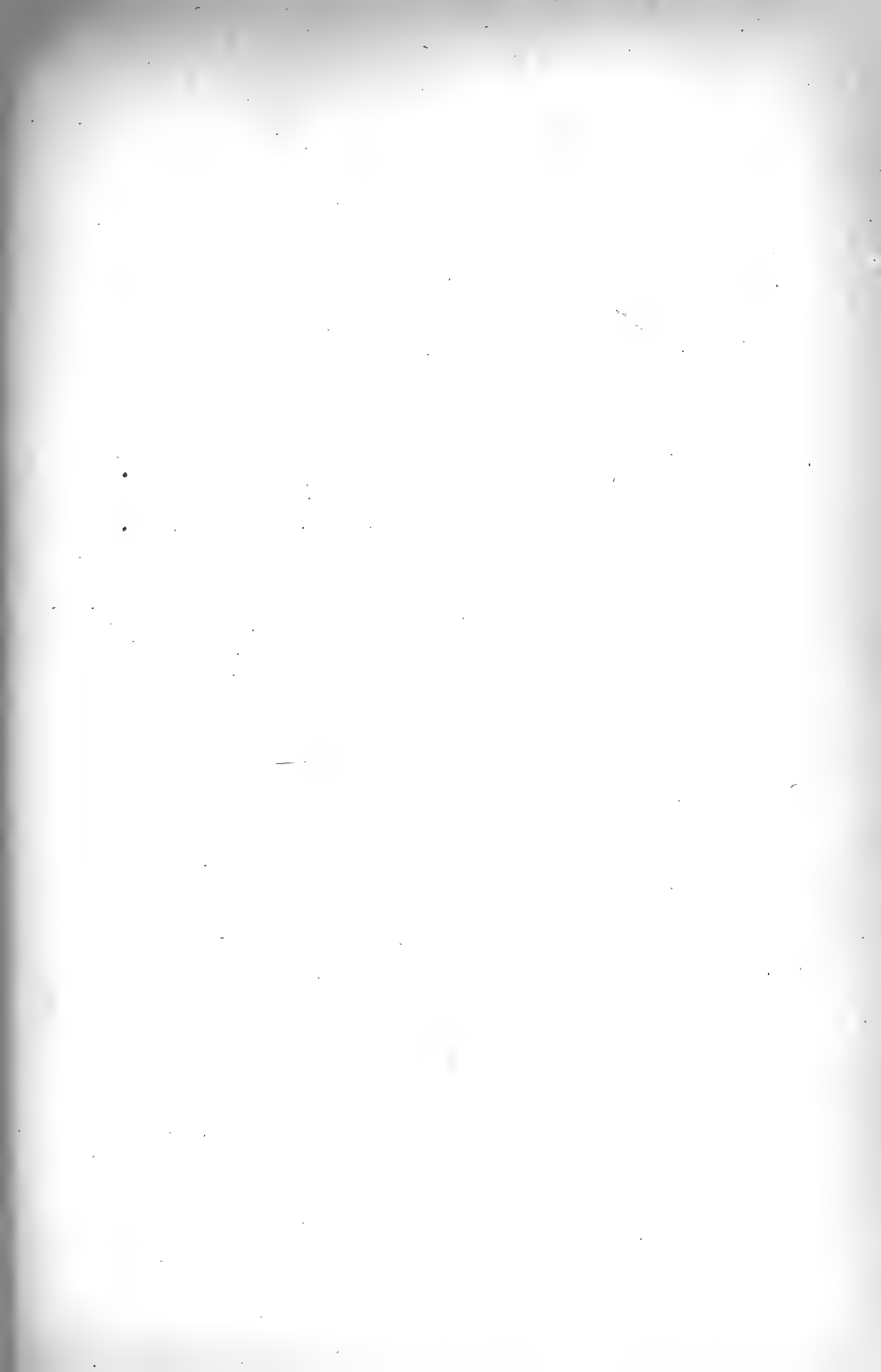
Among lower forms the occurrence of well-developed Müllerian Ducts seems often to be accompanied by the existence of an ovotestis. Cases of this kind have been described by Marshall in the Frog (8), but Fantham (3) seems to have been the first to record a case of true hermaphroditism in the Reptilia. The specimen of *Testudo græca* described by him possessed well-developed oviducts, the lumen of each being continuous throughout. Of the two gonads the right was a typical testis, on the ventral surface of the left however was a "conspicuous yellow egg." On section another was found developing in its proximity, while "a few groups of bodies resembling developing 'ovarian ova' were seen scattered in separate groups (follicles) among otherwise testicular tissue, more especially near the periphery of the anterior portion of the gonad." Epididymes, vasa efferentia and vasa deferentia were present as in normal specimens, the former being rather large.

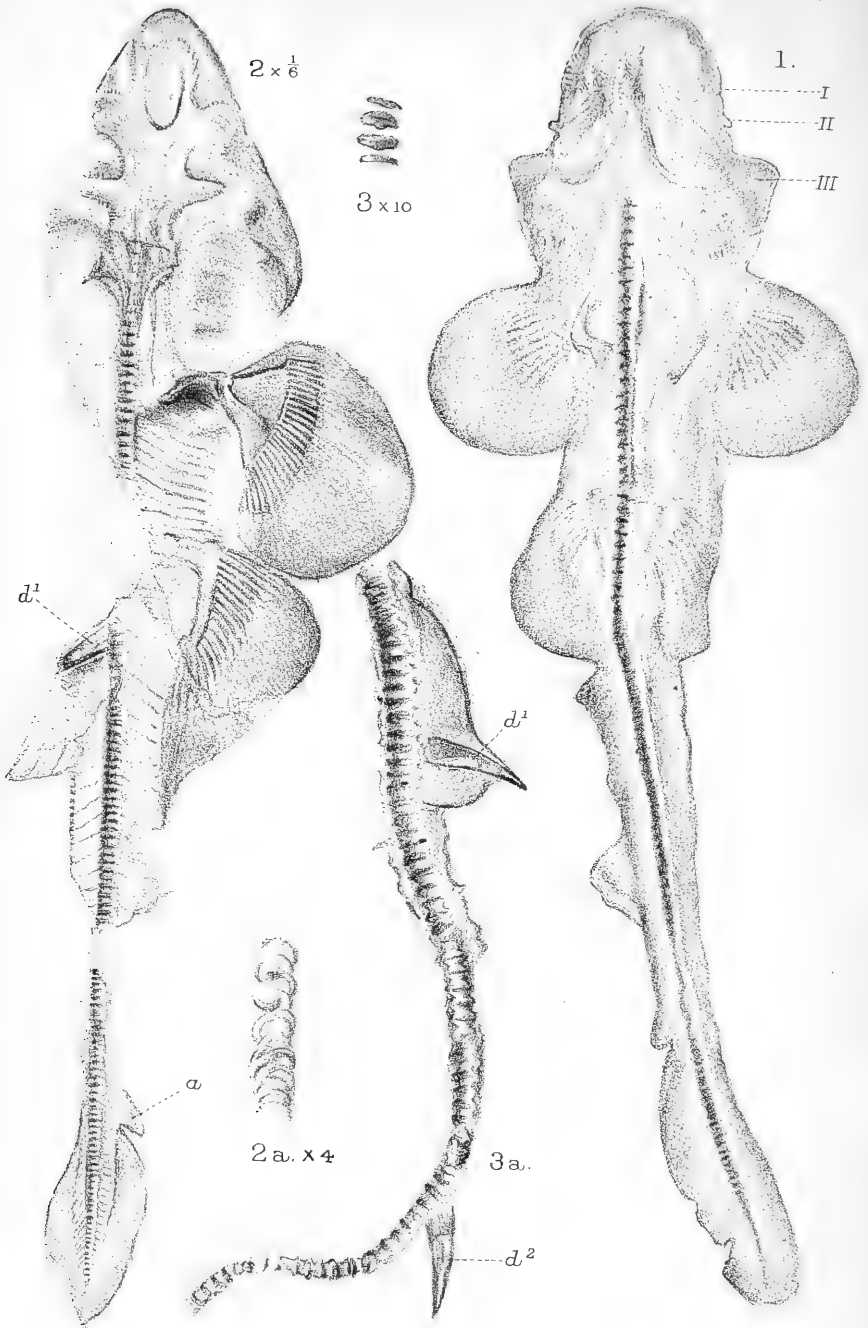
It seems a point worthy of note that the development of the oviducts in the cases referred to above, viz., those of Howes, Hill, and Jaquet, is much more complete than in the subject of the present paper; in all these three cases the oviducts were developed throughout their whole length and opened into the cloaca, yet in none of these cases is any mention made of the presence of ova or ovarian tissue. In the present specimen, on the contrary, numerous ova occur, though only the anterior thirds of the two oviducts are fully developed.

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5. HOWES, G. B.—“On the Vestigial Structures of the Reproductive Apparatus in the Male of the Green Lizard.” *Journ. Anat. & Phys.* xxi. pp. 185-9, 1887.
6. JAQUET, M., (1895).—“Note sur un cas d’hermaphroditisme incomplet observé chez le *Lacerta agilis*.” *Bibliogr. Anat. (Paris-Nancy)* iii. p. 267.
7. LEYDIG.—“Die in Deutschland lebenden Arten der Saurier.” Tübingen, 1872.
8. MARSHALL, A. MILNES.—“On certain abnormalities of the Reproductive Apparatus of the Frog.” *Journ. Anat. & Phys.* xviii. pp. 121-144.





G.M. Woodward del. et lith.

Huth imp.

1. CROSSORHINUS JURASSICUS.  
2, 3. PROTOSPINAX ANNECTANS.



13. On two new Elasmobranch Fishes (*Crossorhinus jurassicus*, sp. nov., and *Protospinax annectans*, gen. et sp. nov.) from the Upper Jurassic Lithographic Stone of Bavaria. By ARTHUR SMITH WOODWARD, LL.D., F.R.S., V.P.Z.S.

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(Plate I.)

Most of the modern groups of Elasmobranch fishes seem to have arisen during the Cretaceous period, but some are of still older date, and a few interesting types are represented by well-preserved fossils in the Upper Jurassic lithographic stone of Bavaria, Württemberg, and France. Two remarkable new examples of these early forerunners of the existing fauna have lately been identified in the British Museum, one apparently indistinguishable from an existing genus, *Crossorhinus* (or *Orectolobus*), the other evidently of a new genus and family closely related to the Spinacidae.

#### Family CROSSORHINIDÆ.

##### CROSSORHINUS JURASSICUS, sp. n. (Pl. I. fig. 1.)

*Specific Characters.*—Head gently rounded in front; length of head and trunk about equal to that of the tail. Three pairs of fringing dermal lappets, all undivided, the first extending along the sides of the front half of the head, the next pair diminutive, and the third pair largest, extending along the sides of the branchial region. Pectoral fins rounded, relatively large, extending nearly as far back as the origin of the pelvic fins, which are also rounded and about two-thirds as wide as the pectorals. Dorsal fins rather small and apparently nearly equal in size; the first dorsal arising opposite the hinder limit of the pelvic fins; the second ending in advance of the much smaller anal fin, which is close to the lower lobe of the caudal. Body and fins covered with very fine shagreen, of which some granules between the pectoral fins have a fluted sculpture.

*Description of Type Specimen.*—The fossil, which is shown of the natural size in Pl. I. fig. 1, is exposed in its anterior half from below, in its caudal half from the side. The snout is short and bluntly rounded, and the rami of the jaws are vaguely seen, meeting in an acute angle at the symphysis, where there are remains of a cluster of very slender, smooth, pointed teeth. The branchial region is relatively long, but the branchial arches are even more obscured by the crushed shagreen than the jaws. A single

pair of large dermal lappets (III), widest in front and gradually narrowing backwards, extends along the whole length of the branchial region. Another pair of minute simple lappets (II) is well seen just in front of this, and the mode of staining of the fossil suggests that there is a long and narrow fringe of skin (I) along each side of the rostral region. The vertebral centra are much constricted and smooth, but where broken they seem to exhibit traces of some secondary calcification round the primitive double-cone. Their arches are not distinguishable, but the comparative shortness of the centra in the front part of the caudal region evidently results from diplospondyly. The large pectoral fins are remarkably rounded, slightly longer than wide, and the stout basal cartilages do not extend more than half-way towards the distal margin. The long unjointed proximal radial cartilages are well seen in the left pectoral. The tapering ascending parts of the pectoral arch are crushed backwards. The pelvic fins, which are much longer than wide, are supported in their basal half by very stout radial cartilages ranged along the basipterygium, which is not produced into claspers. The individual represented is therefore female. The two dorsal fins are crushed downwards to the left side of the fossil, and seem to have been nearly equal in size; but the parts projecting beyond the edge of the tail probably represent only their apical halves. The first dorsal, which is rather fragmentary, arises just behind the end of the pelvic fins, while the second must have been completely in advance of the anal. The anal fin is relatively small, short, and rounded, and close to the lower lobe of the much extended caudal fin. The lower lobe of the latter is clearly notched near its distal end. The head, trunk, and fins are completely covered with very fine shagreen. Most of the granules appear to be flat and smooth, but some are pointed, and a few on the back of the trunk between the pectoral fins are both pointed and slightly enlarged and coarsely fluted.

*Affinities.*—So far as preserved, there is nothing in the fossil thus described to separate it from the existing genus *Crossorhinus*, but it is distinguished from all known species\* by the simplicity of the dermal lappets fringing the head, and by the relatively large size of the pectoral fins.

#### Family PROTOSPINACIDÆ, nov.

Body depressed, but base of pectoral fins not produced forwards. Vertebral centra well calcified (probably tectospondylic). Radial cartilages of paired fins not extending to the margin; two dorsal fins on the tail, each with an anterior spine; anal fin present.

\* Compare C. Tate Regan, P. Z. S. 1908, pp. 354-357, pl. xi. fig. 2, pl. xii. fig. 2; also Ann. & Mag. Nat. Hist. [8] vol. iii. (1909), p. 529. J. Douglas Ogilby & A. R. McCulloch, Journ. Roy. Soc. N. S. Wales, vol. xlii. (1908), pp. 269-280, pl. xlii., pl. xliii. fig. 1. For skeleton see also W. A. Haswell, Proc. Linn. Soc. N. S. Wales, vol. ix. (1884), pp. 92-98, pl. i. figs. 6-8, pl. ii. fig. 13.

## Genus PROTOSPINAX, nov.

Snout short and obtusely rounded. Teeth small, compressed to a sharp edge. Pectoral fins extending as far backwards as the pelvic pair; dorsal fin-spines large, laterally compressed, and smooth, the first inserted opposite the pelvic fins; anal fin very small, close to the elongate-ovoid caudal, which is not notched. Shagreen dense and fine, none enlarged; lateral line supported by a series of calcified ringlets.

## PROTOSPINAX ANNECTANS, sp. n. (Pl. I. figs. 2, 3.)

*Specific Characters.*—Attaining a length of about a metre. Length of cranium slightly less than one-fifth, length of caudal fin about one-sixth of the total length. Teeth smooth and lozenge-shaped, their sharp-edged crown sometimes with a prominent middle point. Antero-posterior measurement of pectoral fin about equal to the length of the cranium, and nearly twice as great as the length of the pelvic basipterygium. Dorsal fins about equal in size, the first arising slightly in advance of the middle of the fish.

*Description of Type Specimen.*—The fossil, which is shown of one-sixth the natural size in Pl. I. fig. 2, is very fragmentary, but there are definite points of contact between the pieces of rock in which it is contained, and most of it is preserved in counterpart, so that its general shape and proportions are recognisable. The head and trunk are seen directly from above, while the greater part of the tail is exposed in side-view. The edges of the head and fins are sharply outlined by fine dense shagreen, while the distinctness of part of the margin of the caudal region is due to fossilised muscle. The cranium is well calcified in the usual small tesserae, and evidently not much distorted. Its postorbital part is about as broad as long, and the postorbital processes are small and slender. There is very little constriction between the orbits, which are completely within the hinder half of the cranium. The olfactory capsules form relatively large rounded lateral prominences in the middle of the cranium. The rostral part is short and wide, not tapering but nearly truncated in front, and remarkable for the large size of the elongated anterior fontanelle which extends backwards between the olfactory capsules. There is no indication of a posterior fontanelle in the cranial roof. The jaws are not seen, but there appears to be a vague trace of the mandibular articulation on the right side well behind the occiput. All the vertebrae are crushed and broken, but they show much secondary calcification round the primary double-cone, and this seems to have been in concentric laminae (on the tectospondylic plan). As in many other fossil Elasmobranchs from the lithographic stone, the body-muscles are well preserved; and it is clear that while in the abdominal region each myotome corresponds with one vertebral centrum, in the anterior part of the caudal region each myotome comprises two

vertebral centra. There is thus the common diplospondyly. The vertebral arches are scarcely seen, except within the caudal fin, which is displayed in direct side-view. Here the hæmals are apparently stouter and less inclined backwards than the neurals. The pectoral arch is only imperfectly shown, but the right pectoral fin is complete. It is relatively large, and the supporting cartilages extend only about half-way from its insertion towards the distal margin. The three basals are distinct, the propterygium being comparatively small and narrow, the triangular mesopterygium about as wide as long, and the metapterygium longer than wide but very little produced backwards. The radial cartilages, which are not much longer than the basals, are rather sparsely arranged and do not clearly exhibit any transverse articulations. About 12 are arranged along both the mesopterygium and the metapterygium. Faint striations are seen in part of the fin-membrane, but there are no distinct remains of dermal rays. The pectoral fins extend as far backwards as the pelvic fins, which are much smaller. The pelvic basipterygium is long and gradually tapering, and bears at least 17 radial cartilages, which (like those of the pectoral) are not closely pressed together and do not show any transverse articulations. The cartilages occupy only half of the total expanse of the fin. As they are imperfect behind, the sex of the individual is uncertain. Of the median fins, one large dorsal, bordered in front by the remains of a smooth, laterally compressed spine ( $d^1$ ), arises just behind the origin of the pelvic fins; but it is very imperfectly preserved. The impression of the fin-membrane shows some fine striations, which may perhaps denote strengthening dermal rays. As the tail of the fish is relatively long, this is doubtless the first dorsal fin, but the fossil is too fragmentary to exhibit the second dorsal. The caudal fin, which is displayed in direct side-view and only incomplete at the upper extremity, is long and ovoid, with the lower lobe the larger. The membrane here again shows faintly some fine striation. Just in advance of its lower lobe, a small deep and narrow fin is shown ( $a$ ), with most of the outline defined by oxide of manganese. Though its separation from the caudal is a little obscured by the rough fracture of the rock, it is almost certainly distinct and may be regarded as an anal fin. Fine shagreen covers the whole of the trunk and fins. Near the margins it is especially smooth and dense, but on parts of the trunk the granules are rather stellate. On the trunk in front of the pectoral fins, and again on the tail just behind the pelvic fins, it is interesting to notice that the course of the lateral line is marked by a close series of incomplete ringlets (fig. 2*a*), as in Chimæroids and in the extinct dog-fish, *Mesiteia*.

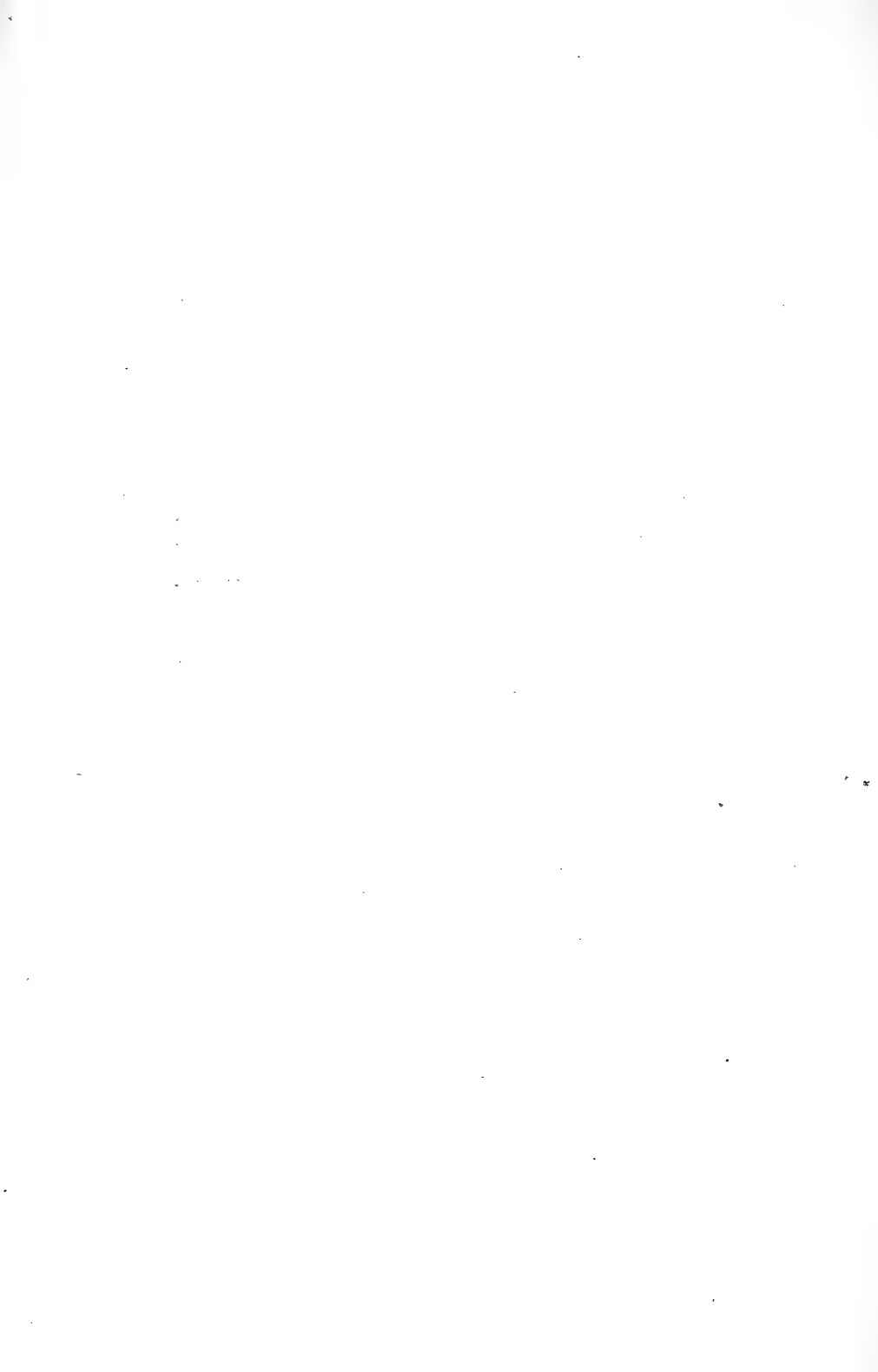
*Young Specimen.*—A second specimen in the British Museum (No. 37014), from the same formation and locality, only 30 cm. in length, evidently represents a young individual of the same species. The cranium and vertebral column are in undisturbed series, with the two dorsal fin-spines in their natural position on

the tail; but the parts of the paired fins are scattered, and only fragments remain. The specimen, however, is of special importance, because displaced portions of both jaws with groups of the teeth are also preserved. The characteristic large anterior fontanelle in the cranium is well displayed as in the type specimen. The teeth (fig. 3) are relatively small and closely arranged, several series evidently functional at one time. Their exact shape is difficult to determine, but they seem to be transversely elongated rhomboids, with a low crown, which is smooth, compressed antero-posteriorly to a sharp edge, and sometimes rising in the middle to a little cusp. Many of the vertebral centra clearly exhibit the secondary calcification round the primary double-cone. A fragment of a pelvic fin seems to denote a male individual, and a row of slightly enlarged, pointed shagreen-granules may have belonged to the clasper. The two dorsal fin-spines (fig. 3a,  $d^1$ ,  $d^2$ ), though fractured, are shown to be nearly similar in size and shape, and their length equals about one-quarter of the distance between their insertions. The spine of the first dorsal is supported not only by a short triangular cartilage behind, but also by a larger and more extended cartilage in front. Traces of the fine stellate shagreen are seen on the rostrum.

*Affinities.*—The new genus and species now described evidently represent a family closely related to the Spinacidæ, but still retaining the anal fin and a less specialised dentition. *Protospinax* is indeed a generalised type such as might be expected among Jurassic Elasmobranchs when the Batoids were beginning to be differentiated. The Batoids themselves were first represented by the Rhinobatidæ, and it is interesting to notice that one member of this family (*Belemnobatis*) contemporary with *Protospinax* had a spine in front of each of its two dorsal fins.

#### EXPLANATION OF PLATE I.

- Fig. 1. *Crossorhinus jurassicus*, sp. n.; nearly complete fish, nat. size.—Lithographic Stone; Eichstädt, Bavaria. I, II, III, the three paired dermal lappets. [British Museum no. P. 11211.]
2. *Protospinax annectans*, gen. et sp. n.; fragmentary fish, one-sixth nat. size.—Ibid. a. anal fin;  $d^1$ . spine of first dorsal fin. [British Museum no. P. 8775.]
- 2a. Ditto: portion of lateral line of same specimen enlarged four times to show supporting ringlets.
3. Ditto: group of teeth enlarged ten times.—Ibid. [British Museum no. 37014.]
- 3a. Ditto: portion of tail of same specimen, showing dorsal fin-spines ( $d^1$ ,  $d^2$ ), nat. size.



## 14. The Function of Pathological States in Evolution.

By MORLEY ROBERTS\*.

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That dissatisfaction with much orthodox biological opinion is growing can hardly be denied. Not a little of this feeling is due to the fact that what is often given as explanation cannot be resolved into factors capable of appreciation, and, possibly, of measurement, by the intellect. The theory has to be accepted as more or less a matter of faith. Where there is a general tendency to rely on authority, speculation is discouraged, for orthodoxy everywhere rests on the native conservatism of man, and even the revolutionary is capable at last of fatigue. As a result, tentative hypotheses offered by the great leaders tend to become objects of faith, and among their less enterprising followers there arises a more or less fervent conviction that, however unsatisfactory they appear now, they will presently become demonstration. Thus the theory of the germ-plasm, even in its later modified form, seems held too dogmatically by many: the 'nature' of inherited living matter accounts for every organ as it appears; while all changes are due to obscure variations of an advantageous kind which give the survivors in the struggle a better chance. On analysis, such opinions do not seem truly scientific, for the "nature" of the germ-plasm can barely be distinguished from the directing entelechy of Driesch, and if the Weismannian cloud of ids and biophors is now somewhat condensed, the magic determinant still remains in a concealed vitalism which is exactly analogous, as regards the organism, with pantheism as regards the universe. Nor, if we are told with certainty that altered characteristics are not transmitted, is the theory of small advantageous variations much more satisfactory, if we know neither how they come, nor how they are inherited. To say so much must not be regarded as treating with disrespect its great author, without whom we might still be wandering in the barren field of teleology.

To regard these theories as hasty and, perhaps, unsound explanations is not to accept without scrutiny the theory of the transmission of acquired, or modified, characteristics. Though this is a view that can be defended on the physico-chemical grounds of catalysts which are measurable determinants of a really scientific order, experiments to prove the fact must take a very long time, and we are compelled to rely on other methods of proof. That the experiments of Tower and Kammerer, for instance, suggest the transmission of modifications cannot be denied. Such as oppose the general view that the environment has thus an inheritable moulding influence on the organism, seem to reply that these are only rare and doubtful

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cases, whereas the theory of inherited advantageous variations, whether continuous or discontinuous, can be made responsible for the whole of the phenomena. As the conclusion is gradually being strengthened that large variations of a Mendelian character deal with other characteristics than those which are racial, all who rely on inherited spontaneous variations are forced back on the Darwinian view that small variations can gradually, if of an advantageous kind, convert one species into two or more, and that all living characteristics, or organs themselves, are due to such a cumulative effect. It is, of course, inferred and definitely stated by Darwin, that any variation in the least degree injurious would inevitably be destroyed. It is this statement I propose to examine, and for the purpose of such an enquiry it must be clearly understood what is meant by the word 'disadvantageous' or injurious.

At first sight nothing seems clearer. Why should we doubt that any functional or organic failure is a handicap in the biological race? By functional trouble of which the cause is not obvious we mean some hindrance, which may be recovered from, to normal or physiological action. It is due to factors which, for the most part, are unknown. We do not doubt that there is a failure somewhere, which, as regards certain cells, might be called organic, but often we cannot do more than guess where the actual failure occurs. In that advanced disorder of function which has visible lesions and destruction or irremediable alteration of the individual parts of the machine there is undoubted organic disease. Can anything seem more certain than the conclusion that any organism which fails in the established functions of its species is as a fact severely handicapped, that the variation is disadvantageous and cannot possibly be transmitted either directly or by survival? There are, however, some reasons for believing that this inference is inaccurate and that the function of disease in evolution is of much greater importance than that of mere elimination. But pathology has very naturally been neglected as a study by biologists. On the views generally held, it has seemed sufficient to recognize that disease destroyed organisms which obviously left offspring, if it left them at all, that were handicapped even more heavily than their parents. It has been understood that their elimination was only a matter of time and that neither their virtues nor their failures could influence the race.

If there is one thing more than another which has struck me when attempting to study these questions, it is that too many men of science appear to believe that any serious investigation of other branches than their own is for them a waste of time. The physiologist ignores the pathologist, who in his turn is far too likely to fix his eyes on morbid phenomena which cannot be properly appreciated save by those with a knowledge not only of normal function but of the general physiology which underlies it. The same can be said of most workers in science, but in no



case is it more likely to occur than in that of the biologist, who, by the very name and nature of his task, should include in his apparatus a considerable knowledge of everything which deals with the organic, and even inorganic, world. Science, however, is kept in more or less water-tight compartments, and it seems left to the mathematician to hold the opinion that his own branch of learning has, somehow or another, deep relations with all things, including life itself. Even by him it does not seem to have been pointed out that in things living and non-living certain principles of construction rule alike. However much they were wedded to mechanico-physical explanations, biologists have assuredly often ignored the fact that any organism is construction, and knowing little of the laws of construction have ignored basal facts familiar to every architect or even every artisan. It was reserved for Wolff, in formulating his law of bone-growth and reaction to stress, to propound a principle more far-reaching than he recognized, when he showed that living bone, reacting to normal or abnormal stimulation, can be proved to develop in accordance with the principles of engineering and architecture. This law may, I feel assured, be extended to every living tissue, and in such an extension will be found the key to many phenomena still awaiting explanation.

To one who holds this view, the work lately done by Starling on the "Law of the Heart," which shows that the force with which the heart contracts is directly proportional to the length of the muscular fibres at the end of the preceding diastole, is by no means surprising. It is indeed on a par with the conclusions of Wolff as regards bone, and might, I believe, have been deduced from it or from the form I suggest, provided it is understood that each varying tissue has its own acquired typical reaction.

If, then, it can be shown that disease has had a profound effect upon the evolution of all organisms, and that analogous results are found in every kind of human constructive effort in such numbers as to suggest a law that all great variational developments result not from the happy-go-lucky aggregation of small advantageous variation or from discontinuous variation, whether of a Mendelian character or not, but rather from partial failure and repair, we seem to be in sight of a general principle of profound importance. If this principle proves sound, it is obvious that immense labour has been spent by biologists endeavouring to explain life without seeking help from other workers. Though they may show some general knowledge of the cell, and even special knowledge of the reproductive cells, I find few who appear to have studied general embryology, to speak only of one branch of physiology. On the other hand, many physiologists and pathologists have done good work in some branches of evolutionary theory. Bland-Sutton, in his fruitful little book 'Evolution and Disease,' pointed out that "Pathology is only a department of Biology, and it is important to bear this in mind in studying disease." It is true that he went little further than to show that

what is pathological in one organism may be physiological in another and that many diseases are reversions, that is, failure in normal growth. Yet this greatly needed to be shown, and it is not to be expected of a great pathologist and surgeon, and perhaps the less the greater he is in his own branches of work, that he should attempt tasks from which many of the biologists themselves seemed to shrink. Claude Bernard made similar remarks as to pathology. It is to be regretted that a stumbling block was placed in the path of progress by Darwin's hopeless dictum as to the explanation of variation, just as another was by Huxley when he declared consciousness an insoluble problem. In every science great discoverers have too often delayed progress as much by authoritative unsound opinion as they have advanced it. Every Bible is first a book of revolution and then a refuge for reaction. Yet no man can possibly know all he should know for the purposes of his own work. This fact affords the only justification for those, who cannot pretend to profound knowledge in any special line, attempting to solve problems which by their nature are beyond the specialist. They may have been able to grasp in a measure the general conclusions of each science and by a happy, perhaps accidental, combination, show at least part of the forest to those more particularly occupied with the trees themselves or the flora of the undergrowth.

It is remarkable that hitherto no one seems to have made the observation that reaction to an actual, or threatened, breakdown is one of the basal laws of all construction and organization. Yet none can read engineering without observing that all development has followed such lines. As new stresses are introduced failure is threatened and steps are taken to obviate disaster. What is a patch in one engine becomes organic in the next. Since waste of energy can be looked on as pathological, we observe the reaction in the engineer against such failures, as the atmospheric engine is succeeded by improved forms ending in the quadruple expansion engine. Many other instances could be adduced in general or special engineering evolution, but the best illustration of the facts which need elucidation can perhaps be found in Gothic architecture. If such a demonstration of this general principle can be made it will go far to obviate the objection, very likely to be made, that what occurs in human construction has no relevance to the living organism, especially if it can be suggested forcibly that human intelligence is in itself a reaction, and that the law obtains in developments of all kinds. That trial and error are at the base of evolution is indeed implied in the current teaching as to variation, and its extension to intellectual processes will surprise no worker who has had to deal experimentally with the unknown. We may expect, but never know where to look for, failure till we see it. When it is seen we can do our best, as reacting agents, to remedy it. Having said so much, and leaving aside the wider implications of such views, we may turn to such a problem of construction

as the evolution of a cathedral, in the hope that it may throw a light on other than architectural puzzles: merely observing, on the way, that no general principle yet discovered is confined in its application to one branch of knowledge. Having once found it, our task is to employ it as a weapon of further analysis.

It is more or less a commonplace that function creates structure, however Lamarekian that may sound, and in the case of architecture of a religious order the function which constructs is public worship. In fine climates the necessary structure is often a roofless temple. In tropical climates a flat roof may be needed as a protection against the sun. In temperate climates a walled enclosure is insufficient and a flat roofed structure cannot keep out rain effectually or bear heavy snow. Thus arose the pointed or sloping roof. But it has been said that "Gothic architecture is not a style. It is a fight." The arch is a mighty warrior. It gives and receives thrusts. The sloping roof partakes of the same nature. Need created it and the nature of materials and the positional energy we call gravity caused thrusts which endangered the simple walls of the building, walls at first meant to endure nothing but flat roofs probably covered with brush or the like material. To build stronger walls might have occurred to the primitive architect, but as the danger was immediate, he probably at once shored those in existence, and then built others at a right angle to act as buttresses. In the meantime the worshippers increased in numbers, and it is indulging in no flight of fancy to suppose the later builder saw that if the new external walls were roofed over and doorways cut into the main building, there would be an immediate increase of space by the creation of chapels. Such a series of embryonic additional walled spaces, with further doorways in them leading to each other, obviously gave him the aisles. The flying buttresses which are such a feature in great Gothic architecture had, I can only suppose, a like origin. They were originally buttress walls carried up to the roof. At some period a genius, already acquainted with arcuated structure, saw that if the inside of these walls was cut away they would still take a heavy thrust and lighten the rest of the building. If, however, on being converted into such slender stone shores they showed signs of yielding, what could be easier than to pile some of the material taken away on the base of the flying arch and thus create the beginning of the pinnacle? Though an architect might develop such a rough statement, he would be the first to admit that it represents in few words much of the evolution of a church; that is, he would own the structure sprang from need, and that each new need caused a constructional failure which, when strengthened and corrected, was the cause of further structure. He would further tell us that all good ornament is organic; that it springs naturally from the work already done, being in its origin just the little more needed to give a margin of safety, though on it later are exercised the aesthetic faculties of man, which are again a response to the need of full

satisfaction for the instinct of workmanship. Human ornament is in fact strongly homologous, if we may use that word here, with the beauty of very energetic birds, who carry out by virtue of their free energy the extension of structures and colours already existing in their less brilliant forms. That, however, is by the way. The main fact we are concerned with is that the structure as a whole evolved through trial and error, through failure and repair, through a threatened structure to a more complete and adequate one for increased function. In a word, the great origin of structure was failure after failure duly compensated for. Is there any reason for believing that variation in the structure of living organisms follows exactly the same principle? Are we entitled to say that the mammal, for instance, with all its complexity, is the result of infinite ages of functional failure or disease which was met by processes of repair and reaction? In a word, can we speak of the evolutionary value of disease, of impaired function, of disadvantageous variations? It seems possible to do so, if what is true of one structure is roughly true of another.

It may seem absurd to speak of the value of disadvantageous variation, but it is no more absurd than to imply that all variation is advantageous because it is perpetuated. What is useful at one period may be harmful at another, and embryologists thoroughly understand that developments useful in foetal or larval life may open up many dangers for the adult. The real point to be considered is whether organisms as species do not vary and run great, even largely destructive, risks by an increased pressure of function which, in the few that finally react or whose descendants react to such stress, results at last in structure that is advantageous *as altered*. The given variation in itself may be a failure of what was normal function in the species, and we should therefore as pathologists or physiologists speak of it as disease, but if the few that recover become a new species, a *mended* race, it is no longer disease. After many generations it may be truly advantageous to individuals. Have such processes occurred in the evolution of organisms as they undoubtedly have in the arts and social progress, where we often observe political failure or organization result in *ad hoc* reaction which leads to a changed social form? I have no doubt that they do, and many organs in mammals, to speak only of them, show it. It is, in fact, a universal principle. As beavers patch up a dam when it yields or threatens to give way, so tissues, organs, and societies react to threatened disaster. In no tissue is this clearer than in bone. It is true that Wolff's law only deals directly with mechanical stresses, since it runs—"every change in the form and position of the bones or their function is accompanied by certain definite changes in their internal architecture and by equally definite secondary alterations of their external conformation in accordance with mathematical law;" but I hope to show reasons for concluding that such a law may

be stated in more general terms and applied to every tissue and organ, provided we add that the more complex the tissue or the organ the greater the liability of failure, and that each tissue reacts in a typical way.

It is unnecessary to go into details of osteogenesis and morphology. It has been recognized by engineers that the head of the femur is formed exactly in accordance with mechanical law. Had any of them been required to design a structure fit for undergoing the stresses borne by the femur in its development and after-life, he would have sketched a figure extremely like it, not only in its general shape, but in the trabeculae which support the bone in every direction where extra stresses are applied by normal function. The important point to note is the fact that femoral development follows stress in individual development, from which we must draw the conclusion that it followed stress during evolution, not that its value for complex function was gradually increased by chance or "spontaneous" variation, unless we attribute to "spontaneous" a meaning which Darwin never gave it, seeing that he denied knowing how variation arose. All the variations were definite responses, and it is easy to infer that before response became rapid and easy every kind of disaster and disablement must have occurred to those subjected to reaction-provoking stresses. The very process of adaptation (and on these lines "adaptation" is no longer a mystic word) implies long periods of disordered function and poor structural response even in those who survived after repair. But now bone is so plastic and fluent that when it is grafted the osteoblasts and osteoclasts shape it according to the form of the main bone of which it becomes a part.

When we speak of repair it may be noted that the treatises on this subject are strictly limited in their purview. They mostly follow Hunter, a vitally important figure in the history of pathology and indeed of all medical science, who, however, lacked the apparatus of knowledge now at every one's disposal. We learn a great deal about the repair of wounds and fractures: of the functions of the fibroblasts or of the wandering cells of the blood-stream, and are told, lately, much of regeneration, but of the evolutionary value of organized exudations we hear nothing. Nor has it been suggested that it is to this and analogous processes that much new structure is due. That this is so is strikingly apparent, as I shall attempt to show, in many organs of a highly specialized type. In no structure, perhaps, is the process so clearly seen as in the mammalian heart, which is a perfect museum of evolutionary failures and dislocations, compensated for by an extraordinary complication of patched-up tissues and organized exudations in which, perhaps, one tissue takes on the functions of another and some evolutionary remnants long survive without function. I was, indeed, first led to take this general view of the variational value of pathological conditions by observing that the heart, when laid open from any

aspect, powerfully suggested an organized or cured aneurism. Many must have made the same observation, even if they have not come to similar conclusions. The anatomist and pathologist perhaps know their subjects too well and are necessarily greatly dominated by current theory. The general adaptation of the heart to the work it performs may well delight the anatomist as he studies its machinery. His main business is not evolution. The pathologist on the other hand, observing its many failures, is scarcely likely to discern that by failure itself may come eventual perfection, and while the physiologist considers its functions rather than its apparatus, he studies it as it is, not as it was. In each case the observer may not see the forest for the trees. Yet when we look at the partially repaired aneurism with its fibrous growths and turn to the opened heart, the essential relationship of the *chordæ tendineæ*, for all their definite functions, to the rude fibres of an aneurism is obvious. Is such a likeness an accident of evolution and pathology, or are we to consider the heart as much an organized dilatation sac of the whole fused circulatory canal as the cured aneurism is of a part of it? It is in embryology that we seek for confirmation of what is suggested by anatomy. But even anatomy alone offers powerful proof of the view that the heart, as we know it, is the latest result of repeated failures of the circulatory canal under strain and of the repairs effected by the stressed tissues in their response to changed and abnormal stimuli, just as bone alters under its particular stresses. During embryological life there is found in the heart a small patch of non-functioning muscle in the anterior segment of the mitral valve. Its presence is intelligible if we consider it a relic of a disrupted and repaired organ. The muscles of the heart are obviously homologous with those of the arteries. Yet they have become striated although they are, of course, still involuntary. Non-striated muscle is the earliest in evolution. It seems that the increased functioning of the cardiac muscle has converted it into its striated form so that it resembles skeletal muscles, which are much more active than non-striated muscle. The whole histology of cardiac muscle probably represents the result of great strains. Structures such as the disks or bands of Ebarth are found nowhere else and may be the result of peculiar stress. There are even portions of muscle which no longer perform muscular functions. Their fibres do not contract but serve instead to conduct stimuli as if they were nervous tissue. All tissue is conductive, but the bundle of His, with its Purkinje fibres, which carries the impulse from the sino-auricular or Keith-Flack node to the ventricle, transmits messages at ten or twelve times the normal muscular rate. When it fails there is heart block. In the embryo the valves arise from the cardiac walls and are composed of muscular tissue which by the action of fibroblasts gradually become non-muscular. This must have been originally a pathological process. It is a reversion, a degeneration made use of. We observe

analogous, or shall I say homologous, results in the hypertrophied heart. The normal male heart weighs about eleven ounces. In some cases of aortic stenosis it may weigh over thirty ounces. In such hypertrophied muscle are often found fibrous tissues which probably represent the connective tissue of muscular fibres which have atrophied from overstrain. The *chordæ tendineæ* of the mitral valve are less muscular and more fibrous than the same attachments of the tricuspid. This adaptation difference lessens strain on the thinner right ventricle. It has, indeed, remained thinner on that account. In the reptile with a functioning *foramen* the valves are purely mechanical, as pressure is relieved by the patent orifice. The *fossa ovalis* in the mammal is a remnant of the early communication between the auricles. In a large number of normal hearts there is a small valvular passage yet remaining in the left margin of the fossa. None of these phenomena seem capable of explanation as the result of spontaneous variations arising from some theoretic instability of the organism. To argue that they are is to give biologic mystics a chance. It appears obvious from all these facts taken together that cardiac evolution has been a series of caused variations due to increased and varying stresses which acted not only as a moulding force on the shape and musculature of the heart but on all its appendages. In the muscle of the ventricular walls with its extraordinary complexity of layers and interlaced fibres lies powerful evidence of such reactions. In both ventricles there are seven muscular layers, while in the arteries there seems but one. In the left ventricle these layers are obviously thicker and stronger than in the less stressed right cavity. But how did the ventricular cavities acquire more layers than the arteries? There is obvious reason for believing that stress can be responded to by increase of muscle fibre during evolution. In the gravid uterus the smooth fibres of the wall increase to eleven times their normal length and are from two to five times as broad. There may be new fibres in it. I doubt if any one knows. But in evolution new fibres are undoubtedly found. In the arteries, the fibres of non-striated muscle in the *tunica media* are for the most part circular, but they appear to have more or less longitudinal branches which interlock with like branches of the neighbouring fibres. One of the most prominent features of an individual aneurism is the thinning out, and sometimes the disappearance, of the *tunica media*. The muscle fibres in such cases are completely broken down, and if the aneurism is repaired in individuals the work is done mostly by an increase of the connective-tissue elements. The process is said by some to be a reparatory endarteritis, in which the tissues of the *adventitia* proliferate actively. But the evolutionary process has obviously taken the path of increase and reactive proliferation of the muscular elements of the *media*.

It is often observed that the aneurism which displays sufficient reacting power to the stresses of the blood stream accumulates

blood clots in layers, and it is therefore all the more interesting to note that in the embryo the *columnæ carneæ* and *chordæ* appear to rise from a spongy network which at an early age fills the primary ventricle. Such origin is strongly suggestive of some process analogous to blood clotting or to an irritative reaction of the embryonic ventricular wall. The evolutionary dilatation sacs which I suggest were originally pathological can be seen in the embryo during the process of their formation. The path laid down by pathology is trodden by physiology. It follows that during evolution there must have been an immense destruction of organisms whose circulating canals did not react and numbers which retained their unaltered "specific" characters. The same process goes on to-day. Though many die of cardiac disease, it may be that much youthful functional trouble and even more serious adult disorders are even now remoulding the heart. No organ is perfect: if it does not degenerate it progresses. Though such processes are "disease," it by no means follows that they will be destructive, any more than that the functional incapacity of the tricuspid valves in athletes, which probably precedes what is known as "second wind," is anything now but a cardiac safety-valve.

As we learn more of the heart and its latent capacities we may perhaps say with the late Dr. H. G. Sutton, "we trust nature too little, to say the least of it." But there are, of course, great difficulties to overcome before we can hope to understand how the cardiac musculature has altered and may still be changing by the addition of new fibres. As yet, little is known of myogenesis. Like a neurone, a muscle cell seems to last a life-time, and though both may degenerate or die, neither proliferates after the early period of development. But whatever their histogenesis, new fibres do appear in evolution. Harvey did not refuse to believe in the validity of his own conclusions because he lived before Leeuwenhoek. With considerable hesitation I venture to suggest that morphogenetic stress is at its height during foetal development. The child *in utero* has not, perhaps, the calm and happy life commonly attributed to it. On the contrary, it probably leads a strenuous existence, and if it inherits a new weakness this is shown just where and when new stresses find plastic embryonic tissues to respond to them. If such a speculation is sound it accounts for many phenomena. But in any case, whatever the machinery of inheritance and evolutionary repair, it is certain that new fibres arise where they are needed.

If such views in any way represent the biological history of the heart, it is obvious that many of the opinions of variation usually held are without foundation. Every variation is definitely caused; it is in no sense accidental or spontaneous; it may not be even at once advantageous to the individual: on the contrary, it may be a severe handicap which puts greater general stress on



all who experience it, though such stresses fall short of those which cause death. Variations of this order may only be advantageous to the whole species as a continuing race. They may destroy, and doubtless have destroyed, individuals without number at an earlier age than the usual life-period of the unvaried type. We may possibly imagine a part of humanity, now responding to stresses which make the heart do more work and fail earlier, displaying such energy during their shorter life as to displace those with a normal cardiac mechanism which survives to the average age of man. It is to be inferred from these considerations that the structure of an organism is not a congeries of minute fortuitous advantageous variations, nor the gradual massing of details in an orthogenetic line, nor the result of large discontinuous variations due to chromosomatic inheritance, but a complex of definite reactions to definite stresses. The true theory of living structure is that its growth is neither casual nor foreseen, but that is what we may call, in political language, the "opportunism" of the organism as a whole. Every advance is a forced, even a desperate, experiment. Life, like a hypothesis or a dam, is built up by stopping leaks.

The evolution of the stomach seems to have followed the lines suggested for cardiac development. From the physiological point of view, a straight intestinal tube which becomes dilated cannot be considered anything but pathological. It has failed under the stresses imposed on it, but the organism which reacted turned a weak dilatation sac into a strong permanent food pouch. The results to the reacting organisms were many. The ingested food became temporarily static, was more thoroughly dealt with, and the organism was not continually feeding. Its whole available energy was not devoted to nutrition: it had time at its disposal and could develop other functions leading to further structures. That the human stomach is such an organized failure is suggested forcibly by the musculature. In the small intestine this is composed of two layers of fibres, circular and longitudinal. In the stomach it is made of three sets, an inmost layer of oblique fibres being added. This oblique layer is obviously a later growth and, as would be expected on the lines laid down as to disaster and repair, its strongest fibres are found just where they are wanted, that is, supporting the greater curvature or dilatation of the stomach. This later layer is naturally less well developed than the longitudinal and circular fibres. Other oblique fibres are formed about the pylorus where they form the sphincter. I suggest that these oblique muscle fibres arose as points of strain, under intense stimulation. The dilated pouch has reacted in accordance with mechanical law, just as the heart did with its more complex arrangement of oblique fibres woven into a structure capable of giving in the left ventricle a thrust of over fifty pounds. The reacting organism is no fool of a mechanic either in its bones or its muscles, and

these phenomena are additional reasons for extending Wolff's law to all tissues. If protoplasm did not so react there would be no problems to solve.

Such views on the mammalian gastric apparatus are so obviously supported by the embryology of the organ that there is no need to go into details beyond noticing that in the fourth week there comes the first dorsal bulging in the fore-gut. Of the curiously shaped fundus, Keith has remarked that it is in origin like the cæcum, but I do not think it has been suggested that its form has possibly been moulded by the presence of the large air bubble so often seen in X-ray photographs. It is an elastic air-reaction pouch just as the whole stomach itself is a food-reaction pouch. It began to give way there, but the process was stayed. So far as I am aware, it is not provided with obvious oblique fibres. Further investigation may find them.

If evolution is still proceeding, is it absurd to suggest that the common disorder known as dilated stomach may be a pathological process actually in the process of becoming physiological? According to some physicians, few modern stomachs do not suffer at times from an amount of dilatation which is pathological; *i. e.*, their gastric musculature fails to react correctly. The stomach may yet be such a functioning dilatation pouch as to enable the human race to do with no more than one meal a day or even less. Our descendants will have all the more time for work. This by no means implies that the empty stomach should be any larger than it is now in healthy subjects. Before the invention of X-rays the gastric apparatus was always pictured in text-books as usually seen on the post-mortem table. The dead stomach was shown as the portrait of the live one: the weakened pouch of the sick man as that of the live and healthy subject. But nowadays it is known that such extreme dilatation is natural only when a large meal has been taken. When the healthy stomach is empty it contracts so that it nearly resumes its ancient cylindrical character and is of a size not much greater than that of the small intestine. With further development it might hold still more and yet react in the same way. The suggestion that functional failure or disease which becomes organic and destructive in many, may, in reacting and surviving organisms, alter their outlook on life and all their activities, seems to me powerfully reinforced by these considerations. The disadvantageous variation does work, and finally improves the race.

It can even be shown that disadvantageous variations actually become permanent racial characters. We may consider hernias. In the prone position of most animals, hernial sacs, now known not to be essentially pathological until they are forced open by mechanical stresses or relaxed by organic weakness, are not a great source of danger. They may even be considered as an additional means of securing the peritoneum to its connective tissue. During the processes of evolution, however, a mammalian

hernia seems to have occurred almost universally and to have established itself as normally physiological. The *tunica vaginalis propria* of the testis is actually part of the original peritoneal sac, as can be seen in the embryo. During foetal life it is separated from the parent tissue. In whatever sense we now call such a change physiological it seems impossible to regard it as originally anything but pathological. Is it too startling to declare that it is an evolutionary sloughed tissue such as is often seen in strangulated hernias? I certainly do not know how we can describe the scrotum as anything else than the coverings of an evolutionary hernial sac which is not only of no advantage but a positive danger to most male animals. In some, the pigs for instance, the testicles do not descend into an external pouch but are supported and protected by the normal skin tissues, not by a thinned and delicate integument of later development like the scrotum, a tissue still scantily supplied with the non-striated muscular fibres which might have reinforced it and are perhaps now developing slowly. When we consider the rarity of muscular fibres in human skin tissues in comparison with those of animals, their greater frequency in the scrotum and perinæum suggests that they are a reaction product. They act in the *dartos*, or deeper layers of the scrotal dermis, at right angles to the rugæ and are something of a support. The pink colour of this structure is due to the presence of these muscular fibres. They are not connected in any way with the *cremaster* muscle and therefore not affected by the cremasteric reflex. In no sense can the descent of the testes be called advantageous. It causes a weak spot, recognized as such by men and animals. The Japanese wrestlers are trained from youth to return the testes into the inguinal-canals. If the translation of the testis from a safe place to an exposed one has had any good results they have been indirect and only discoverable, though not yet discovered, over long periods during which the change must have been disastrous to many. To argue that they were advantageous to begin with is to destroy the authority of reason.

It may seem an undue extension of the view that pathology has played an immense part in evolution if it is suggested that it was upon pathological conditions that the very existence of the Metazoa depended. There can be no doubt that they originated from some protozoon by a failure of normal physiological fission. We see here how theories of disease may be modified according to the point of view taken. From that, shall I say, of a protozoan Hippocrates or Hunter nothing can be more obvious than that a failure of mitosis would be a calamity, the birth of a monster, of Siamese twins, among the normally constituted unicellular organisms. It is still in the processes of reproduction that we find the strongest evidence of the part played by disease.

When considering such problems in this light it seems somewhat difficult to account for the satisfaction of many with the theory of small cumulative advantageous variations. What ground

is there for imagining such machinery could result in a complex series of adaptations such as the uterus and what we may call its habits and customs in dealing with the embryo from the entrance of the ovum till birth? Ever those who adapt to their own ideas some theory of large discontinuous variation will, in the end, be compelled to attribute the uterine growth and functions to a mystic power or virtue in the original germ. They may follow some philosophers and "unpack" powers out of a conjurer's bag without telling us how they got there. Yet if we regard the uterus as the result of tissue reactions under abnormal stimuli, being guided in research by the processes seen every day in disease, the variations, whether small or large, continuous or discontinuous, assume an aspect neither fanciful nor mystical, and our need for biological faith is reduced to a decent scientific minimum.

The fact that the embryo acts upon the maternal organism as a parasite against which the mother has to be protected, is commonly recognized, but I have not seen the obvious conclusion drawn that the whole history of the mammal must have been due originally to a pathological accident in some one or more of their ancestors. The mammalian animal still lays eggs, but they are not extruded. When such retention first took place, it must have been due to an accidental pathological delay of the travelling ovum, owing perhaps to catarrh of the tube. Even now the mother has to be rendered immune to the products of the offspring. Many of the phenomena of early gestation are those of immunization, in many cases a very slow process, as is shown in human beings by vomiting and malaise. It has, moreover, not been clearly or generally recognized except by pathologists that the very methods by which the ovum attaches itself to the uterine wall are, so far as the hostess is concerned, actually pathological and bordering on the malignant. Yet they have resulted in a series of protective reactions which save the parent and permit the growth of the parasite. The method by which the ovum becomes partially buried in the tissues is obviously of a destructive kind and curiously analogous to the malignant processes seen in chorion-epithelioma. Bland-Sutton remarks, "This disease is instructive because the erosive action of the trophoblast is the physiological type of the invasiveness so characteristic of many varieties of cancer." It may, I think, be added that it is the balance established by reaction which makes the trophoblastic action physiological.

That the influence of the ovum on the undeveloped tube must have been of an exceedingly dangerous character is now seen in tubal pregnancies during which the chorionic villi frequently penetrate the wall of the tube, which does not react as powerfully as the uterus. Such a process in the uterus, which is itself a tubal dilatation, is now normal because these villi, the earlier nutrition roots or organs of the parasite, are prevented from injuring the

uterine wall irrevocably by the transformation of the reactive uterine decidua and the chorionic villi and the allantois of the fœtus into the combined temporary organ known as the placenta. It may be noted that the non-placental mammals are less exposed to the destructive and toxic effects of their offspring as they are born at an earlier stage than in the case of the deciduate mammals. The marsupial fœtus is about half an inch in length when transferred to the milk-pouch. It is impossible to look at the placenta without recognizing that it is what we may call a compromise growth, one which serves the embryo without destroying the parent hostess. That all mammals are not yet fully armed against any morbid alteration of function in the penetrating chorionic villi is seen, as suggested above, in chorion-epithelioma, where the energy of the villi trophoblasts leads to a malignant overgrowth of the epithelial elements, which the maternal tissues fail to inhibit. The hydatid mole, which does not as a rule become malignant, is a case where such inhibition has been sufficient. All these cases, malignant or benign, support the view held by many that malignancy always depends on the failure of some tissue inhibition, and that if bacilli play any part in the drama it is that of helping to upset the balance between tissues which are fundamentally hostile though they exist normally in symbiosis. These phenomena regarded as a whole establish on a firm foundation the view that the uterus and its reactions during gestation are definite protective processes or variations springing originally from a purely pathological accident in some ancestors of the mammalians. However complex the embryology of the uterus and its appendages, the broad facts are compatible with this view, which is strengthened by the later parasitic history of the offspring after birth. The mammæ appear to be a compromise between the needs of the infant and the protection of the mother: they originated in sore or tender spots on the epithelium most exposed to the assaults of the parasite. The growth of the nipple is a complex variation depending on the mechanical action of sucking with a reaction proliferation of the epithelial elements of the sweat and sebaceous glands and an increased blood-supply as special maternal protections against oral infection. It seems to me that few stronger instances can be found of the fact that the development of many organs, if not all of them, is the result of direct reactions or adaptations which are in the nature of repair to tissues otherwise likely to suffer disastrously.

It is large macroscopic results of this order which enable us to reason about other finer reactions, and even help us to link to the general process those of a microscopic and ultra-microscopic character which we class under "immunity." Such phenomena are reactions under stress which, by the provocation of catalysts, influence life. Much of human character, even, is similar reaction, perfect or imperfect, to the infections to which the race

has been and still is exposed. Thus psychology itself must at last be classed as the result of physical reactions, a conclusion fully in accord with the work of Pavloff on conditioned reflexes.

If any further illustration of the conclusions so far suggested is necessary, it may be found in the growth of the mesentery. It has often been pointed out that the embryonic processes by which it is formed are histologically those of plastic organized exudations. The attachments of the whole tube do not come about at the same period of fœtal development, and it seems of significance when we note that the mesentery of the small gut has an oblique attachment, to the posterior abdominal wall from the duodenum to the right iliac fossa, only found in animals which have assumed the upright posture. This comes into existence as late as the fourth or fifth month of fœtal development. Before this band was formed there must have been a great series of disasters, for even now the last part of the mesentery to become attached to the abdominal wall, that is, the angle between the ileum and ascending colon, sometimes remains free. A volvulus may easily form there by rotation of the ileo-colic loop. The whole history suggests a series of lymph effusions, caused by pathological states, some of which were sorted out by the lethal process of natural selection, the remainder surviving and leaving offspring with the liability to organize the effusion in the safe way. The pathology of those cases in which what are known as Lane's Kinks can be found is obviously of a similar character. The stasis of the affected bowel causes lymph effusion and the formation of a band which is morphologically homologous with the early mesentery.

After reviewing phenomena such as these, the conclusion seems inevitable that single small favourable variations have not done the whole work of evolution. They may play their part as correlated changes, but they then take their place in a series of which the causes can be recognized. In combination with reasonable views of use and disuse and of increased or decreased blood-supply they may, perhaps, be held to explain such phenomena as the delicate co-aptation of some cardiac valves. Their place in the explanation of the phenomena of mimicry seems obvious. But though they may help us to comprehend how tissues become finished structures if they are combined with the results of functional energy, they yield no hint as to great or decisive developments and the mechanism involved in them. If the reasons adduced for the thesis laid down carry any weight, it is obvious that many, if not most, of the really decisive variations in all internal structure depended and still depend, not on variations which can be called favourable but on those that for the major portion of the organisms involved are directly disastrous: not on variations which are small but on those which are big enough to be appreciable as the cause of

immense functional and structural results: not on changes which can in any sense be called spontaneous, by which we may suppose is meant those no cause can be assigned to, but on variations, which, though they occurred ages ago, were obviously due to the very same causes that the pathologist can demonstrate to be working at the present day. Only such organisms as respond by direct reactions in a manner that finally turns out to be useful, or at the very least compatible with life and reproduction, are able to survive. The whole of growth and development thus becomes largely a function of effective morphogenetic repair to organic failure and disease.

Though this is not the place to deal at length with the vexed question of transmission of modifications, it may be remarked that the foregoing arguments seem to imply that such alterations as a matter of fact are inherited. I think some progress can be made if we simply assume provisionally that organisms *do* tend to repeat themselves and that it is *unlikeness* rather than *likeness* which requires explanation. We know that gross unlikeness is almost always due to a lack or excess of some internal secretion, hormone, or enzyme, and from this it may be inferred that likeness is due to such catalytic machinery coming over in the zygote, and to each differentiation producing anew its own peculiar products which stimulate or inhibit further growth and differentiation. Some time ago I was struck by a remark of Starling's that each new organism seemed a fresh "creation." He gave this up on account of the difficulty he found in the "time element" of the problem, but I venture to think he was right in his surmise. There is a growing body of opinion in support of this view, as the names of Cunningham, McBride, Dendy, and Bourne seem to bear witness. We must certainly take into account these regulators of metabolism, and if we accept the view that hypo-thyroidism determines cretinism, or, in the adult, myxedema; that hyper-thyroidism is the direct cause of the phenomena seen in Graves' disease, just as hyper- or hypo-pituitarism causes gigantism or infantilism in children while a later overgrowth of the gland causes acromegaly, I see no difficulty in accepting the hypothesis that growth is determined, *i. e.* stimulated or finally inhibited, by non-living catalysts or secretions not necessarily confined to the endocrine organs. In this way a bridge may perhaps be built between the orthodox Weismannian and the Lamarckian. Growth and character are caused by determinants, but these are not part of the cytoplasm itself, they are the machinery by and through which living matter acts. The organism is not built up by special protoplasm or by entelechies or by any mysterious *dan créatif*. It arises from the definite influence of definite catalysts originating, in an orderly sequence, as the organs become differentiated, while the individual is as a whole exposed in an infinite progression to the internal and external stimuli of a like but slowly changing

environment to which it reacts. The factors which did the work are working now.

To recapitulate the tentative conclusions arrived at, it may be suggested that—

1. Mechanical reaction to stress is a general law of all tissues.
2. Morbid conditions in many cases give rise to repair which becomes physiological.
3. Such repairs lead to new functions, new stresses, further morbid states and further repair.
4. These factors are some of the main causes of specific and generic differences.
5. In all probability transmission of changes caused in the way indicated does take place by a morphogenetic reply *in utero* to increased functional stresses.
6. As it is a narrow view to assume that pathology in all cases tends to death, the study of pathology and general physiology should be part of the preparation of the biologist.



## 15. Notes on the Beavers at Leonardslee, 1916-1918.

By Sir EDMUND G. LODER, Bart., Vice-President Z. S.

[Received June 24, 1918; Read October 22, 1918.]

From the books on Natural History we have been given to understand that Beavers breed only once in the year, and that the young ones are born between the end of April and the beginning of June, after a period of gestation which is believed to last about fourteen weeks.

In a book called 'In the Beaver World,' by E. A. Mills, it is stated that the number in a litter varies from one to eight, and that the eyes of the young ones are open from the beginning, and in less than two weeks they appear in the water accompanied by their mother.

It is difficult to give an opinion as to how old the young Beavers are when we first see them at Leonardslee. They are then about the size of rabbits, and we have supposed them to have been born six weeks or two months before, but we feel we have very little evidence to go on. I have always noticed the young ones of this size swimming about alone, the mother taking no notice of them.

In January 1916 a pair of Canadian Beavers were received here. (I will call these No. 1 and No. 2.)

On Dec. 11, 1916, a young beaver was seen, about the size of a rabbit. (I will call this one No. 4.)

On July 10, 1917, three young ones were seen; these again were about the same size as No. 4 when it was first seen. (I will call these three Nos. 6, 7, and 8.)

Some time in August 1917 two young beavers were seen on the bank together. One was considerably larger than the other. The smaller one was recognized as No. 4, and we have to come to the conclusion that the other must have been born in the spring of 1916, soon after the arrival of the pair Nos. 1 and 2. (I will call this one No. 3.)

On June 15, 1918, a young beaver was seen for the first time. Although only seen so lately, it is clear from its size that it must have been born some months ago, perhaps in December 1917 or January 1918. (I call this one No. 5.)

At the end of 1917 we had noticed that the old female seemed heavy in young, and were rather disappointed not to have seen any signs of a litter, but it seems that she had one after all.

On June 18, 1918, a very small beaver was seen (I call this one No. 9). It was not larger than a big rat. The little one was obviously out before the authorized time, for the mother (*not* the old female) went after it, and taking hold of a piece of its skin swam back with it to the mouth of the burrow, which is under water, and, letting go with her mouth, pushed it with her paws.

I think this young mother must be No. 3, which I suppose was

born in May or June 1916, therefore she was only just two years old when this little one was born.

It will be interesting to see how long it will take the young one to grow to "rabbit" size.

Now that there are two females bearing young ones, it will be difficult or impossible to make any exact observations.

It is certain that the old female had young ones twice in one year: in October 1916 (seen December 1916) and in May 1917 (seen July 1917), and it is probable that she had young ones on the following dates:—

April	1916,
October	1916,
May	1917,
December	1917.

For some periods Beavers will show up continually in the daylight, and then will come an interval when they are seldom on view, or only one or two.

When the pair of Canadian Beavers first arrived in January 1916, I saw only one at a time for several months, until at last I was afraid that one must have died; but, just as I had come to this conclusion, I saw the two together on the bank.

To get accurate statistics is not so easy as might be imagined, but I think that the notes I have made are not far from the truth.

16. On the Madagascar Frogs of the Genus *Mantidactylus*  
Blgr. By G. A. BOULENGER, F.R.S., F.Z.S.

[Received September 18, 1918: Read October 22, 1918.]

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Among the many peculiar features of the herpetological fauna of Madagascar is the fact of the genus *Rana*, so numerous in species in Continental Africa and the Indo-Malayan Region, having only two representatives: *R. (Tomopterna) labrosa* Cope, allied to the South African *R. natalensis* A. Smith, and *R. (Ptychadena) mascareniensis* D. & B., distributed over the greater part of Africa, the Seychelles and the Mascarenes included.

Most of the Madagascar frogs originally referred to *Rana* or *Limnodytes* (*Hylorana*) have proved to be distinguished by the presence of an intercalated bone between the penultimate and distal phalanges of the fingers and toes and have been referred to an autochthonous genus, *Mantidactylus*\*. In the species grouped by me under this genus, the swellings or discs in which the fingers and toes terminate bear on the lower surface a ring-shaped groove, defining a circular or transversely elliptic area, thus affording a further distinctive character by which to recognise them among those species of *Rana* in which digital discs are likewise present.

One species, *Limnodytes madagascariensis* A. Dum. (*R. inguinatis* Gthr.), which I had left in the genus *Rana*, has been shown by the late Dr. F. Mocquard to be also provided with the intercalary phalanx and therefore referred by him to *Mantidactylus*; but as in this species the small digital terminal expansions are devoid of the groove to which I now draw attention, I consider it to be entitled to generic distinction, under the new name of *Aglyptodactylus*. In this *A. madagascariensis*, the omosternum is forked at the base, as in *Mantidactylus*, the nasal bones are small, oblique, and separated from each other as well as from the frontoparietals, and the terminal phalanges are obtuse; there are no femoral glands.

We are now acquainted with 22 species of *Mantidactylus*, to which a twenty-third is here added. A key to the identification

\* Ann. & Mag. N. H. (6) xv. 1895, p. 450.

of the species was drawn up by Mocquard in 1909\*, but as this key does not seem to me to work well and as the arrangement therein followed does not at all express the natural affinities, I have prepared a synopsis in which I have endeavoured to make good these deficiencies, so far as it is possible to do so in a linear sequence.

*Synopsis of the Species of Mantidactylus.*

I. Glandular dorso-lateral fold, if present, not confluent with the supratemporal fold.

A. Discs of fingers very small, usually smaller than those of the toes; snout rounded or very obtusely pointed, not or but feebly projecting beyond the mouth; loreal region oblique; belly perfectly smooth, or very feebly granulate behind.

1. Toes entirely or nearly entirely webbed; head broader than long; back granulate.

Tympanum hidden or small, very indistinct, and distant from the eye; tibio-tarsal articulation not reaching beyond the eye; heels meeting or not, when the limb is folded at right angles to the body; tibia  $2\frac{1}{2}$  to 3 times as long as broad,  $2\frac{1}{2}$  to  $2\frac{3}{4}$  times in length from snout to vent..... *M. guttulatus* Blgr. 1881 †.

Tympanum distinct, small and distant from the eye; tibio-tarsal articulation reaching eye or tip of snout ..... *M. grandidieri* Mocquard, 1895.

Tympanum distinct,  $\frac{2}{3}$  diameter of eye; tibio-tarsal articulation reaching posterior border of eye..... *M. inaudax* Peracca, 1893.

2. Toes  $\frac{1}{2}$  to  $\frac{2}{3}$  webbed; head as long as broad; tympanum very distinct,  $\frac{2}{3}$  to  $\frac{1}{2}$  diameter of eye.

Series of vomerine teeth nearly equidistant from each other and from the choanæ; tibio-tarsal articulation reaching eye; heels meeting; tibia  $2\frac{2}{3}$  to 3 times as long as broad,  $2\frac{1}{4}$  to  $2\frac{3}{4}$  times in length from snout to vent; back smooth..... *M. alutus* Peracca, 1893.

Series of vomerine teeth much nearer the choanæ than each other; tibio-tarsal articulation reaching tip of snout, or between eye and tip of snout; heels strongly overlapping; tibia  $3\frac{1}{2}$  to 4 times as long as broad,  $1\frac{3}{4}$  to 2 times in length from snout to vent; back with glandular longitudinal folds..... *M. betsileanus* Blgr. 1882 †.

B. Discs of fingers small, as large as or larger than those of the toes; belly smooth or granulate only on the sides and behind.

1. Head as long as broad or a little broader than long; snout rounded or obtusely pointed; toes at least  $\frac{1}{2}$  webbed.

a. Tibio-tarsal articulation reaching tympanum or posterior border of eye; heels not overlapping; tibia  $2\frac{1}{2}$  to 3 times as long as broad, 2 to  $2\frac{2}{3}$  times in length from snout to vent; first and second fingers equal; loreal region oblique; back smooth or with indistinct flat warts; belly smooth.

Tympanum  $\frac{1}{2}$  to  $\frac{2}{3}$  diameter of eye; toes  $\frac{2}{3}$  webbed. *M. curtus* Blgr. 1882.

Tympanum  $\frac{2}{3}$  to  $\frac{1}{2}$  diameter of eye; toes  $\frac{1}{2}$  to  $\frac{1}{3}$  webbed..... *M. biporus* Blgr. 1889.

\* N. Arch. Mus. (5) i. p. 55.

† Includes *M. piger* Mocquard, 1900.

‡ Includes *M. multiplicatus* Boettg. 1913.

- b. Tibio-tarsal articulation reaching eye or between eye and nostril; toes  $\frac{2}{3}$  to  $\frac{3}{4}$  webbed; tympanum  $\frac{2}{3}$  to once diameter of eye.
- Loreal region oblique; tympanum not more than  $1\frac{1}{2}$  times its distance from the eye; tibia  $2\frac{1}{2}$  to 3 times as long as broad; inner metatarsal tubercle  $\frac{1}{4}$  to  $\frac{1}{2}$  length of inner toe; back with or without small elongate warts; belly perfectly smooth. .... *M. ambohitombi*, sp. n.
- Loreal region oblique; tympanum 2 to 3 times its distance from the eye; tibia 3 to  $3\frac{1}{2}$  times as long as broad; inner metatarsal tubercle  $\frac{1}{4}$  to  $\frac{1}{2}$  length of inner toe; back with elongate warts or glandular folds; belly granulate on the sides and behind ..... *M. ulcerosus* Boettg. 1880.
- Loreal region nearly vertical; inner metatarsal tubercle  $\frac{1}{2}$  length of inner toe; two glandular folds along the back ..... *M. bellyi* Mocquard, 1895.
- c. Tibio-tarsal articulation reaching beyond tip of snout; toes  $\frac{1}{2}$  webbed; tympanum a little smaller than the eye; three glandular folds along the back; belly smooth ..... *M. opiparis* Peracca, 1893.
3. Head a little longer than broad; snout pointed, strongly projecting beyond the mouth; tibio-tarsal articulation reaching anterior border of eye or nostril; toes not more than  $\frac{1}{4}$  webbed; belly smooth.
- Tympanum larger than the eye; first finger shorter than second; two glandular folds along the back ..... *M. arumnalis* Peracca, 1893.
- Tympanum about  $\frac{1}{2}$  diameter of eye; first finger as long as or slightly shorter than second; back with large glands ..... *M. glandulosus* Meth. & [Hew. 1913.
- C. Discs of fingers rather large, at least nearly twice as broad as the penultimate joint, as large as or larger than those of the toes.
1. Belly perfectly smooth; tibio-tarsal articulation reaching eye; heels meeting; tibia 3 times as long as broad, 2 to  $2\frac{1}{2}$  times in length from snout to vent; toes entirely or nearly entirely webbed; first finger much shorter than second; loreal region nearly vertical.
- Head longer than broad; snout pointed, strongly projecting beyond the mouth; tympanum  $\frac{3}{4}$  diameter of eye ..... *M. majori* Blgr. 1896.
- Head as long as broad; snout rounded or obtusely pointed, moderately projecting; tympanum  $\frac{1}{2}$  to  $\frac{3}{4}$  diameter of eye ..... *M. cowanii* Blgr. 1882.
2. Belly granulate behind and on the sides only; heels overlapping; tibia  $3\frac{1}{2}$  to 4 times as long as broad; toes  $\frac{3}{4}$  to nearly entirely webbed; inner metatarsal tubercle  $\frac{1}{4}$  to  $\frac{1}{2}$  length of inner toe; first finger a little shorter than second; tympanum  $\frac{2}{3}$  to  $\frac{3}{4}$  diameter of eye; loreal region nearly vertical.
- Tibio-tarsal articulation reaching eye, nostril, or tip of snout; tibia  $1\frac{3}{4}$  to 2 times in length from snout to vent; tongue usually with a conical papilla in the middle of the anterior third ..... *M. lugubris* A. Dum. 1853\*.
- Tibio-tarsal articulation reaching tip of snout or beyond; tibia  $1\frac{3}{4}$  times in length from snout to vent ..... *M. flavivrus* Blgr. 1889.
3. Belly granulate; heels strongly overlapping.
- a. Tibio-tarsal articulation reaching eye or tip of snout; tibia  $3\frac{1}{2}$  to  $4\frac{1}{2}$  times as long as broad,  $1\frac{3}{4}$  to 2 times in length from snout to vent; tympanum  $\frac{1}{2}$  to  $\frac{2}{3}$  diameter of eye; loreal region nearly vertical.
- Toes  $\frac{2}{3}$  webbed; inner metatarsal tubercle small, feebly prominent,  $\frac{1}{4}$  length of inner toe; a narrow dorso-lateral glandular fold ..... *M. granulatus* Boettg. 1884.

\* Includes *M. femoralis* Blgr., 1882, and *ambreensis* Mocquard, 1895.

- Toes  $\frac{1}{2}$  webbed; inner metatarsal tubercle strong and prominent, compressed,  $\frac{1}{2}$  to  $\frac{2}{3}$  length of inner toe; no dorso-lateral fold ..... *M. redimitus* Blgr. 1889.
- b. Tibio-tarsal articulation reaching beyond tip of snout; tibia  $4\frac{1}{2}$  to 5 times as long as broad,  $1\frac{1}{2}$  to  $1\frac{3}{4}$  times in length from snout to vent; loreal region oblique.
- Toes nearly entirely webbed; inner metatarsal tubercle  $\frac{1}{3}$  length of inner toe; tympanum  $\frac{1}{2}$  to  $\frac{2}{3}$  diameter of eye; a pair of inwardly curved glandular folds on the anterior third of the back, from the upper eyelids; heel with a dermal process or spur ..... *M. luteus* Meth. & Hew. 1913.
- Toes  $\frac{1}{2}$  to  $\frac{2}{3}$  webbed; inner metatarsal tubercle  $\frac{1}{2}$  to  $\frac{2}{3}$  length of inner toe; tympanum  $\frac{1}{2}$  to  $\frac{2}{3}$  diameter of eye; a curved glandular fold on each side from the upper eyelid to between the shoulders, followed by a straight fold ..... *M. pliciferus* Blgr. 1882.
- Toes  $\frac{1}{2}$  webbed; inner metatarsal tubercle  $\frac{2}{3}$  to  $\frac{3}{4}$  length of inner toe; tympanum  $\frac{2}{3}$  to  $\frac{3}{4}$  diameter of eye; upper parts rough with prominent glandular folds and tubercles; heel with a dermal process or spur ..... *M. asper* Blgr. 1882.
- II. Glandular dorso-lateral fold extending from behind the eye to the hip; loreal region vertical; tympanum  $\frac{3}{4}$  to once diameter of eye; discs of fingers and toes rather large; tibio-tarsal articulation reaching tip of snout or a little beyond; tibia  $4\frac{1}{2}$  to 5 times as long as broad,  $1\frac{3}{4}$  to  $1\frac{1}{2}$  times in length from snout to vent; toes  $\frac{1}{2}$  webbed; belly granulate behind. *M. albofrenatus* F. Müll. 1892\*.

Nothing is known of the development and larvæ of these frogs, but the eggs are remarkably large, measuring 5 mm. in diameter in *M. guttulatus* (♀ 120 mm. from snout to vent), 3 mm. in *M. lugubris* (♀ 50 mm.), 2.5 mm. in *M. betsileanus* (♀ 33 mm.).

#### MANTIDACTYLUS AMBOHIMITOMBI, sp. n.

Vomerine teeth in short transverse or oblique series behind the level of the choanæ, equidistant from the latter and from each other. Head a little broader than long; snout rounded, feebly projecting beyond the mouth, with indistinct canthus and very oblique, concave loreal region; nostril equidistant from the eye and from the end of the snout; interorbital region as broad as or a little narrower than the upper eyelid; tympanum distinct,  $\frac{2}{3}$  to  $\frac{3}{4}$  the diameter of the eye, 1 to  $1\frac{1}{2}$  times its distance from the latter. Fingers moderately long, first and second equal or first a little the longer, the discs small, not very much larger than the well-developed subarticular tubercles. Toes moderately long,  $\frac{3}{4}$  webbed, the discs about as large as those of the fingers; no tarsal fold; inner metatarsal tubercle oval, moderately prominent,  $\frac{1}{4}$  to  $\frac{1}{3}$  the length of the inner toe; no outer tubercle. Tibio-tarsal articulation reaching the eye or between the eye and the nostril; tibia  $2\frac{1}{2}$  to 3 times as long as broad,  $1\frac{1}{3}$  to 2 times in

\* *M. frenatus* Boettg., 1913, is probably identical with this species, although the hind limb is longer and the discs of the fingers and toes are described as very small.

length from snout to vent, as long as or a little shorter than the foot. Skin finely granulate above, with or without elongate flat warts on the sides of the body; a strong, curved glandular fold from the eye to the shoulder; lower parts smooth; femoral gland more or less distinct, with a single pit, or absent. Brown above, spotted or marbled with darker, often with a large dark triangular spot between the eyes; a dark canthal streak and a temporal band, usually light-edged beneath; a yellow vertebral streak sometimes present; limbs with more or less distinct dark cross-bands; hinder side of thighs usually dark brown, with small yellow spots. White beneath, uniform or mottled with brown, or nearly entirely brown. Male without vocal sacs.

Nasal bones rather large, narrowly separated from each other and from the frontoparietals.

From snout to vent 65 millim.

Several specimens from the Ambohimitombo Forest, Madagascar, from the collection of Dr. Forsyth Major, 1896.





17 Ciliary Action in the Internal Cavities of the Utenophore  
*Pleurobrachia pileus* Fabr. By JAMES F. GEMMILL,  
M.A., M.D., D.Sc., F.Z.S.

[Received October 2, 1918: Read November 5, 1918.]

(Text-figures 1 & 2.)

During life ciliation is active throughout the internal cavities of *Pleurobrachia*; and the latter are wide enough to allow the direction of the ciliary action on their different surfaces to be made out from the motion of particles suspended in the contained fluid, *e. g.* small oil globules, alimentary particles, and debris.

The "circulation" \* is an extremely orderly one and meets the physiological need for continuous regulated change through the whole of the internal cavities.

On the whole the circulation inside the funnel system goes on independently of that within the stomodæum †. So far as I could make out, except under the influence of peristaltic action, only slight interchange of fluid between the stomodæum and the funnel takes place.

I. *Stomodæum* (text-figs. 1 & 2).

Round the margin of the mouth there is a very narrow band best seen in young specimens, the cilia of which strike into the mouth-cavity. Up the middle of each lateral wall of the stomodæum, and continued on the thickenings in this region, and to the infundibular opening, there is a track with aboralward ciliation. Over the rest of the lateral wall of the stomodæum the ciliation is oralwards with a slant towards the sagittal angles. Along the sagittal angles from the opening of the funnel to that of the mouth the ciliation is stronger and in the oralward direction.

II. *Funnel and Canal System* (text-fig. 2).

We may best follow the circulation here by beginning in the floor (oral wall) of the funnel at points on opposite sides of the opening from stomodæum into funnel. It will be remembered that the aboralward currents up the middle of the sides of the stomodæum lead to these points. Working transversely outwards

\* Reference may be made to the following recent papers on ciliation:—

Carlgren, O. Biol. Centralbl. xxv. 1905, pp. 308-322 (Actinians, Madreporarians).

Orton, J. H. Journ. Mar. Biol. Assoc. U. K. ix. 1912, pp. 144-478 (Ascidians, Molluscs).

Orton, J. H. Ibid. x. 1913, pp. 19-49 (*Amphioxus*, Ascidians, Molluscs).

Gemmill, J. F. Proc. Zool. Soc. Lond. 1915, pp. 1-19 (Starfish).

Widmark, E. M. P. Zs. Allg. Phys. Jena, xv. 1913, pp. 33-48 (*Aurelia aurita*).

† In this paper the whole of the cavity between mouth and funnel-opening is called stomodæum.

Text-figure 1.

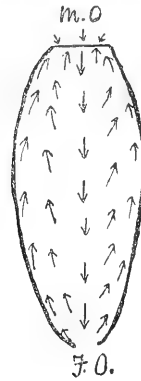


Diagram of lateral wall of stomodæum of *Pleurobrachia*, showing direction of ciliary currents.

M.O., mouth-opening; F.O., funnel-opening.

(For explanation see text.)

Text-figure 2.

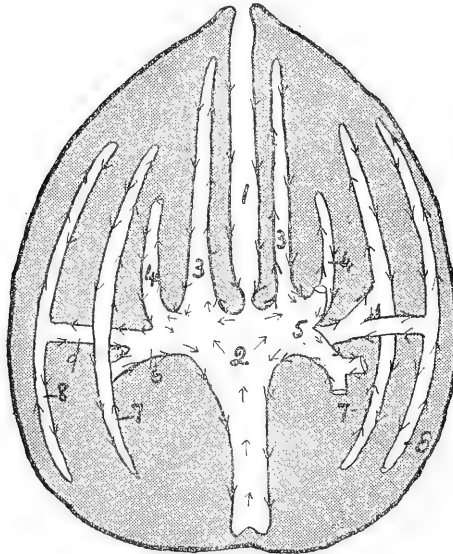


Diagram of internal cavities of *Pleurobrachia* (transverse or infundibular plane in plane of paper). The arrow-heads in the walls of the cavities point in the direction of the ciliary currents.

1. Stomodæum. 2. Funnel. 3. Paragastric canal. 4. Tentacular canal.  
5. Perradial canal. 6. Interradial canal. 7. A sub-sagittal canal. 8. A sub-transverse canal. 9. Adradial canal.

from either of the points in question we find the current strongly outwards towards the equator, in the floor of the funnel, but soon meet the opening into the paragastric canal. The axial wall of this canal carries cilia which strike oralwards, while on its abaxial wall the cilia strike in the aboral direction. The canal is thus bathed mesially by an in-going and laterally by an out-going current (text-fig. 2, 3). Exactly the same thing holds good for the ciliation and currents within the tentacle-canals (text-fig. 2, 4). On the floor (oral wall) of the perradial, interrarial, and adradial canals the ciliation is outwards, *i. e.*, towards the entrances into the meridional canals.

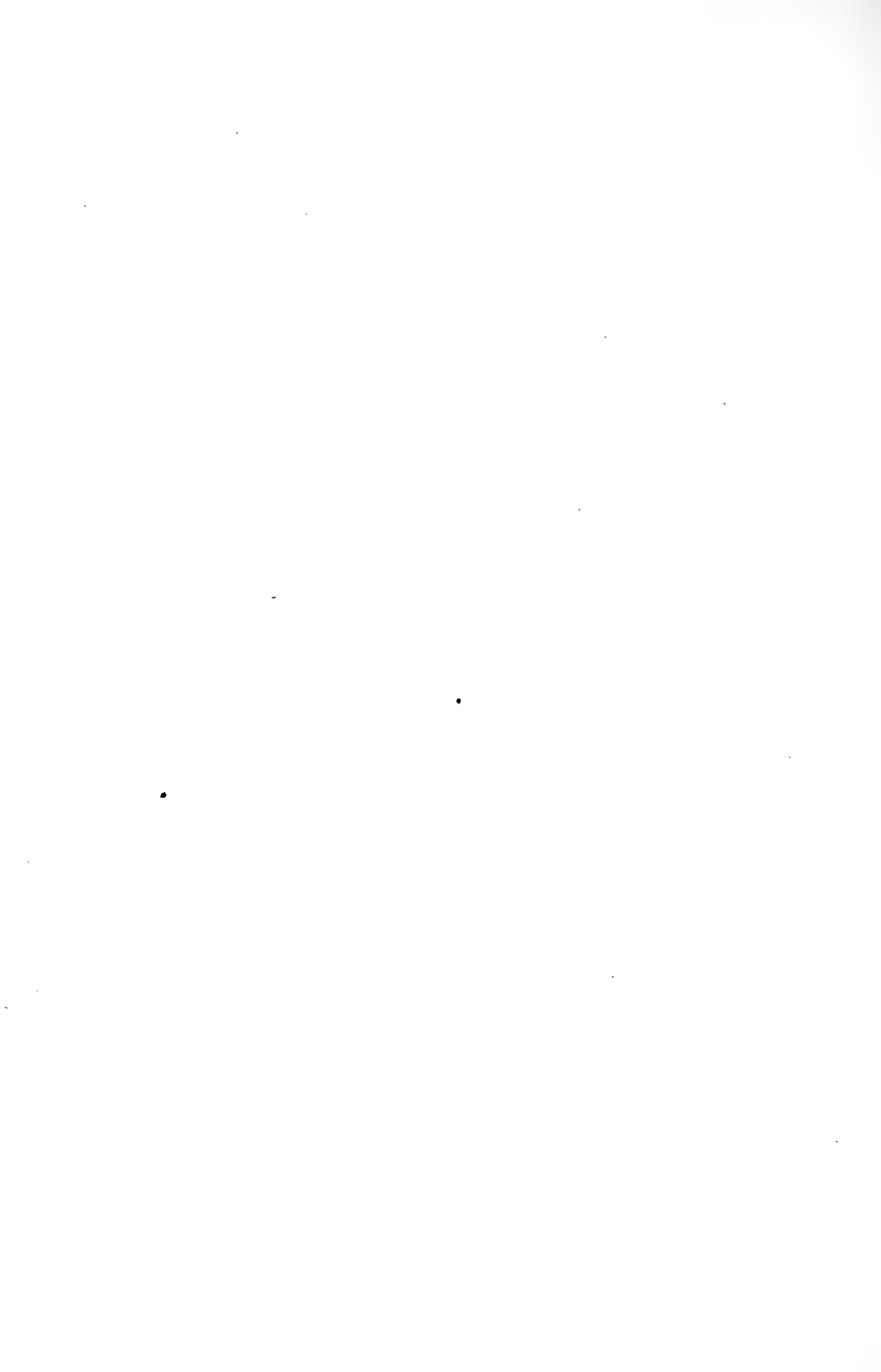
The adjacent halves of neighbouring sub-sagittal canals are ciliated along the whole length of their axial walls in the oralward direction. This holds good also for the adjacent halves of neighbouring sub-transverse canals. The areas of oralward ciliation thus correspond with the distribution described for the female gonads at the sides of the canals. The axial walls of the remaining halves of all the meridional canals (*cf.* distribution of the male gonads) are ciliated in the aboralward direction.

Along the roof (aboral wall) of the adradial, interrarial, and perradial canals the ciliation is inwards, *i. e.*, towards the main cavity of the funnel. The walls of the aboral extension of the funnel have an aboralward ciliation, while an oralward reflux takes place down the middle of this extension into the main cavity of the funnel.

Here mixing occurs and currents are caught up anew into the paragastric, tentacle, and other canals.

The arrangement above described proved constant for a considerable number of large and small *Pleurobrachia* examined. The tissues are transparent enough to allow the examination to be made in undissected specimens with the help of a binocular microscope. Fine carmine grains can be used to supplement the evidence of the particles floating in the gastrovascular fluids. Mixed with sea-water the powdered carmine will occasionally be ingested into the stomodæum by natural peristaltic action, or it may be injected into this cavity with the help of a pipette. After a short interval the carmine is expelled from the mouth, but meantime in successful cases sufficient particles to be visible have found their way into the funnel and the cavities leading therefrom.

The specimens were obtained last June at the Millport Biological Station, and the work was done partly there and partly at Glasgow University, the cost of obtaining material being met out of a grant from the Carnegie Scottish Universities Trust.



18. On *Seymouria*, the most primitive known reptile. By D. M. S. WATSON, M.Sc., Capt. R.A.F., Lecturer in Vertebrate Palæontology, University College, London.

[Received September 9, 1918 : Read November 19, 1918.]

(Text-figures 1-15.)

The reptile *Seymouria bayloriensis* was originally described from two imperfect skulls, one in connection with a few vertebræ and the shoulder-girdle, by Prof. Broili of Munich, whose excellent description made us well acquainted with the structure of the upper and lateral surfaces of the greater part of the skull, and gave general information about the palate, occiput, and anterior axial skeleton.

In 1910 Williston described as *Desmospondylus anomalus* a collection of vertebræ, a humerus, femur, and some other bones, which he subsequently recognised as belonging to a young *Seymouria*. In 1911 the same author described a beautifully complete skeleton, publishing a restoration to whose accuracy I am glad to be able to bear testimony. At the same time he suggested that the skull described by Cope as *Conodectes favosus* was really *Seymouria*, a determination which is undoubtedly correct. As Cope's description of *Conodectes* is quite insufficient for recognition of the skull, and *Seymouria* is a name universally known, I propose to regard *Conodectes* as a *nomen nudum* and relegate it to the synonymy.

In 1914, v. Huene published figures of the type skull of *Conodectes*, but added nothing to our knowledge; and in 1915 I gave a short description of such knowledge of the otic region as could be obtained from the rather badly preserved skull of *Conodectes*.

In January 1914, through the kindness of Prof. Broili, I was able to make a careful examination and drawings of the type material of *Seymouria* in Munich, which at that time, owing to a new and more complete preparation, showed many features of the structure of the palate and occiput which were not referred to in the original description.

In 1915 I was so fortunate as to collect some *Seymouria* material in Texas. The most important of my specimens was found weathered out on the side of a small hillock about 20 yards away from the Cradock bone-bed quarry. I at first supposed it to be a single individual, but have subsequently found that two are represented. The better individual is represented by the pelvis, both hind legs, fifteen presacral, the sacral and the caudal vertebræ in a connected series, and many ribs; these bones are connected by matrix and are all articulated. Almost certainly belonging to this individual are the atlas and axis and three

succeeding vertebræ, with the incomplete right scapula, coracoid, and clavicle attached by matrix, the occipital region and part of the right side of the skull and lower jaw, the lower end of a radius and ulna, and a metacarpus. The associated skeleton is represented by a sacral and nine presacral vertebræ, an incomplete femur and ischium.

Another specimen collected on West Coffee Creek consists of numerous fragmentary bones of a young individual washed perfectly clean. I also obtained certain isolated bones.

This material and the new preparation of that at Munich allow me to add materially to our knowledge of the structure of this most interesting form, perhaps the most perfect annectant type known to us.

### *Skull.*

Profs. Broili and Williston have given a satisfactory account of the upper and lateral surfaces of the skull. The Munich skulls and that of my skeleton give an equally complete knowledge of the occiput and palate. For reference I shall refer to that Munich skull which has a shoulder-girdle belonging to it as A, the other as B.

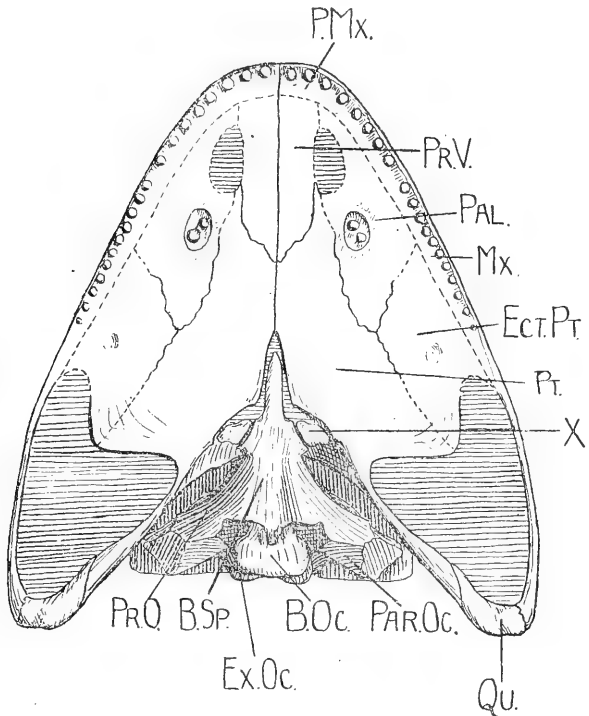
*Basioccipital.*—This bone is very well shown in my skull. It is a small bone, remarkably thin dorso-ventrally and of considerable width. The dorsal surface appears to be completely covered by the exoccipitals and forms no part of the floor of the brain-cavity. The posterior surface forms part of the condyle, which is wide from side to side, shallow and rounded. The ventral surface is widely exposed as a quadrangular area bounded in front by the suture with the basisphenoid. The posterior part of the lateral border is in contact with the exoccipitals, in advance of which it is cut out into a shallow notch, the lower border of the fenestra ovalis. Anteriorly the lateral margin is produced downward and outward to take part in the formation of the tuber basisphenoidalis.

*Basisphenoid.*—The basisphenoid is completely known, so far as concerns its inferior surface, from the Munich skulls and that of my skeleton.

Posteriorly it has a suture with the basioccipital, the ends of which lie on the summits of the well-marked tubera. From the tubera a pair of prominent ridges run forward on the ventral surface, so that this face forms a smooth concavity between them. At the level of the basipterygoid processes these ridges die out, so that the surface becomes gently convex. The basipterygoid processes (shown in Munich A & B) are extremely short and end in a flat articular surface, which does not directly support the pterygoid but is attached to a separate small bone very clearly shown in Munich B. The lateral surface of the basisphenoid, between the tuber and the basipterygoid process, is concave and passes indistinguishably into that of the prootic. About three millimetres above the lower edge of the tubera a minute foramen

opens out from the basisphenoid. A broken face about 5 mm. in advance of the tubera shows that in that region the basisphenoid is a thin plate scarcely a millimetre thick medially.

Text-figure 1.



*Seymouria bayloriensis* Broili.—Restoration of the palate,  $\times \frac{3}{2}$ .

General shape and palate from the types in Munich. Details of maxillary dentition from fragments in my possession. Basisphenoid and occipital region from my skeleton.

Reference letters:—B.Oc., basioccipital; B.SP., basisphenoid; Ect.Pr., ectopterygoid; Ex.Oc., exoccipital; Mx., maxilla; P.Mx., premaxilla; PAL., palatine; PAR.Oc., paroccipital; PR.O., prootic; P.R.V., prevomer; Qu., quadrate; X, autogenous basipterygoid process?

*Parasphenoid.*—The parasphenoid is well shown in Munich B as a short narrow rostrum projecting forward in the palate between the pterygoids.

The type of *Conodectes* shows that it supports a large ethmoidal ossification which surrounds the anterior part of the brain.

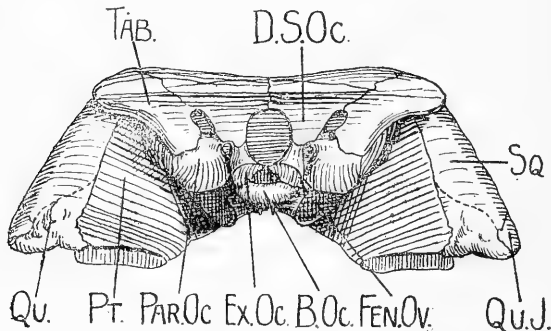
*Exoccipital.*—The right exoccipital is well shown in my skull,

in which unfortunately a piece about 2.5 mm. thick is missing from the middle of its height, this not having been collected.

The exoccipital rests on the upper and lateral surface of the basioccipital, meeting its fellow above that bone so as to form the floor of the brain-cavity in the occipital region. Posteriorly it projects behind the basioccipital and is provided with an articular face looking downwards and backwards which forms about a quadrant of the occipital condyle. Above the body the bone is continued up so as to form the side wall of the brain-cavity until its posterior surface is overlapped by the occipital flange of the dermo-supraoccipital.

On the inner surface the exoccipital is excavated into a deep pit from which a rather large hypoglossal foramen starts to pass through the bone and open into the large vagus foramen. In

Text-figure 2.



*Seymouria baylориensis* Broili.—Restoration of the occipital view,  $\times \frac{3}{4}$ .

Membrane-bones from Munich A. Quadrate from a young individual collected by the writer. Occiput from my skeleton.

Reference letters as before with :—D.S.Oc., dermo-supraoccipital; FEN.Ov., fenestra ovalis; QU.J., quadrato-jugal; Sq., squamosal; TAB., tabular.

front of the ridge which bounds the hypoglossal foramen anteriorly, the inner surface of the exoccipital turns outward and forms the posterior margin of the foramen for the Xth nerve. The upper end of the exoccipital is fused with the paroccipital, no suture being visible. It approaches its fellow of the opposite side over the foramen magnum, but leaves a space for the cartilaginous supraoccipital. In my skull the space where the supraoccipital should be is entirely free from bone, but in the type of *Conodectes* there is some evidence of a slight supraoccipital ossification.

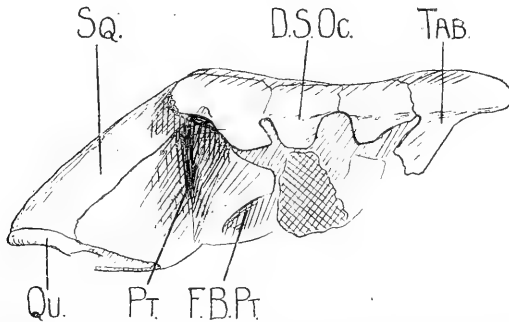
*Paroccipital*.—The paroccipital is fused with the exoccipital on the back of the skull. It is separated from the lower part of that bone by a large notch, the foramen for the vagus nerve.



Laterally to this it forms a deep plate extending downwards nearly to the level of the ventral surface of the basioccipital, where it ends in a suture with the prootic laterally and in a free margin, part of the border of the fenestra ovalis, at its inner end. The upper outer part of the posterior surface is overlapped by the occipital flange of the tabular. Between this region and the top of the exoccipital the upper part of the posterior surface is turned forward so as to form a groove, the lower part of the post-temporal fossa. The cranial end of the paroccipital appears to be narrow, so that the inner ear is widely open to the cranial cavity in the bony skull.

*Prootic*.—The prootic is fused with the lateral margin of the basisphenoid below and has a suture with the paroccipital behind. Its lateral face, which alone is satisfactorily shown, has

Text-figure 3.



*Seymouria baylориensis* Broili.—Occipital view of the type-skull  
Munich A,  $\times \frac{3}{2}$ .

Reference letters as before with:—F.B.Pt., facet on the pterygoid for articulation with the "basipterygoid process."

a powerful ridge running horizontally along it at about the middle of its height. Below this it is concave, its lower border forming part of the rim of the fenestra ovalis mesially and laterally uniting with the paroccipital, the joint bones forming the massive paroccipital process which in section has a V-shaped lower surface. Above the ridge the prootic is essentially flat, having however a deep groove leading to a foramen towards the outer end. The anterior edge of the bone is damaged, but the minute foramen for the facial nerve is just preserved.

The endocranial end of the bone is shown to be formed by an extremely thin shell.

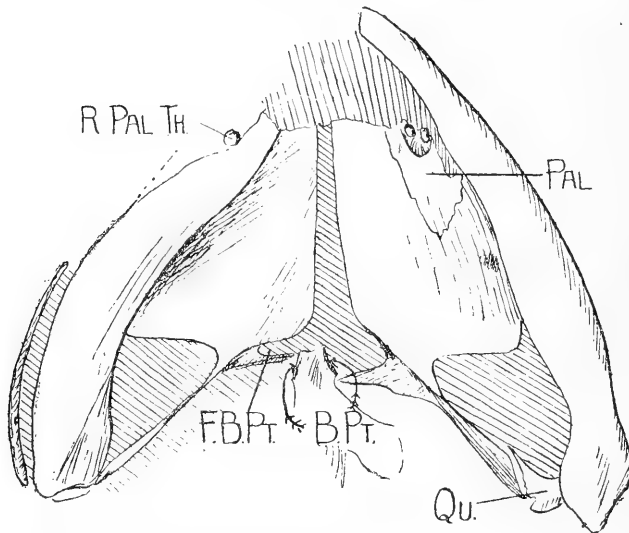
*Dermo-supraoccipital and Tabular*.—The dorsal exposure of these bones on the upper table of the skull has been accurately described by Broili. Munich A shows their occipital aspect perfectly. Each dermo-supraoccipital has a small descending

lappet passing vertically downward, the inner border of this forms part of the margin of the foramen magnum, the outer, that of the post-temporal fossa.

The tabular has a similar occipital flange forming the outer margin of the post-temporal fossa and covering a large area of the posterior surface of the paroccipital.

My skull suggests the presence of some sort of a flange on the ventral surface of the tabular articulating with the end of the paroccipital process.

Text-figure 4.



*Seymouria baylориensis* Broili.—Palate,  $\times \frac{3}{2}$ . Drawn from Munich A.

Reference letters as before with:—B.P.T., the basiptyergoid articulations on the basisphenoid; R.PAL.TH., right palatine tusk.

*Pterygoid.*—The pterygoid is completely exposed in Munich A.

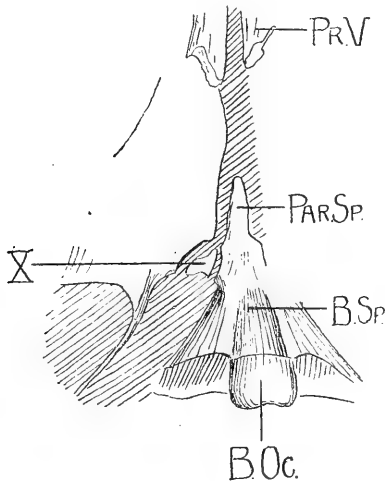
The quadrate ramus forms a vertically standing plate whose posterior surface is concave. The outer margin has a long suture with the squamosal below the otic notch, ventrally it separates from that bone so as to leave exposed an area of the quadrate, with which bone it has a large powerful suture.

The inner margin of the quadrate ramus approaches the anterior border of the prootic closely, the bone in this region though deep not nearly reaching the skull-roof. This part of the ramus bears towards its ventral edge a large, well-developed, slightly cupped articular facet.

When the perfectly preserved pterygoids and basisphenoids of Munich A and B are compared, it is seen that there is a large

triangular space between this facet on the pterygoid and that on the basiptyergoid process with which in ordinary reptiles it should articulate. In Munich B, this space is filled up by a small separate bone on the right side of the skull. The fact that although in A this bone is not preserved, the facets on the pterygoids and basiptyergoids are identical in the two specimens, shows beyond dispute that it is a separate bone. Nothing similar is known in any other Tetrapod.

Text-figure 5.



*Seymouria bayloriensis* Broili.—Palate,  $\times \frac{3}{2}$ . Drawn from Munich B.

Reference letters as before with:—PAR.SP., parasphenoid.

In advance of the quadrate ramus the pterygoid is represented by a large flat bone in the palate which articulates with its fellow in the middle line in advance of the parasphenoid, and laterally has sutures with the transverse, palatine, and prevomer. That margin of the palatal part of the pterygoid which forms the anterior limit of the subtemporal fossa is slightly deflected laterally, so that with the ectopterygoid it forms a small flange against the inner surface of the lower jaw.

*Ectopterygoid*.—The ectopterygoid is a bone of few features. It forms merely a plate in the palate articulating with the pterygoid in a suture only shown incompletely in my skull, a long suture with the palatine and presumably another with the maxilla. About the middle of its area in Munich A is a small depression probably intended to receive a tooth on the lower jaw.

*Palatine*.—The palatine is well shown in Munich A and in my

skull. It has a long suture with the pterygoid, is bounded posteriorly by the transverse, and in front forms certainly the back and apparently also a large part of the lateral margin of the internal narial opening.

Its most interesting feature is the presence of a pit surrounded by an upstanding ridge, lying on the palatal surface just posterior to the nostril. This pit contains two large tusks, which replace one another so that normally only one is functional at once. The whole arrangement is identical with the large palatine tusks and their pits in *Labyrinthodonts*. It is remarkable that this tooth has only been described by Cope in *Conodectes*. It is well shown also in Munich A and my skull.

*Prevomer*.—Only the posterior end of the prevomer is known. The two separate the internal nares and articulate with the anterior ends of the pterygoids.

*Quadrate*.—An incomplete but isolated and extremely well-preserved left quadrate belongs to my young West Coffee Creek specimen. It has a well-ossified and rounded articular margin rather conspicuously divided into two condyles. The anterior face is concave. The outer side is entirely occupied by a sutural surface for the quadrato-jugal and squamosal, and the inner retains the impression of the tip of the quadrate ramus of the pterygoid. The exposed posterior surface is triangular and bears an irregular knob.

*Ductus naso-lachrymalis*.—My skull shows quite clearly the presence of a naso-lachrymal duct lying within the substance of the lachrymal and extending from the orbit to the nostril.

*Septomaxilla*.—Whilst removing the matrix from the symphyseal region of the mandible of my skull, I found a single septomaxilla which had obviously dropped down through the posterior naris.

This element is a thin plate of bone bent round so as to clasp Jacobson's organ, and has a flat face for articulation with the dorsal surface of the prevomer.

*Lower jaw*.—My skeleton retains the right ramus of the lower jaw from the symphysis to behind the anterior end of the supra-meckelian fossa. Both inner and outer surfaces are well exposed, and a fortunate fracture along a horizontal plane lying just above the upper surface of the cavity of the jaw, which passes through the dentary and the three coronoids, places the structure beyond doubt, as it permits a definite distinction between sutures and cracks. The sutures are usually very visible, being filled with red iron oxide and the bone white.

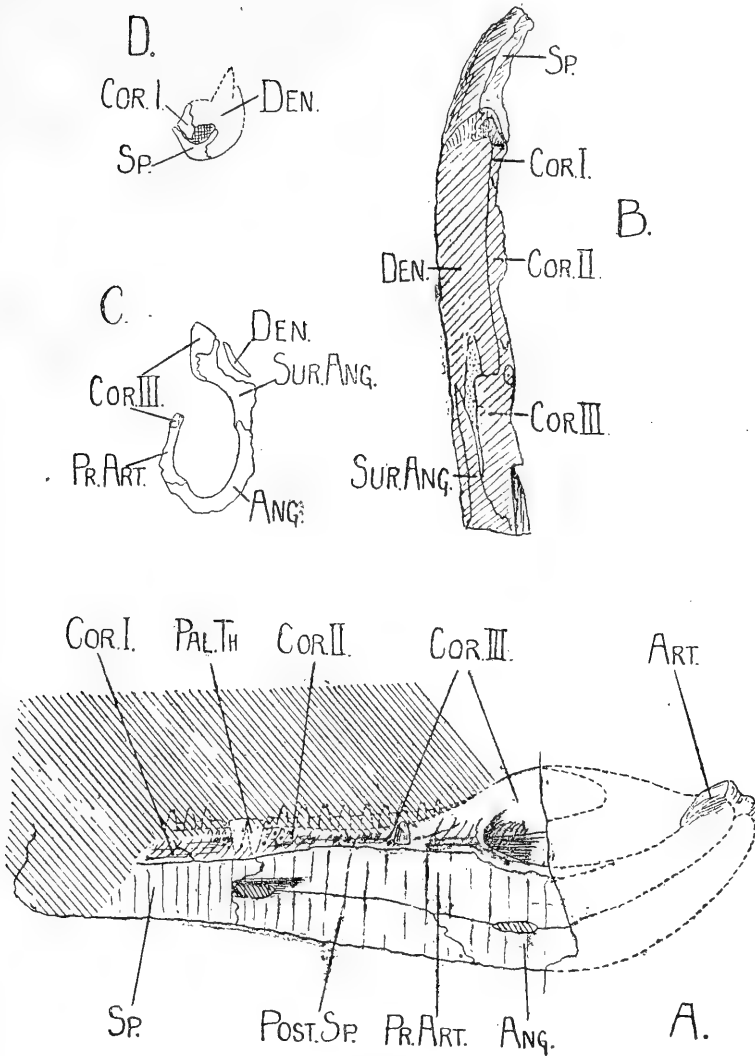
*Articular*.—Both articulars of the young specimen from Coffee Creek are preserved.

The bone is very short and ends anteriorly in a flat face continued in life by the remains of Meckel's cartilage.

The articular surface is convex from back to front and is divided into two areas, corresponding to the condyles of the quadrate, by a low ridge running obliquely across.

The outer face has a deeply depressed sutural area for the

Text-figure 6.



*Seymouria bayloriensis* Broili.—Right ramus of the lower jaw of my skeleton,  $\times 1$ .

- A. Inner surface. The area covered with parallel oblique lines is covered with matrix; the teeth in the dentary are restored on the evidence of fragments of that bone of a young individual. The articular is drawn from that of a young individual and is probably slightly too small.
- B. Ventral view of a horizontal fracture passing just above the cavity of the lower jaw of my skeleton.
- C. Vertical section seen on the broken posterior end of the jaw.
- D. Vertical section seen on a fracture through the splenial region.

Reference letters:—ANG., angular; ART., articular; COR. I, II, III, the 1st, 2nd, and 3rd coronoids; DEN., dentary; POST.SP., post-splenial; PR.ART., pre-articular; PAL.TH., the palatine tusks, represented in dotted lines to show their position with the mouth closed; SP., splenial; SUR.ANG., surangular.

surangular; the inner, more faintly marked depressions for the prearticular and angular. The posterior surface bears a minute knob representing the postarticular process.

*Dentary.*—In general the sutures on the outer surface of the jaw are not well shown. The dentary, however, forms the entire outer surface for some distance behind the symphysis, posteriorly it ends in a point which is received in a groove in the surangular. Fragments belonging to the young individual show that it carried a single series of rather large round teeth. Its admesial surface has a long perfectly straight suture with the coronoids.

*Splénial.*—The splénial appears to enter the symphysis. It forms the lower border of the anterior portion of the jaw, its suture with the dentary running along just above the lower edge on the outer surface. The greater part of the bone, however, forms a flat inner surface articulating above with the first and second coronoids, and behind with the prearticular and preangular.

*Preangular.*—The preangular is a channel-shaped bone forming the lower part of the jaw, articulating above with the dentary on the outer surface and the prearticular on the inner, with the splénial in front and the angular behind.

*Angular.*—The angular is only very incompletely preserved, but is a bone of the ordinary reptilian pattern.

*Prearticular.*—The prearticular is a very large bone running from the articular to the splénial. Its lower edge has long sutures with the angular and preangular, interrupted so as to leave an anterior internal mandibular vacuity between the prearticular and preangular and a posterior vacuity bounded by prearticular and angular.

*Coronoids.*—The fracture referred to above shows that there are three coronoids forming together a continuous strip wedged in between the dentary and surangular on the outside and the prearticular and splénial within.

The 1st or anterior bone is small and incompletely exposed, it is not shown to bear any teeth.

The 2nd is of considerable size, and in the middle of its length, which in life lies immediately outside the palatine tusks, is thickened and carries a tightly packed mass of small granular teeth.

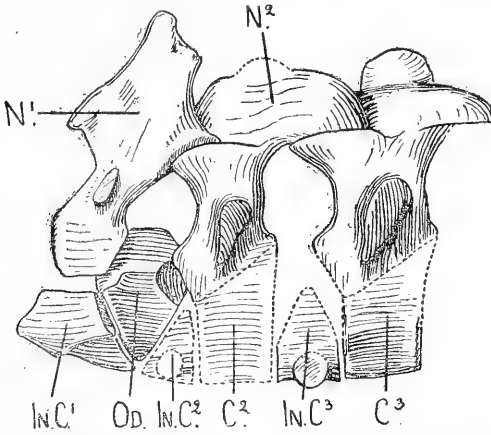
The 3rd, posterior, coronoid forms the anterior border of the supra-meckelian vacuity, extending back along the sides of that opening in contact with the inner surface of the surangular outside and the upper edge of the prearticular below. This 3rd coronoid bears one large bluntly pointed tusk at about the middle of its length: this tooth is oval in cross-section and was apparently received in a special pit in the ectopterygoid.

#### *Vertebral Column.*

*Atlas.*—The first vertebra preserved in my skeleton is the atlas. The parts preserved are slightly displaced.

There is a large hemicylindrical intercentrum whose width agrees with that of the basioccipital part of the condyle. The lower surface is smooth, short blunt-ended backwardly directed processes forming its lateral margin. The upper surface of this bone has laterally two large flat triangular areas for articulation with the neural elements; between these areas the anterior end of the bone is excavated into a conical pit, only half of which is present, but which resembles exactly that in the end of an ordinary centrum.

Text-figure 7.



*Seymouria bayloriensis* Broili.—Three anterior vertebrae,  $\times 2$ .  
Right lateral aspect. Left surface.

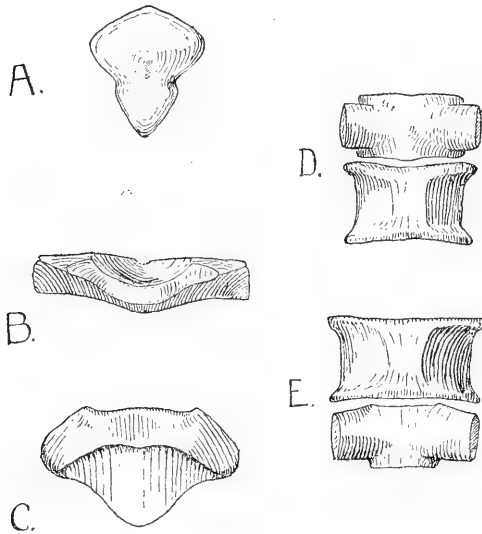
The atlas is composed of drawings of the elements in my skeleton replaced in what appears to be their natural relations, the centrum of the axis and the intercentrum before it are hypothetical.

C², C³, centra of 2nd & 3rd vertebrae; IN.C.<sup>1,2,3</sup>, intercentra 1, 2, & 3;  
Od., odontoid; N¹ & N², neural arches of 1st & 2nd vertebrae.

One pair of other elements is preserved. Each of these has a high laterally compressed but antero-posteriorly elongated neural spine, whose posterior margin descends directly to the hinder end of a well-formed posterior zygapophysis. The anterior margin of the spine descends vertically about to the level of this articular face, and then turns forward so as to lie horizontally and form the upper edge of a squarish area of bone whose front edge is rounded and articular and of considerable width. The lower part of this region ends in a short blunt point. It is obvious that the neural spines of the pair of elements lay in contact with one another and that the zygapophyses were supported by those of the succeeding vertebra. The anterior end could have articulated with the exoccipital part of the condyle, the intercentrum supporting the basioccipital part.

The odontoid is a single bone. Its upper surface is slightly rounded but presents no trace of any articulation. The posterior surface is not exposed. The anterior surface is slightly convex, rising to a small point. This surface is in general triangular with the point at the mid-ventral surface. The lateral edges are slightly emarginate at about the middle of their height so as to divide the whole area into three; of these, the lowest articulates with the anterior intercentrum, and the two dorsal with the neural arches. The lateral surface is nearly flat, but rises somewhat towards the ends; it is triangular, so that there must be a gap for a triangular intercentrum between the odontoid and the axial centrum.

Text-figure 8.

*Seymouria bayloriensis* Broili.  $\times 2$ .

- A. Odontoid from in front.
- B. Atlantal intercentrum from in front.
- C. Atlantal intercentrum from below, anterior end upward.
- D. Third intercentrum and centrum from below.
- E. Fourth centrum and fifth intercentrum.

*Axis*.—The second vertebra preserved differs in no important respect from the third and fourth. It has large well-formed and somewhat swollen zygapophyses, which are not very much produced laterally, the lateral part of the neural arch immediately below the articular surface being extended outward into a short



but well-formed transverse process bearing a rib-facet distally. The neural spine of this vertebra is destroyed.

The restoration (text-fig. 7) is only uncertain in the shape and size of the intercentrum between the odontoid and axial centrum and of that element itself. The sutures between the neural arch and centrum of the axis are obliterated.

The 3rd and 4th vertebræ exactly resemble the 2nd, except that the arches are wider and the transverse processes longer. The neural spine is represented only by a little ridge.

The 5th vertebra exactly resembles that in front of it except that it has a low but very massive neural spine.

The centra of the 3rd, 4th, and 5th vertebræ are short antero-posteriorly and have a very well-marked keel, their sides being excavated into deep concavities on each side of the middle line. The intercentrum between the 4th and 5th vertebræ is well displayed, it is nearly as long as the centrum before it, and laterally is carried out into well-marked processes for articulation with the capitula of the ribs.

The next vertebra completely preserved is the 9th, from which the series is complete and naturally articulated to the 10th caudal.

The 9th is a typical *Seymouria* vertebra with a small well-rounded centrum, considerably longer than that of the 5th. The arch is enormously wide and massive, but the ends of the comparatively slender transverse processes project well beyond the extremities of the zygapophyses. The 9th vertebra has a low but very massive spine whose summit is bifid.

From this vertebra to the sacrum the structure of the vertebræ remains very uniform, the only changes being that the transverse process gradually shortens, the spine becomes lower and more slender, and the ventral surface of the centrum becomes flattened.

The 10th vertebra is unique in that it is entirely devoid of the slightest trace of a spine. I myself removed the matrix which covered it, and the surface is still practically perfect.

My skeleton is abnormal in that the 23rd vertebra is asymmetrical, on the left side agreeing exactly with that in front, whilst the right side of the neural arch is much elongated and carries a sacral rib.

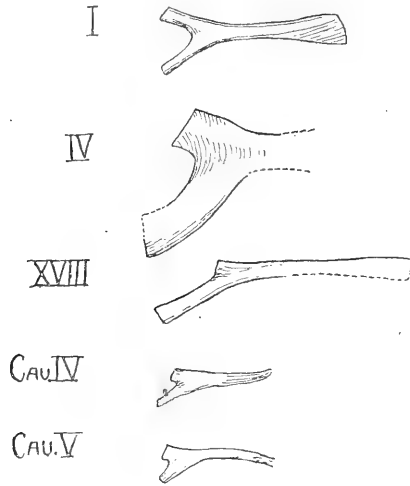
The 24th vertebra, the sacral, is only exposed on the left side, where it carries a very massive sacral rib, applied to the inner aspect of the ilium in the usual way. This vertebra has a relatively high and massive spine.

As Prof. Williston has already remarked, the first caudal differs markedly from all that precede it in its narrow and unexpanded neural arch. It has a fairly long transverse process. From here to the sixth the caudals do not differ much, except that the spine gets progressively more and more slender and leans more steeply backward.

The seventh and succeeding caudals bear no ribs and the transverse process has disappeared from them; their centra are

small and hourglass-shaped and separated from one another by an interval of more than their own length. The neural arch rests on the anterior part of the centrum and presents a large articular face to the space between the centra; the lower part of this space is in part filled up by the top of the chevron, but there can be no doubt that the condition in life was essentially embolomorous, the cartilaginous intercentrum not having ossified.

Text-figure 9.

*Seymouria bayloriensis* Broili. Ribs,  $\times 1$ .

The numbers are those which the bones drawn occupy in the series.

CAU. IV. & V. are caudal ribs.

*Ribs.*—The general distribution and structure of the ribs have been well described by Williston, to whose account, however, I am able to add some details of interest.

The long slender *atlantal* rib is double-headed, the capitulum and tuberculum being carried at the ends of two widely separated branches.

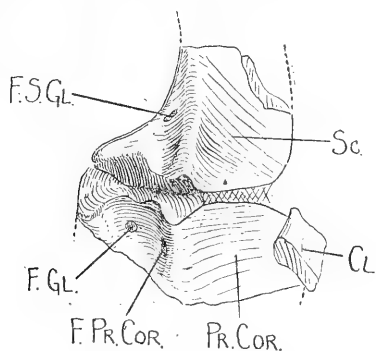
The upper part of the 5th rib, which has a very expanded distal end, is extraordinarily deep and massive. The two heads are widely separated, the capitulum articulating with a special process on the intercentrum.

From here backwards the ribs are more slender, and in the middle of the back the tuberculum is merely a facet on the upper edge of the rib, and not carried out as a special process.

The sacral ribs cannot be described in detail. The caudal ribs are remarkably long and massive, they are well curved, and if found separately would have been regarded as dorsals.

The ribs on the 4th and 5th caudals are very distinctly double-headed, having a distinct emargination between the well-marked tuberculum and capitulum. This feature is, I believe, known in no other vertebrate.

Text-figure 10.



*Seymouria bayloriensis* Broili.—Outer surface of the incomplete right scapula and precoracoid,  $\times \frac{2}{3}$ .

The fragment lying on the anterior end of the coracoid is clavicle.

Reference letters:—CL., clavicle; F.G.L., glenoid foramen; F.PR.COR., precoracoid foramen; F.S.G.L., supra-glenoid foramen; PR.COR., precoracoid; Sc., scapula.

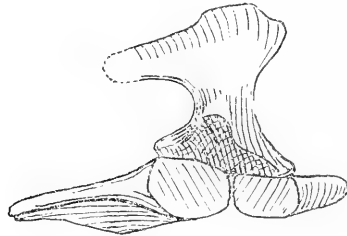
*Shoulder-girdle.*—The shoulder-girdle has already been well described by Broili and Williston, but some features of its structure have so far escaped observation and others are worthy of further emphasis. The scapula is exactly as Williston has described it, with a very broad supra-glenoid fossa, high up in which lies the small supra-glenoid foramen. My specimen shows clearly not only that it only articulates with a single coracoidal element, but also that it differs from the somewhat similar condition in *Varanoops* in not presenting an articular face for a cartilaginous posterior coracoidal element. In fact the evidence makes it quite plain that there was only a single coracoid, corresponding to the anterior one of most *Cotylosaurs*, the posterior not being represented even by a cartilage. The pre-coracoid is as Williston has described it, with a very deep fossa on its outer surface behind the front of the glenoid cavity. A small glenoid and a much larger precoracoid foramen open into the fossa.

The glenoid cavity is represented by a deep groove, V-shaped in section. This groove during life must have been filled up with cartilage, its margins map out a typical screw-shaped glenoid articulation.

*Sternum.*—The hard matrix lying on the inner surface of the

scapula and coracoid shows quite distinctly traces of an ossification or ossifications over an area about 2.5 cm. by 1.5 cm. This bone is of very open texture and has no definite surface, it was exposed so irregularly in development and its matrix is so extremely hard that no account of its shape can be given. It is certain that it does not represent a series of abdominal ribs or other dermal ossifications. It does not show any tendency to form long columns such as sternal ribs would be, and must apparently represent a sternum, the first evidence of an ossification in this element in a Lower Permian reptile.

Text-figure 11.



*Seymouria bayloriensis* Broili.—Right side of the pelvis,  $\times \frac{2}{3}$ .  
From my skeleton.

*Pelvis.*—The perfect pelvis of my skeleton agrees very well with Prof. Williston's figures and description, but the very well exposed ilia show certain significant differences from the young bone figured by Williston ('American Permian Vertebrates,' pl. xxix. fig. 7). In them that part of the bone which lies behind the acetabulum and articulates with the ischium is quite large, and a more interesting difference is that the upper margin of the bone has a distinct projection towards its anterior end. This feature is shown by both right and left ilia.

*Femur.*—The two well-preserved femora of my skeleton agree generally with Williston's figures, but appear to be considerably less massive. The lower end is very markedly divided into condyles.

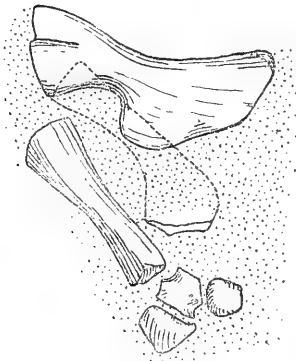
*Tarsus.*—Both hind limbs are in position with the femur directed forward with its head in the acetabulum. The knees are very strongly flexed. The right foot lies naturally articulated, but has been slightly laterally compressed, so as to slide the head of the third over that of the fourth metatarsal. Only four tarsals are preserved, and it appears extremely unlikely that any more were ossified at the death of the individual. The tarsus and foot are exposed from the plantar surface.

There are three proximal tarsals all closely articulated with one another and with the tibia, but separated by an interval of about 8 mm. from the fibula.

The *tibiale* is a small squarish bone with rounded edges and corners. It has a somewhat definite edge towards the intermedium.

The *intermedium* is a well-formed bone with a cylindrically concave ventral surface. Towards the tibia and fibula it has well-formed edges, which are separated proximally by a smooth well-rounded notch of considerable breadth. It articulates with both tibiale and fibulare, the faces towards those bones being separated distally by a small smooth notch.

Text-figure 12.



*Seymouria baylориensis* Broili.—Right hind leg of my skeleton,  $\times \frac{2}{3}$ .

The bones are represented as they lie in the matrix. The dotted part of the fibula is exposed on the lower surface of the block and is represented as seen through it, and its distal end beyond the line which crosses it is drawn reversed from the bone of the left side.

The *fibulare* is a small rounded bone resembling the tibiale in general characters. It is separated from the intermedium by a definite layer of matrix.

The only other tarsal preserved is a small rounded element above the upper end of the 3rd metatarsal.

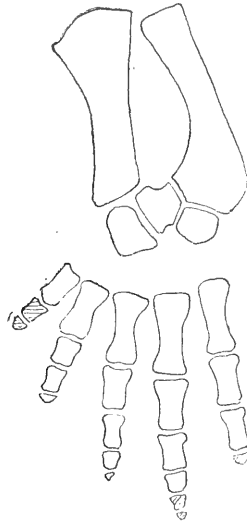
In text-fig. 12 I have represented the right femur, tibia, fibula, and proximal tarsals in the position in which they lie in the matrix. The part of the fibula indicated in dotted lines is exposed on the other side of the block, and the distal strip of the fibula about 1 mm. wide is restored from the bone of the left side, as the right bone is slightly weathered here.

In text-fig. 13 I have restored the tarsus by moving up the fibula into contact with the proximal tarsals, the resulting accuracy of fit is good evidence for the reliability of the figure.

This leg differs from Prof. Williston's figure somewhat in the shape of the lower end of the fibula, and much more importantly in showing the clearest evidence of an intermedium. There is no

doubt that the distal notch in that bone formed part of the foramen which occurs in all Permian reptiles between the "tibiale" and fibulare.

Text-figure 13.



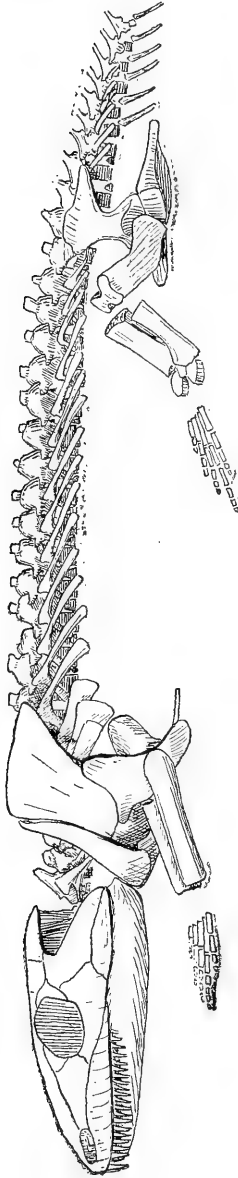
*Seymouria bayloriensis* Broili.

Right tibia, fibula, tarsus, and pes, reconstructed from my skeleton, the cross-hatched phalanges are not preserved.

The left foot retains a complete 2nd toe and a third which has obviously been complete but from which part of the first and the whole of the second phalange are missing, the piece of matrix containing them not having been collected. These toes have respectively 3 and 4 phalanges, the terminal one being in each case a little conical bone.

The foregoing description when read in connection with those given by previous authors renders *Seymouria* nearly as well known as any reptile recent or fossil, and should allow of a very thorough study of its taxonomic relationships and of the bearing of its structure on morphological problems. Broili in his original discussion recognised the extraordinary Stegocephalian appearance of its skull. Williston, from a study of the whole skeleton, concluded "That the relationships of *Seymouria* are not very intimate with any other reptiles known from the Permian; at

Text-figure 14.



*Seymouria baylortiensis* Broili.—Restoration of the skeleton,  $\times \frac{1}{3}$ .

Skull from the Munich material completed from Williston's figures, its size fixed by the fragments of that of my skeleton. Vertebral column and ribs from my skeleton. Shoulder-girdle from Williston's figure, size fixed by that of my skeleton. Manus and parts of radius and ulna from my skeleton. Humerus from other isolated bones. Pelvis and hind leg from my skeleton.

least any that are tolerably well known. In the skull the presence of the deep otic notch, the arrangement and number of the temporal bones, the slender, elongate teeth, longest in the maxilla, and the shape, all differentiate the genus widely from either *Diadectes* or *Limnoscelis*, as well as the chief forms now referred to the Pariotichidae, and also from the known foreign forms." "In any event, it is certainly very remarkable that this cotylosaur reptile with all its other strange amphibian affinities should mimic so closely the temporal structure of the real amphibians." "However, it is very much of a question whether these resemblances [to Amphibia in skull and limbs] are so much the result of heredity and relationships as of adaptive, parallel, or convergent evolution. We have been speculating on the assumption that the known temnospondylous amphibians like *Cacops*, *Eryops*, *Euchirosaurus*, are, if not the actual ancestors of the reptiles, their first or second cousins. But this presumption is, in my opinion, quite unjustified."

In several papers during the last five years, I have upheld the view that *Seymouria* is the most primitive of all known reptiles, and that its resemblances to Temnospondyls, particularly to the Embolomeri, are due to inheritance. I now propose in the light of a practically complete knowledge of the skeleton in the Cotylosaurians *Diadectes*, *Labidosaurus*, *Captorhinus*, *Limnoscelis*, *Pariasaurus*, and *Procolophon*, and in the Temnospondylous Amphibia *Eryops*, *Cacops*, *Trematops*, *Trimerorachis*, *Archegosaurus*, *Lydekkerina*, and *Rhinesuchus*, and a good knowledge of the skull and much of the skeleton in many Embolomeri, to discuss the position of *Seymouria* in detail.

*Labidosaurus* and *Captorhinus* belong to the same family; each of the other forms represents an independent family; *Diadectes*, *Pariasaurus*, and *Procolophon* represent the superfamily Diadectomorpha. The other Cotylosaurs are Captorhinomorphs (Watson, 1917).

The skull and lower jaw of *Seymouria* as a whole resemble those of Labyrinthodonts in their reticulate ornamentation. Similar sculpture is retained by the Captorhinomorpha alone amongst Cotylosaurs, that of other types being less markedly composed of pits, sometimes elongated to form long twisted channels.

*Basis Cranii*.—The basioccipital of *Seymouria* agrees with those of all other Lower Permian Cotylosaurs, rachitinous Amphibia, and certain Embolomeri, in being excluded from the brain-cavity by the meeting above it of special flanges from the exoccipitals. Certain Embolomeri (*Pteroplax*) have the basioccipital entering into the border of the foramen magnum, a condition which appears to be the primitive one for Tetrapods. *Seymouria* is unique amongst Cotylosaurs in the very large part which the exoccipitals play in the condyle. They form well-marked, downwardly-projecting areas strongly reminiscent of those of *Eryops*, and not exactly paralleled in any other reptile.



The large ventral exposure of the basioccipital is a reptilian character not achieved in Amphibia.

*Basisphenoid.*—The presence of large powerful tubera basi-sphenoidales in the basis cranii of *Seymouria* is a reptilian character. Definite tubera do occur in certain Temnospondyls (*Eryops*), but these are always small. In Embolomeri tubera are absent.

The short basiptyergoid processes of *Seymouria* supporting the pterygoid through the intervention of a special bone are unique, nothing similar occurring in any other known adult reptile or amphibian. The shape and position of the pterygoid render it certain that these special bones cannot be the epipterygoids, which in *Dimetrodon* are known to articulate with the basisphenoid. Swinnerton and Howes showed that in the development of the skull of *Sphenodon* special articular cartilages are developed between the basiptyergoid processes and the pterygoid, and it is not impossible that these are the representatives of the articular bones in *Seymouria*.

On the other hand, Gaupp has shown that in *Lacerta* the basiptyergoid processes contain independent centres of ossification, and it is feasible and attractive to regard the *Seymouria* bones as permanently separate autogenous basiptyergoid processes.

The way in which the sides of the lower surface of the basisphenoid of *Seymouria* pass on directly into the outer surface of the prootic is reptilian, agreeing exactly with the conditions in most Cotylosaurs. The structure of this region is, however, equally similar to that of *Pteroplax* and another Middle Coal-Measure Embolomerous amphibian; but it is quite different from the conditions in *Rachitomi*.

The parasphenoid of *Seymouria* is of normal reptilian type, and also agrees with that of Embolomeri. It differs in its small size from that of *Rachitomi*.

*Brain-case and Otic region.*—The brain-case and otic region of *Seymouria* present a wonderful mixture of features occurring in other Cotylosaurs and in Labyrinthodontia.

*Seymouria* is unique amongst reptiles in not possessing an ossified supraoccipital. It also differs in this respect from the Embolomeri, but agrees exactly with the conditions in most *Rachitomi*.

The whole structure of the exoccipital, its relations to the basioccipital and paroccipital, and to the skull-roof especially in its connection with a special descending lappet from the dermo-supraoccipital, is that of such an amphibian as *Trimerorachis*, which resembles *Seymouria* even in the unusual position of the hypoglossal foramen.

The *Rachitomous* amphibian in which the brain-case is most completely known is *Eryops*, where the structure has been described by v. Huene, Broom, the present writer, and Williston.

Although Prof. Williston criticises certain points of my

description, the discrepancies between his account and mine seem to be almost entirely, and in all important points are entirely, differences of interpretation and not of structure. The only significant difference is that the foramen I hold to be for the Xth nerve Williston takes to be that for the XIIth. It is undeniable that it does greatly resemble a hypoglossal foramen, but in the several specimens in the American Museum which show both its outer opening and the suture between the exoccipital and paroccipital, there is no doubt that it opens between these two bones as a vagus foramen always does. The course of the Xth nerve demanded by Williston's interpretation leads through the large cavity, which is definitely shown by an American Museum skull, which I have described and figured, to have housed the vestibule of the inner ear, and passes out high up in the lateral walls of the skull through a foramen which is certainly absent in certain well-preserved New York material, and therefore cannot be for any cranial nerve. I thus still prefer my own interpretation of the structure, although for theoretical reasons I should wish to see a XIIth nerve in *Eryops* as in so many other Labyrinthodonts.

The brain-case and otic region of *Seymouria* resemble the corresponding regions of a Rachitomous amphibian in the following features:—

1. The large opening from the brain-cavity to that for the inner ear.
2. The position of the inner ear in the side-wall of the skull.
3. The way in which the inner anterior corner of the prootic reaches up to the skull-roof.
4. The extremely massive paroccipital process.
5. The upward direction of the paroccipital process.
6. The presence of an occipital flange from the tabular covering a large area of the back of the paroccipital.

The only difference of importance between the ear-region of *Seymouria* and Rachitomous amphibia is that in the reptile the fenestra ovalis lies very low down, being bounded below by the basisphenoid and basioccipital along the posterior margin of the tubera basisphenoidalis, whilst in the Amphibia the lower border of the fenestra is formed by the parasphenoid, the basioccipital at any rate never entering into its margin.

In characters 4, 5, 6, *Seymouria* differs from and is obviously more primitive than all other reptiles, for it is easy to derive the very diverse conditions in other Cotylosaurs from those in it.

The condition of the fenestra ovalis in *Seymouria* is paralleled amongst Cotylosauria only by the Captorhinidæ, which in this region present an almost identical structure.

The conditions in such types as *Diadectes* and *Pariasaurus* seem to depend on a reduction in size of the stapes and a corresponding diminution of the fenestra which receives its proximal

end. The reduction seems to have taken place at the ventral end of the opening. The Captorhinidæ retain a very large stapes.

*Sphenethmoid.*—The anterior end of the brain of *Seymouria* is surrounded by a badly known bone, which agrees exactly in its main features with the sphenethmoid of *Eryops*, and with the same bone in *Pariasaurus* and similar bones in other Cotylosaurs.

*Palate.*—The palate of *Seymouria* is in essentials identical with that of the Embolomerous Labyrinthodonts.

The resemblances depend on the identity in shape of the large pterygoid, meeting its fellow in the middle line anteriorly, laterally articulating with the prevomer, palatine, and ectopterygoid, and having the quadrate ramus formed by a vertically standing plate reaching nearly up to the skull-roof, and bending round behind the quadrate to meet the squamosal in a long suture.

This bone is covered, apparently all over, by a shagreen of granular teeth in *Seymouria* and *Pteroplax*.

The palatine of *Seymouria* agrees exactly with that of Temnospondyli in structure, the most striking similarity lying in the tusk. This tooth is unique amongst reptiles in its mode of insertion in a pit which also encloses the replacing tooth, but agrees exactly with all the large palatal teeth of Stegocephalia.

The ectopterygoid of *Seymouria* agrees exactly with that of *Eryops* in contributing to a rudimentary flange which is applied to the lower jaw, and consists essentially of a deflected corner formed by pterygoid and transverse. The only feature of the palate of *Seymouria* which cannot be matched in Temnospondyli is the approximation of the posterior nares to the middle line.

The palate of *Seymouria* differs from those of all other reptiles in the presence of the palatine tusks and the very weak development of the flanges which face the lower jaw.

The Captorhinid palate more nearly resembles that of *Seymouria* than those of other Cotylosaurs, but differs in not having the quadrate ramus of the pterygoid reaching the squamosal, in the stronger transverse processes, and the loss of the palatine tusk. The maxillary teeth of *Seymouria* exactly resemble those of Temnospondyls in being fused to their base and to a labial wall of bone, in having fluted roots, and in being replaced alternately. No other Cotylosaur has at all a similar dentition.

Prof. Broili has already shown that in its general build, in the deep otic notch, and the backwardly-inclined quadrate, and in the presence of the intertemporal, the skull of *Seymouria* resembles that of the Temnospondyls. In all these features it differs from all other reptiles.

The elongated lachrymal reaching from the orbit to the nostril is, however, a reptilian characteristic known in scarcely any Temnospondyl.

The septomaxilla of *Seymouria* agrees with that of Temno-

spondyli in lying within the nostril and not appearing in the face. The condition of this bone is known in few other Cotylosaurs.

*Lower jaw.*—The mandible of *Seymouria* is typically Labyrinthodont in structure, agreeing very closely with that of *Trimerorachis*, in possessing a post-splenial and three coronoids.

The presence of a patch of small granular teeth on the second coronoid is also a point of resemblance to most Rachitomi.

The single large tusk on the 3rd coronoid is unique amongst Tetrapods, being unparalleled in either Amphibia or Reptilia, but of constant occurrence in Osteolepid fish.

The non-fusion of the articular with the surangular is a point in which *Seymouria* differs from the Temnospondyls and agrees with the majority of reptiles.

*Vertebral column.*—The atlas of *Seymouria* is unique in the lateral compression and great antero-posterior length of its neural elements. This feature comes out most clearly in the large spine composed of two apposed halves. The pair of neural elements together much more resemble a normal dorsal neural arch than in any other known Tetrapod, and are undoubtedly extraordinarily primitive. The odontoid is thoroughly reptilian.

The axis of *Seymouria* in its complete unspecialisation, resembling as it does the vertebra next behind it, is quite different from that of any other reptile, whilst it agrees with that of Temnospondyls, where the 2nd and 3rd vertebræ have a similar resemblance to one another.

Prof. Williston in a recent paper has given an account of the mode of evolution of a *Seymouria* vertebra from an Embolomeres type, with which I am in perfect agreement. He shows that the *Seymouria* vertebra is more primitive than that of any other known reptile in having a larger intercentrum, only slightly reduced from the disk which represents that bone in Embolomeri.

The presence of distinct processes for the head of the rib in certain *Seymouria* intercentra is a condition known in many Rachitomi and occurring in no other reptile.

The presence of a single sacral vertebra only is an Amphibian feature very rare in reptiles. The wide separation of the centra of the caudal vertebræ suggesting the presence of a ring-shaped intercentrum, is a very primitive feature.

On the other hand, the massive neural arches of the pre-sacrals with horizontally placed and widely separate zygapophyses are typically Cotylosaurian, and occur in no Labyrinthodont whatsoever. The caudal neural arches are also of typical reptilian type.

*Ribs.*—In possessing double-headed ribs throughout the whole pre-sacral part of the vertebral column, *Seymouria* differs from all other known Cotylosaurs and agrees with the Embolomeri. There can be no doubt that two-headed ribs are primitive, and

that they are preserved on the atlas and axis in all early reptiles together with a permanent primitive temnospondylous structure.

The double-headed caudal ribs of *Seymouria* are unique amongst Tetrapods.

*Shoulder-girdle.*—I have endeavoured to show that primitively the Tetrapods had only a single cartilage element on each side of the shoulder-girdle, that a precoracoid was then added to this, and subsequently a coracoid appeared. If this view be justified, *Seymouria*, which has only a precoracoid and presents no trace even of a cartilaginous coracoid, is primitive, more so indeed than any other known lower Permian reptile.

The preservation of all three foramina of the Rachitinous shoulder-girdle is a primitive feature known in few other reptiles.

*Pelvis.*—The ilium of *Seymouria* differs in the antero-posterior elongation of its dorsal end from that of any Rachitinous Labyrinthodont, but in this character it exactly resembles the four known Embolomerous ilia. It agrees with these also in the process from the upper edge toward the anterior end of that border. Several cotylosaur ilia resemble that of *Seymouria* in the production of the caudal end of the upper part of the bone.

*Fore limb.*—Williston has already called attention to the remarkably Temnospondyl appearance of the humerus, but he has also pointed out that this bone differs from all amphibians, and resembles all early reptilian humeri in the presence of an entepicondylar foramen.

*Hind limb.*—Williston has shown how much the *Seymouria* femur resembles that of such a Rachitinous amphibian as *Eryops*, and I have nothing to add to his account.

It is, however, of great interest to note that it also presents a still more striking resemblance to the Lower Carboniferous (Lower Mississippian) femur which I recognised as probably reptilian and called *Papposaurus traquari*. This bone is very nearly as old as the oldest known amphibian bone, and far older than any other known reptile.

The tarsus as revealed by my skeleton is thoroughly amphibian in retaining a separate intermedium. In all other reptiles except *Limnoscelis*, where the fibulare is unossified, and the Plesiosaurs and Ichthyosaurs, there are only two proximal tarsals, the fibulare and a compound bone formed of the fused intermedium and tibiale.

The phalangeal formula is apparently that common to all early reptiles.

The foregoing series of comparisons show how wonderful a primitive and annectant form *Seymouria* is. In every part of its skeleton it shows a mixture of Temnospondyl and Reptilian characters, each recognisable, and in general showing little evidence of an intermediate condition. The whole effect of its

structure is that of a mosaic of separate details, some completely amphibian, some completely reptilian, and very few, if any, showing a passage leading from one to the other. In this feature our study of *Seymouria* lends support to the belief first upheld by the Mendelians and now accepted and used by many palæontologists, that an individual animal consists of an aggregate of separate characters which are to a large extent capable of separate evolution, and may indeed proceed with their evolutionary change at very different relative rates in different stocks, although of course they react on one another so as to produce a workable result.

It thus appears desirable to have a tabular statement of the characters in which *Seymouria* shows an advance on *Temnospondyl* structure, using so far as possible that of the *Embolomeri* as standard, and pointing out where these advances are in different directions from those which occur in the *Rachitomi* *Labyrinthodonts*, the cousins of the *Reptilia*.

List of characters in which *Seymouria* has advanced  
above the *Embolomeri* :—

1. The basioccipital is depressed and no longer presents a round concave condyle. *Rachitomi* parallel.
2. There are tubera basisphenoidales. *Rachitomi* parallel.
3. The exoccipitals exclude the basioccipital from the brain-cavity. Some *Embolomeri* and *Rachitomi* parallel.
- [4. A hypoglossal foramen is present. ? If really absent in *Embolomeri*, *Rachitomi* parallel.]
5. The exoccipitals reach up to be overlapped by the occipital flanges of the dermo-supraoccipitals. *Rachitomi* parallel.
6. The supraoccipital is not ossified. Some *Rachitomi* parallel.
7. The inner ear, though widely open to the brain-cavity, is distinctly separated by a rim of bone. Some *Rachitomi* parallel.
8. The fenestra ovalis is large and placed low down so that its lower margin is formed by that of the basiptyergoid process. *Rachitomi* not parallel.
9. The paroccipital is partly covered behind by an occipital flange from the tabular. *Rachitomi* parallel.
10. The lachrymal extends from the orbit to the nostril. *Rachitomi* not parallel.
11. The ductus naso-lachrymalis lies in the substance of the lachrymal. *Rachitomi* parallel (*Micropholis*).
12. The choanae lie near to the middle line. *Rachitomi* not parallel.
13. The articulating surfaces of the zygapophyses are horizontally placed and the neural arches wide and swollen. *Rachitomi* not parallel.

14. Intercentra with reduced and unossified dorsal halves occur. Rachitomi parallel.
15. A distinct sacral vertebra is present. Rachitomi parallel.
16. A cleithrum is absent. Rachitomi not parallel.
17. An additional bone occurs on each side of the cartilaginous shoulder-girdle. Some Rachitomi parallel.
18. An entepicondylar foramen is present in the humerus. Rachitomi not parallel.
19. The presacral part of the vertebral column is shortened.
20. An articular not fused with the surangular occurs. Rachitomi not parallel.
21. The odontoid is a single bone. Rachitomi not parallel.

The only characters which show that *Seymouria* is a reptile are: 8, 10, 12, 13, 16, 18, 20, 21, of the foregoing list.

It is specially to be noted that some of these [10, 18, 20] are features apparently of very minor interest, and that the really important characters, in the absence of knowledge of which no one would be justified in recognising the reptilian nature of *Seymouria*, are those of the vertebral column. Nothing like the large swollen neural arches with horizontally placed articulations is known in Temnospondyls, and the small notochordal centra when taken in conjunction with the crescentic intercentra are equally distinctive.

It thus appears that the vertebral column affords the best evidence for the reptilian nature of any Palæozoic tetrapod.

It is of interest to compare *Seymouria* in more detail with other Cotylosaurs and putative Cotylosaurs.

*Sauravus*.—The small, rather imperfectly-known animal from the upper part of the Stephanian of France described by Thevenin as *Sauravus costei* was regarded by its describer as a reptile, and referred by Case to the Cotylosauria. This attribution has not yet been challenged; it appears to have been founded on the presence in the hind foot of two proximal tarsals and a digital formula 2, 3, 4, ? ?.

The structure of the vertebral column shows beyond all doubt that this form is a Lepospondylous amphibian. There are no intercentra in any part of the column, and in the caudal region the hæmal spines, which in all reptiles are supported by intercentra (which in Mososaurs may fuse with the centra), project from the lower surface of the whole length of the "centrum." They have peculiar fluted ends, exactly similar to *Ceratopterion* and other types forming Miall's family Nectridia. The dorsal "centra" are slender hourglass-shaped bones shown by the section figured by Thevenin to be continuous with the neural arch. The presacral neural arches bear a flat lamellar expansion, the middle of which forms the rib-carrier, the whole structure being identical with that of a nectridian vertebra. In fact the whole column differs so fundamentally from that of a Cotylosaur

as to be incapable of ready derivation from an Embolomeric type, while it seems to resemble that of living Amphibia in being "pseudocentrous," *i. e.* with the apparent centrum derived from a membranous ossification lying between the notochordal sheath and the cartilaginous blocks of the embryonic vertebra. The animal is of considerable interest as showing that a reptilian type of foot may occur in Amphibia in no way connected with reptilian ancestry.

*Eosauravus*.—The remarkable skeleton from the Coal Measures of Linton named by Williston *Eosauravus copei*, and described by Cope, Williston, Moodie, and Case, seems to be certainly a Cotylosaur if Case is correct in stating that the "neural arches are low and broad with horizontal zygapophysial faces and short, heavy spines." The "intercentral" position of the ribs, which has troubled certain American authors, really means very little. The skeleton (which I have not seen) is probably not well preserved, and if it be that of a reptile as primitive as *Seymouria*, no doubt had double-headed ribs of which the capitulum articulated with the intercentrum. The slab may have been split so that only this head is preserved.

The chief interest of the specimen lies in the proportions of the animal. Twenty-three left dorsal ribs are preserved, and the position of the left hand suggests that twenty-eight or more presacral vertebrae were present. There are preserved twenty-three caudals, the latter half of which series shows no signs of tapering, so that the tail may easily have been quite as long as the presacral part of the body. These proportions at once recall the aquatic Embolomeri. *Pteroplax* has more than 28 presacrals, so has *Pholidogaster*, which animal has a tail as long as its body. The long slender form of *Cricotus* is familiar from Cope's two skeletons. Thus it is not improbable that *Eosauravus* retains a primitive form.

In possessing only two proximal tarsals, it is undoubtedly more advanced than *Seymouria*.

*Papposaurus*.—I have already pointed out that the Lower Carboniferous femur which is the type and only known material of *Papposaurus traquari* distinctly recalls *Seymouria*. This resemblance increases the probability (admitted by Williston and Broili) that the form is a reptile. If so, it is by far the earliest known.

*Limnoscelis*.—The large Cotylosaur from New Mexico described by Williston as *Limnoscelis* is in its limb-structure one of the most primitive known. The skull is, however, far more advanced than in *Seymouria*; it retains no trace of the typical Eryopine shape of the latter skull, in particular the long slender otic notch of the more primitive form is lost, the posterior surface appearing to be truncated. The occiput unfortunately has not yet been described in detail, but from Prof. Williston's outline drawing it appears to be derivable from that of *Seymouria* by a migration downwards of the ends of the paroccipital



processes, the fenestra ovalis retaining its position quite at the lower surface of the skull.

The palate of *Limnoscelis* has advanced far beyond that of *Seymouria* in the wide interpterygoid vacuity and in the pronounced pterygo-transverse flanges.

The lower jaw seems to have lost the post-splenial and probably the anterior coronoids.

The vertebræ in retaining a quite long spine are probably more primitive than those of *Seymouria*, for all the Temnospondyls have high neural spines.

The single-headed ribs are, however, an advanced feature.

In the shoulder-girdle *Limnoscelis* is advanced in having a posterior coracoid element, but retains in its cleithrum a primitive bone lost by *Seymouria*.

The pelvis of *Limnoscelis* much resembles that of *Seymouria* in the general form of the ventral surface, which is very reminiscent of *Rachitomi* in the short pubes. The posteriorly produced ilium is also a primitive feature retained by both reptiles.

The hind leg of *Limnoscelis* resembles that of *Seymouria* in having a separate intermedium, but the conditions are different in the non-ossification of the tibiae in the former animal.

*Limnoscelis* is thus in most ways more advanced than *Seymouria*, although it is still a very primitive reptile.

*Diadectidae*.—The Diadectids, known from New Mexico, Texas, and probably also Europe (*Stephenospondylus*), are obviously much more advanced reptiles than *Seymouria*. They have a remarkably specialised palate and occiput—which region I have recently discussed in detail. The brain-case is theoretically derivable from that of *Seymouria*, but is so extremely modified that no useful end will be served by a further discussion.

*Pariosauridae*.—With the Middle and Upper Permian group of the Pariosaurs, we pass to reptiles which have advanced much from the primitive *Seymouria* structure in all features of skull and skeleton. Some of these differences I have already pointed out, others are at once obvious from any comparison. One important feature which deserves emphasis is the high position of the fenestra ovalis, which lies on the front of the paroccipital process far removed from the basioccipital and the tuber basisphenoidalis. The opening is small and the stapes is a slender rod, without the much expanded base-plate it must have had in *Seymouria*.

*Procolophonidae*.—*Procolophon* and its allies are the most advanced Cotylosaurs known. They differ extremely from *Seymouria* in nearly all features. The differences which at present most interest me are those in the brain-case and otic region. In essentials these regions resemble the condition in *Sphenodon*, and differ from that in *Seymouria* in ways I have already pointed out, perhaps most markedly in the slender paroccipital process with a grooved lower surface in which the stapes lies, and in the high position of the fenestra ovalis.

The Cotylosaurs so far considered all differ markedly from

*Seymouria* in the condition of the brain-case and of the ear. Although their structure could in practically all points be derived from that of *Seymouria*, they do not in any way recall that reptile. In the Captorhinids we find features which distinctly hark back to the structure of *Seymouria*, although the group as a whole is one of the most advanced of the Texan Cotylosaurs.

Through the work of Cope, Broili, Case, and especially Williston, we have a nearly perfect knowledge of the skeleton of both *Captorhinus* and the more advanced *Labidosaurus*, and I have given a somewhat more detailed account of the occiput than is to be found in earlier writings.

The skull of *Captorhinus* is advanced in the loss of the intertemporal and tabular and the very great reduction of the supratemporal; it retains the primitive feature of a lachrymal reaching the nostril, and of a septomaxilla not appearing on the face.

It resembles *Seymouria* in the following important characters:—

1. The occipital condyle is tripartite, the exoccipitals forming a good deal of its surface.
2. The fenestra ovalis is large, surrounded by the prootic, paroccipital, basioccipital, and basisphenoid; it is placed low down in the skull so that its margin below lies on the border of the tuber basisphenoidalis.
3. The basisphenoid is remarkably similar in the two genera.
4. The palate of *Captorhinus*, though advanced in the loss of the palatine tusks and in the greater development of the pterygo-transverse flanges, is on the whole not unlike that of *Seymouria*.

In the vertebral column the remarkably swollen neural arches of the presacral vertebrae and the short nearly obsolete neural spines, are points of resemblance between the two forms.

The Captorhinids have advanced over *Seymouria* in the following ways:—

1. In the downgrowth of a process of the paroccipital between the lateral margins of the basioccipital and the inner border of the fenestra ovalis, so as to separate that opening more widely from its fellow.
2. In the reduction of the paroccipital processes and the rotation of their ends downwards.
3. In an enormous widening of the supraoccipital.
4. In a great deepening of the whole brain-case.
5. In a reduction of the prootic so that it no longer reaches the skull-roof.
6. In the loss of the tabular and the restriction of the dermo-supraoccipital to the occipital surface.
7. In the loss of the intertemporal and in *Labidosaurus* of the supratemporal.

8. In the narrowing of the face.
9. In the loss of the palatine tusks.
10. In the better development of the pterygo-transverse flanges.
11. In the lateral compression of the quadrate so that its horizontal section is no longer U-shaped.
12. In such reduction of the pterygoid that it no longer reaches the squamosal.
13. In a considerable compression of the lower part of the articular.
14. In the loss of the two anterior coronoids and the post-splenial.
15. In the somewhat more modified axis.
16. In the presence of two sacral vertebræ.
17. In the development of single-headed ribs.
18. In the reduction of the intercentra.
19. In the development of a coracoid in addition to the pre-coracoid.
20. In the reduction and loss of ornament of the lower parts of the clavicles and the anterior end of the interclavicle.
21. In the loss of the long posterior extension of the dorsal part of the ilium.
22. In the more advanced humerus.
23. In the loss of the long adductor crest in the femur.
24. In the fusion of the intermedium and the tibiale.
25. In the obliteration of the otic notch by the swinging backward of the upper end of the quadrate, so that the posterior end of the skull seems cleanly truncated.

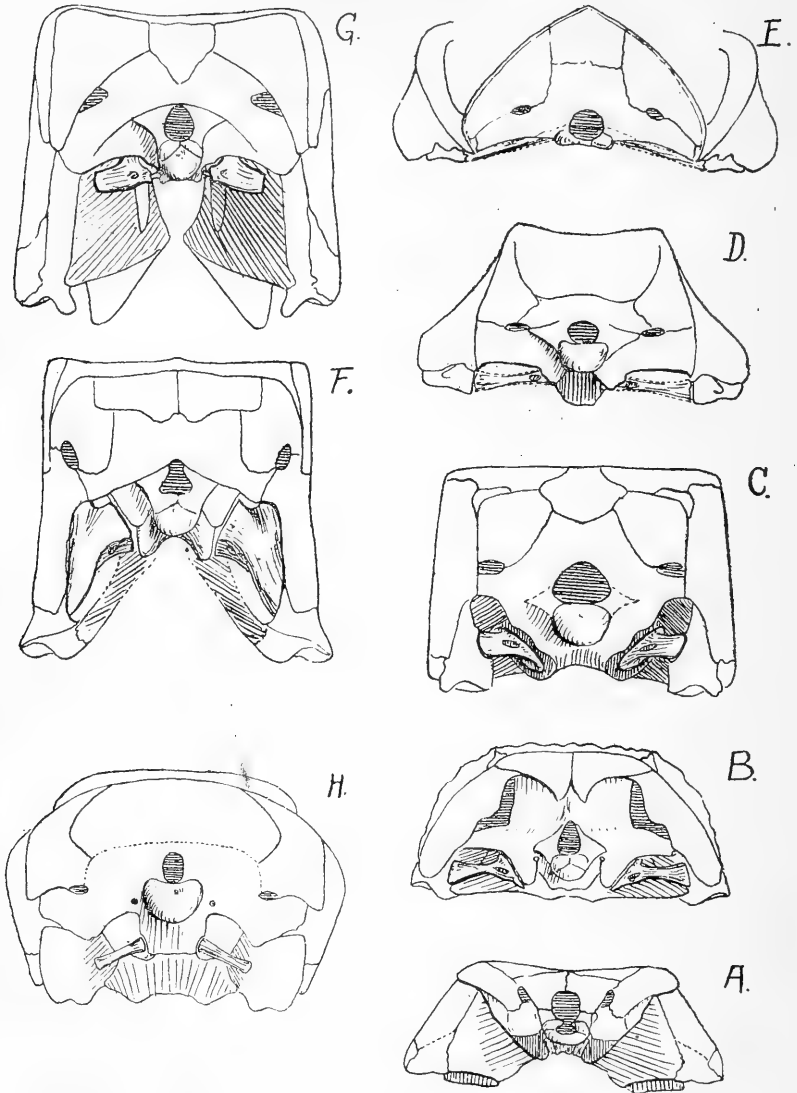
Thus the Captorhinids alone amongst Cotylosaurs present definite significant resemblances to *Seymouria*, which in the case of the palate are due merely to the retention of a primitive structure, but in the important characters of the fenestra ovalis and the vertebræ are due to the possession by both types of a structure which is certainly not derived from amphibian ancestors.

The position and character of the fenestra ovalis common to *Seymouria* and *Captorhinus* is preserved throughout the whole series of mammal-like reptiles, the Pelycosaurs and all the later S. African types. This fact is clearly illustrated in the drawings of text-fig. 15, where the stapes is indicated by shading.

This position of the fenestra is of course connected with that restriction of the inner ear to the lower part of the side wall of the brain-case which I have shown to be one of the most constant and significant characters of the Anomodontia, and one which is entirely restricted to them and the Captorhinids, which Prof. Williston and the writer believe to be their ancestors. Comparison of the occipital views of skulls in text-fig. 15, with similar drawings of any other reptiles, will bring out the difference between the two types of structure of this region clearly.

Apart from the Captorhinids, only *Limnoscelis* and *Seymouria*

## Text-figure 15.



Series of occipital views, reduced to the same width, of the skulls of Anomodonts and of Cotylosaurs connected with that group. To show the low position, at the back of the tubercle basisphenoidalis, which the fenestra ovalis occupies in these reptiles, its situation is indicated by the stapes.

A. *Seymouria baylориensis*.

C. *Varanosaurus acutirostris*.

E. *Diademodon browni*.

G. *Dimetrodon* sp.

B. *Captorhinus* sp.

D. *Arctops willistoni*.

F. *Deiopsus leptocephalus*.

H. *Mormosaurus seeleyi*.

A, from text-fig. 2; B, from Watson, 1916. C. Restored from the type-skeleton in Munich; D, E, & H, from Watson, 1914; F, modified from Watson, 1916; G, from a skull figured by Case, modified by other material.

A-E form an approximate morphological series; F & G represent an aberrant side line arising from C; and H another distinct line also arising from a form near C.

have this peculiar structure. I have already brigaded *Limnoscelis* with the Captorhinids. *Seymouria* is so much more primitive that it is remarkable to find in it a character of this kind connecting it clearly with a definite series of more advanced reptiles.

It remains to be seen whether the other reptiles have lost this type of fenestra ovalis, or whether, as seems more probable, their ancestors never possessed it.

It is a remarkably interesting fact that the primitive Pelycosaurs such as *Varanosaurus* retain primitive features found in *Seymouria* which have been lost by the Captorhinids. Such are:—

The retention of a supratemporal lost in *Labidosaurus*.

The retention of a quadrate which is U-shaped in horizontal section.

The retention of a suture between the pterygoid and squamosal behind the quadrate.

The non-ossification of a posterior coracoidal element in *Varoops*.

The retention of a considerably expanded lower end of the clavicle and a largely expanded interclavicle.

The retention of a posterior process on the ilium.

The characters in the above list represent features in which the Captorhinids are more advanced than the early Pelycosaurs; they are, however, all acquired by later Anomodonts and represent parallel evolutionary changes which have gone on in the Captorhinids and Pelycosaurs independently, since their separation. The most striking of these characters is the peculiar flattening and lateral compression of the quadrate. In principle the quadrates of *Captorhinus* and *Dimetrodon* are identical, differing only in the wide articular condyle of the Cotylosaur. As this type of quadrate is restricted to the members of the Superfamily Sphenacodontidæ, we have a very remarkable case of parallel evolution, which in the original stock does not follow the main line of the evolution of the derived group, but duplicates a structure restricted to a single aberrant side line.

The study of the *Seymouria* skeleton which fills this paper shows that that reptile is far more primitive than any other, presenting a strange mosaic of characters derived without change from the Embolomeroous Labyrinthodonts with common reptilian characters marking distinct advance over an amphibian structure, and one or two which are restricted to the mammal-like reptiles and such Cotylosaurs as can be brought into connection with them.

These facts have an important bearing on reptilian classification, suggesting as they do that all reptiles may be divided into two groups, one composed only of the Anomodontia and the Captorhinomorpha, the other of all other reptiles.

In the Cotylosaurs this division corresponds with that which I have previously founded on the character of the otic notch, and the mode in which a vertically placed quadrate is arrived at. I have recently found that this division on the character of the otic notch applies to all reptiles, affording a sharp distinction between the Anomodonts and all other groups, so that we have now two quite independent series of characters, the otic notch and the structure of the fenestra ovalis, which allow us to split all reptiles, *Seymouria* excepted, into two groups. *Seymouria* itself shows characters definitely connecting it with one of these.

The curious way in which the structure of *Seymouria* is built up of perfectly well-developed amphibian characters and equally decisive reptilian features, those of intermediate type being very rare, affords a magnificent example of the way in which the evolution of great groups may have taken place by the rapid change of all the definite morphological entities of which it may be regarded as made up, the changes occurring quite independently and over a considerable time, the passage from the structure of the more primitive to the advanced group being quite gradual when viewed as a whole, but when further considered and analysed found to depend on a rapid evolution of separate regions apparently independently of each other.

I hope that this study of *Seymouria* will be regarded as placing beyond dispute the origin of the reptiles from the Embolomerous Labyrinthodonts.

I wish to express my thanks to the Percy Sladen Trustees, who paid the expenses of my visit to Texas, to Prof. S. W. Williston, who allowed me to study freely the superb collection of Lower Permian Tetrapods which he has built up in Chicago, to President Osborn and the Staff of the American Museum for similar privileges there, and to Prof. F. Broili, who placed the treasures at Munich at my disposal. I regret that circumstances at present forbid my obtaining his permission to publish a description of the *Seymouria* material of which he gave so excellent a description. Finally, I wish to thank my wife for editing this paper and thereby removing many obscurities.

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## EXHIBITIONS AND NOTICES.

May 7th, 1918.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,  
in the Chair.

*The Ages of Elephants, as inferred from the Molar Teeth.*

Mr. R. I. POCOCK, F.R.S., F.Z.S., Curator of Mammals, exhibited a series of the molar teeth of Elephants that had died in the Gardens, and drew particular attention to the state of wear of the last tooth of an elephant known to be about 50 years old. Since this tooth comes into use in about the 40th year and had lost by wear more than one-third of its laminæ in 10 years, Mr. Pocock concluded that the animal would have been toothless and would have come to the end of her time before she was 70.

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Mr. E. HERON-ALLEN, F.L.S., F.R.M.S., F.Z.S., gave a lantern exhibition of Arenaceous Foraminifera of the genus *Thurammina*.

May 28th, 1918.

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

The SECRETARY read the following Report on the Additions to the Society's Menagerie during the month of April 1918:—

The registered additions to the Society's Menagerie during the month of April were 209 in number. Of these 129 were acquired by presentation, 77 were received on deposit, and 3 were bred in the Menagerie.

The following may be specially mentioned:—

1 Barbary Sheep (*Ammotragus lervia*), born in the Menagerie on April 18th.

1 Blossom-headed Parrakeet (*Palaeornis cyanocephala*) ♂, from India, presented by Miss H. F. Dunbar on April 27th.

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Mr. C. TATE REGAN, M.A., F.R.S., F.Z.S., gave an account, illustrated by lantern-slides, of the Freshwater Fishes of Great Britain, with special reference to their value as food and to the possibilities of increasing their economic use.

June 11th, 1918.

A. EZRA, Esq., Vice-President, in the Chair.

The SECRETARY read the following Report on the Additions to the Society's Menagerie during the month of May 1918 :—

The registered additions to the Society's Menagerie during the month of May were 68 in number. Of these 14 were acquired by presentation, 46 were purchased, and 8 were bred in the Menagerie.

The following may be specially mentioned :—

2 Grecian Ibexes (*Capra ægagrus*), born in the Menagerie on May 9th and 15th.

1 Ruby-throated Warbler (*Calliope calliope*), from India, presented by W. H. St. Quintin, F.Z.S., on May 29th.

1 Indian Chameleon (*Chamæleon calcaratus*), from Calabar, presented by A. M. Kinloch on May 11th; new to the Collection.

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*Observations on a Colony of Burrowing Bees (Andrena fulva)  
on Primrose Hill.*

Lt.-Col. S. MONCKTON COPEMAN, M.D., F.R.S., F.Z.S., exhibited examples of the Burrowing Bee, *Andrena fulva*, and made the following remarks :—

The existence of a flourishing colony of a burrowing bee (*Andrena fulva*) on the western slope of Primrose Hill, where, during the present year, it has spread over a much more extended area than previously occupied by it, appears worthy of record for the reason that one locality only in the neighbourhood of London—a small area on Hampstead Heath—is cited as a habitat of this insect in the British Museum Catalogue of Hymenoptera.

For the past six years this particular colony has been kept under observation, during which period the number of nests has not markedly varied from season to season until the present year. The unexampled spread of the colony this year (1918), curiously enough, was consequent on the manœuvres of a Cadet Battalion last autumn having converted a previously grassy slope into a quagmire of mud, now represented by a smooth bare surface of clayey loam. This patch of ground the bees have found so much to their liking for nesting-purposes that (as indicated by a scale-plan drawn by my son last year) they have, in large measure, deserted their former haunts alongside a neighbouring path to seize upon the new territory so conveniently provided for them.

Notwithstanding the hardness of the ground, the female bee excavates in it a tunnel which in many instances, on probing with a fine flexible wire, I have found to extend to a depth of

ten or twelve inches, and occasionally even more. This insect is usually about the size of the "worker" honey-bee, which she somewhat resembles in form. She is, however, handsomer, and also appears larger than her actual size owing to the abdomen especially being covered with a thick pubescence, which ranges in colour from a pale orange to a tawny-red in hue. This bee is, in consequence, a conspicuous object on a sunny morning as she flies in mazy flight, usually a few inches only above the ground. The male insect is utterly unlike her, being smaller, less pubescent, and more sombre-toned in hue.

As the outcome of six years' observations it has been found that over a period which has varied, according to prevalent meteorological conditions, from the middle of April to the first week in May the bees make their first appearance quite suddenly, following on one or two days of warmer weather. For the first few days the number of males emerging greatly exceeds that of females, the relative divergence in numbers being as great as fifty to one.

Careful examination of bare patches of ground in the neighbourhood, so soon as the bees are first seen, discloses a number of small round holes which look as though they had been punched out with the point of a pencil. These are the open doorways of the burrows in which eggs were laid in the previous spring and in which the bees, passing through the stages of larva and pupa, have finally developed into the perfect insect. Herein the bee awaits the stimulus of warmth to give it strength to break through the slight covering of earth beneath which it has been sheltering since the previous autumn.

Within a few days further, mating having taken place, the male bees are no longer met with, their brief life ending when the object of their existence has been attained. Almost immediately the females begin to dig their burrows, as indicated by the appearance of numerous little mounds like miniature volcanoes, eventually three or four inches in width and somewhat less in height. These are gradually built up of the tiny particles of earth thrown out, a few grains at a time, as the work progresses. In the first stages of the excavation the bee throws out the particles of earth between her hind legs, after the fashion of a dog when digging for a rat or rabbit, aiding the process by sweeping motions of her abdomen. Later on, however, when progress has been made beneath the surface, she brings up the grains of earth she has dug out, on the top of her head, generally waiting a few moments on reaching the mouth of her burrow, before pitching them over the edge with a sudden jerk. The resulting mounds are easily recognizable owing to the material of which they are composed being lighter in colour than the surrounding soil.

On completion of the main burrow small nurseries are opened out from its sides, in each of which is deposited a carefully kneaded pellet of pollen and honey, which has to suffice for the

needs of the grub which will develop from the egg laid upon its surface. This done, the little chamber is sealed up, and the process again repeated.

During the numerous foraging expeditions necessary for obtaining sufficient pollen and nectar for the sustenance of her future broods, no care is taken to protect the burrow, a fact of which advantage is occasionally taken by a *Nomada* bee, too lazy herself to build nurseries or to gather stores of food. Waiting therefore till the rightful owner has set out on her travels, the "cuckoo" bee slips in and deposits an egg on any pellet of food of adequate size not yet sealed up.

The *Andrena* bee not infrequently appears to experience considerable difficulty in recognizing her own burrow, as she may often be seen to tentatively explore the entrance to several before suddenly diving down her own. Marking the bee with a little powdered chalk as she leaves her burrow will render it easy to recognize the rightful owner on her return.

The burrowing bee having finished her labours underground does not take the precaution of closing up the mouth of the burrow, but on her death, within about a month from emergence from her winter quarters, leaves it to be gradually obliterated by the levelling of the mound outside under the influence of rain and wind.

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October 22nd, 1918.

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

The SECRETARY read the following Report on the Additions made to the Society's Menagerie during the months of June, July, August, and September, 1918:—

JUNE.

The registered additions to the Society's Menagerie during the month of June were 38 in number. Of these 22 were acquired by presentation, 14 were bred in the Menagerie, and 2 were deposited.

The following may be specially mentioned:—

1 White-bearded Gnu (*Connochaetes albojubatus*), born in the Menagerie, June 17th.

4 Taurus Lizards (*Lacerta taurica*), new to the Collection, from Calamaria, Salonika, presented by G. H. Colt, F.R.C.S., on June 20th.

JULY.

The registered additions to the Society's Menagerie during the month of July were 328 in number. Of these 24 were acquired

by presentation, 9 were bred in the Menagerie, and 295 were deposited.

The following may be specially mentioned :—

1 Kiang (*Equus kiang*), from Tibet, born in the Menagerie, July 15th.

1 Eland (*Taurotragus oryx*), from South Africa, born in the Menagerie, July 16th.

#### AUGUST.

The registered additions to the Society's Menagerie during the month of August were 81 in number. Of these 59 were acquired by presentation, 9 were bred in the Menagerie, and 13 were deposited.

The following may be specially mentioned :—

1 Thar (*Hemitragus jemlaicus*), from the Himalayas, born in the Menagerie, August 10th.

5 Coypus (*Myocastor coypus*), from the Argentine, born in the Menagerie, August 16th.

2 Verticillated Geckos (*Gecko verticillatus*), from Rangoon, presented by Mrs. Hilda D. Sedgwick, August 10th.

#### SEPTEMBER.

The registered additions to the Society's Menagerie during the month of September were 31 in number. Of these 15 were acquired by presentation, 2 were bred in the Menagerie, 8 were deposited, and 6 were received in exchange.

The following may be specially mentioned :—

Two hybrid Porcupines (*Hystrix cristatus* × *H. africe australis*), born in the Menagerie on September 20th.

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On behalf of Mr. E. Gerrard, Mr. R. I. Pocock, F.R.S., exhibited the skin of an abnormally coloured red deer stag shot by Major R. C. Forster in Scotland, where it had been known for many years. It was a partial albino, the red hairs of the body being mixed with grey, the face, throat, and legs being white, the hoofs pale horn-colour, the muffle pink, and the eyes blue.

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Professor H. M. LEFROY, F.Z.S., Hon. Curator of Insects, gave an account, illustrated by lantern-slides, on the work he had accomplished for the Wheat Commission on Wheat Weevil in Australia.

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November 5th, 1918.

Prof. E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,  
in the Chair.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a mounted specimen of a hybrid Cockatoo ( $\sigma$  Roseate *Cacatua roseicapilla*  $\times$   $\text{f}$  Lesser Sulphur-Crested *C. sulphurea*), bred in 1917 at Hartwell House, Aylesbury, by Mrs. Lee.

---

*Diagnosis of Helminth Infections.*

Dr. R. T. LEIPER, M.D., D.Sc., F.Z.S., gave a lantern exhibition on Diagnosis of Helminth Infections from the character of the eggs in the fæces. He stated that, by examination of the fæces of a living animal, the extent and specific nature of most helminthic infections could be accurately determined, and the method had been applied successfully as a routine practice in the case of man, rabbit, dog, cat, and pig, and was apparently capable of indefinite extension.

The eggs of parasitic worms were constant in character and of great systematic importance. The ground-plan of the egg-shell indicated the genus or even subfamily to which the parasite belonged, and specific differences were found in slight but constant peculiarities in relative length and breadth, and in the conformation of excrescences on the surface of the shell.

---

*The "New" Rabbit Disease.*

Dr. R. T. LEIPER also gave a demonstration on the "new" rabbit disease. Examination of a large number of rabbits shows that the chief cause of mortality is a coccidial invasion of the intestinal wall or of the lining of the bile-ducts. According to Fantham and others the causal agent in both types of disease is *Eimeria stiedæ*, but Dobell holds that the intestinal lesion is due to a distinct species. In many cases changes in the liver attributed to coccidiosis were the result of infection with *Cysticercus pisiformis*, the larval stage of the dog tapeworm *Tænia serrata*. Large swellings in the region of the head and neck, suspected to be cancerous, were due to *Cœnurus serialis*, the larva of the dog tapeworm *Tænia cœnurus*. Of relatively small economic importance are infections with the threadworm *Oxyuris ambiguus* and the tapeworm *Ctenotænia leuckarti*. There is some evidence that a bacterial infection may occasionally be the cause of death.

The coccidial infections pass from infected to healthy animals through the fæces. When freshly passed the coccidial oocysts

are not infective. They only become so after a period of delay, in which certain developmental changes take place. These changes proceed more rapidly in dry than in wet fæces. Prevention depends upon the systematic periodical removal and destruction by burning of all pellets and contaminated bedding, and the use of some fluid which will destroy such oocysts as remain in the hutch.

Although several cases of coccidial infection in man have been recorded, Dobell maintains that in none of these cases is *Eimeria stiedæ* the causal agent. There would appear therefore to be no risk of infection to man.

The cystic stages of the tapeworms of the dog appear to occur chiefly in those rabbits fed with dandelions and other green stuffs collected from the roadsides, where the vegetation is especially liable to contamination with fæces of dogs which have acquired their infections from eating uncooked rabbit offal.

---

Professor H. M. LEFROY, F.Z.S., exhibited a series of lantern-slides, from photographs taken during the recent visit to the Zoological Gardens, Sydney, N. S. Wales.

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### November 19th, 1918.

Dr. A. SMITH WOODWARD, LL.D., F.R.S., Vice-President,  
in the Chair.

The SECRETARY read the following Report on the Additions to the Society's Menagerie during the month of October, 1918:—

The registered additions to the Society's Menagerie during the month of October were 22 in number. Of these 8 were acquired by presentation, and 14 were deposited.

The following may be specially mentioned:—

1 Black-cheeked Cercopitheque (*Cercopithecus ascanius*), from the Lower Congo, presented by Chevalier E. Carton de Wiart on October 2nd.

2 Mississippi Alligators (*Alligator mississippiensis*), from North America, deposited on October 28th.

1 Reticulated Python (*Python reticulatus*), from the East Indies, deposited on October 11th.

Special attention may also be directed to a captured German Carrier-Pigeon Loft, with 35 of the captured Pigeons, taken by the Canadians at Folies, France, on August 9th, and presented to the Society on October 30th by the British Armies in France, at the suggestion of the War Office.

Miss K. LANDER, F.Z.S., described the method of preparing skeletons by the use of trypsin, and exhibited a number of successful examples from the Society's Prosectorium.

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Mr. E. HATSCHKEK described his investigations into the forms assumed by drops and vortices of gelatin in various coagulants, exhibited a series of the formations he had obtained which simulated animal structures, and demonstrated the method by which he obtained his results.

---

Professor F. WOOD-JONES, F.Z.S., exhibited a cast and a set of Röntgen-ray photographs taken from a Chimpanzee belonging to the Society, which had recently died from pulmonary tuberculosis, and called attention to the possibility of diagnosing tubercle by this method in living subjects.

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ERRATA in Mr. L. A. Lanz's communication *supra*, pp. 11-17.

Table, last line.

For 26, read 36.

Page 13. Footnote, line 3 from bottom.

For 24, read 28.

Page 14. Line 9 from bottom.

For 37, read 39.

Page 15. Last line.

For 121, read 171.



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

October 22nd, 1918.

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

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a list of additions to the Menagerie in the months of June, July, August, and September 1918.

On behalf of Mr. E. Gerrard, Mr. R. I. Pocock, F.R.S., exhibited the skin of an abnormally coloured red deer stag shot by Major R. C. Forster in Scotland, where it had been known for many years. It was a partial albino, the red hairs of the body being mixed with grey, the face, throat, and legs being white, the hoofs pale horn-colour, the muffle pink, and the eyes blue.

Sir E. G. Loder, Bart., Vice-President, read a communication entitled "Notes on the Beavers at Leonardslee, 1916-1918," containing evidence of the hitherto unrecorded fact that Beavers may breed twice in a season.

A memoir by Mr. G. A. Boulenger, F.R.S., F.Z.S., on Madagascar Frogs of the Genus *Mantidactylus*, Blgr., was presented to the Meeting.

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Professor H. M. LEFROY, F.Z.S., Hon. Curator of Insects, gave an account, illustrated by lantern-slides, on the work he had accomplished for the Wheat Commission on Wheat Weevil in Australia.

---

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 5th, 1918, at 5.30 P.M., when the following communications will be made :—

Professor H. M. LEFROY, F.Z.S.

Exhibition of Lantern-slides illustrating the Sydney Zoological Gardens.

Dr. R. T. LEIPER, F.Z.S.

(1) Lantern Exhibition on Diagnosis of Helminth Infections from the Character of the Eggs in the Fæces.

(2) Demonstration of the "New" Rabbit Disease.

JAMES F. GEMMILL, M.A., D.Sc., M.D., F.Z.S.

On Ciliary Action in the Internal Cavities of the Ctenophore, *Pleurobrachia pileus* Fabr.

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The following Papers have been received :—

D. M. S. WATSON, F.Z.S., Capt. R.A.F.

On *Seymouria*, the most primitive known Reptile.

K. M. SMITH, A.R.C.S.

A Comparative Study of certain Sense-organs in the Antennæ and Palpi of Diptera.

HAROLD W. LEIGH-SHARP, B.Sc. Lond.

The Comparative Morphology of the Secondary Sexual Characters of Elasmobranch Fishes. The Claspers, Clasper Siphons, and Clasper Glands.

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The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited as far as possible to the description of new results.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*October 29th, 1918.*



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

November 5th, 1918.

Professor E. W. MACBRIDE, D.Sc., F.R.S., Vice-President,  
in the Chair.

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Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited a mounted specimen of a hybrid Cockatoo ( $\sigma$  Roseate *Cacatua roseicapilla*  $\times$   $\text{f}$  Lesser Sulphur-Crested *C. sulphurea*), bred in 1917 at Hartwell House, Aylesbury, by Mrs. Lee.

The CHAIRMAN gave an account of a communication by Dr. James F. Gemmill, in which was described the cause of the ciliary action in the internal cavities of the Ctenophore, *Pleurobrachia pileus*.

Dr. R. T. LEIPER, M.D., D.Sc., F.Z.S., gave a lantern exhibition on Diagnosis of Helminth Infections from the character of the eggs in the fæces. He stated that, by examination of the fæces of a living animal, the extent and specific nature of most helminthic infections could be accurately determined, and the method had been applied successfully as a routine practice in the case of man, rabbit, dog, cat, and pig, and was apparently capable of indefinite extension.

The eggs of parasitic worms were constant in character and of great systematic importance. The ground-plan of the egg-shell indicated the genus or even subfamily to which the parasite

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belonged, and specific differences were found in slight but constant peculiarities in relative length and breadth, and in the conformation of excrescences on the surface of the shell.

Dr. R. T. LEIPER also gave a demonstration on the "new" rabbit disease. Examination of a large number of rabbits shows that the chief cause of mortality is a coccidial invasion of the intestinal wall or of the lining of the bile-ducts. According to Fantham and others the causal agent in both types of disease is *Eimeria stiedae*, but Dobell holds that the intestinal lesion is due to a distinct species. In many cases changes in the liver attributed to coccidiosis were the result of infection with *Cysticercus pisiformis*, the larval stage of the dog tapeworm *Taenia serrata*. Large swellings in the region of the head and neck, suspected to be cancerous, were due to *Coenurus serialis*, the larva of the dog tapeworm *Taenia caninus*. Of relatively small economic importance are infections with the threadworm *Oxyuris ambiguus* and the tapeworm *Ctenotaenia leuckarti*. There is some evidence that a bacterial infection may occasionally be the cause of death.

The coccidial infections pass from infected to healthy animals through the faeces. When freshly passed the coccidial oocysts are not infective. They only become so after a period of delay in which certain developmental changes take place. These changes proceed more rapidly in dry than in wet faeces. Prevention depends upon the systematic periodical removal and destruction by burning of all pellets and contaminated bedding, and the use of some fluid which will destroy such oocysts as remain in the hutch.

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The cystic stages of the tapeworms of the dog appear to occur chiefly in those rabbits fed with dandelions and other green stuffs collected from the roadsides, where the vegetation is especially liable to contamination with faeces of dogs which have acquired their infections from eating uncooked rabbit offal.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, November 19th, 1918, at 5.30 P.M., when the following communications will be made:—

The SECRETARY.

Report on the Additions to the Society's Menagerie in the month of October 1918.

Miss K. LANDER, B.Sc., F.Z.S.

Exhibition of Skeletons prepared by the "trypsin" method.

E. HATSCHKE.

Notes on Investigations into the Forms of Drops and Vortices of Gelatin in various Coagulants.

D. M. S. WATSON, D.Sc., F.Z.S.

On *Seymouria*, the most primitive known Reptile.

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The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,  
*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*November 12th, 1918.*





ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

November 19th, 1918.

Dr. A. SMITH-WOODWARD, LL.D., F.R.S., Vice-President,  
in the Chair.

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The SECRETARY read a report on the Additions to the Society's Menagerie in the month of October 1918, calling special attention to a captured German Carrier-pigeon Loft, with thirty-five of the captured Pigeons, taken by the Canadians at Folies, France, on August 9th, and presented to the Society by the War Office through Major A. H. Osman, Officer Commanding the English Carrier-Pigeon Service.

Miss K. LANDER, F.Z.S., described the method of preparing skeletons by the use of trypsin, and exhibited a number of successful examples from the Society's Prosectorium.

Mr. E. HATSCHKEK described his investigations into the forms assumed by drops and vortices of gelatin in various coagulants, exhibited a series of the formations he had obtained which simulated animal structures, and demonstrated the method by which he obtained his results.

Professor F. WOOD-JONES, F.Z.S., exhibited a cast and a set of Röntgen-ray photographs taken from a Chimpanzee belonging

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to the Society, which had recently died from pulmonary tuberculosis, and called attention to the possibility of diagnosing tubercle by this method in living subjects.

Dr. D. M. S. WATSON, F.Z.S., gave an account of a Memoir entitled "On *Seymouria*, the most primitive known Reptile," and illustrated his remarks by lantern-slides.

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The next Meeting for Scientific Business will be held on Tuesday, February 4th, 1919, at 5.30 P.M. Notice of the Communications to be made will be issued early in 1919.

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The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed and be limited so far as possible to the description of new results.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*November 26th, 1918.*

No. 187.

ABSTRACT OF THE PROCEEDINGS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.\*

February 4th, 1919.

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

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The SECRETARY read a report on the Additions to the Society's Menagerie in the months of November and December, 1918.

Mr. C. DAVIES SHERBORN, F.Z.S., exhibited and made remarks on a letter written in 1693, by Malpighi to Dr. Mathew Faber.

Sir DOUGLAS MAWSON read a communication on Australasian, Antarctic, and Subantarctic Life, and exhibited a large series of lantern-slides illustrating the scenery and mammals and birds of the South Polar Zone. He commented on the urgent need of international measures to preserve the fauna of these regions. The Chairman, expressing the sense of the Meeting, assured Sir Douglas Mawson of the active sympathy and support of the Zoological Society.

A communication by Mr. R. I. Pocock was deferred to the next Meeting, with the consent of the Author.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, February 18th, 1919, at 5.30 P.M., when the following communications will be made:—

R. I. POCKOCK, F.R.S., F.Z.S.

On the External Characters of the Existing Chevrotains.  
(Illustrated by lantern-slides.)

K. M. SMITH.

A Comparative Study of certain Sense-Organs in the Antennæ and Palpi of Diptera. (Illustrated by lantern-slides.)

The following Papers have been received:—

G. A. BOULENGER, F.R.S.; F.Z.S.

On a Collection of Fishes from Lake Tanganyika, with Descriptions of Three new Species.

Miss JOAN B. PROCTER, F.Z.S.

On the Skull and Affinities of *Rana subsigillata*, A. Dum.

\* The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W. 8.

February 11th, 1919.

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

February 18th, 1919.

A. SMITH WOODWARD, Esq., LL.D., F.R.S., Vice-President,  
in the Chair.

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The SECRETARY read a Report on the Additions to the Society's Menagerie in the month of January 1919.

Mr. R. I. POCK, F.R.S., F.Z.S., read a paper upon the external characters of existing Chevrotains (*Tragulina*), and showed that the Indian species, commonly cited as *Tragulus meminna*, differs in so many important characters from the Malaysian species that it is necessary to sever it from them as a distinct genus, for which the name *Moschiola*, used by Thomas in a subgeneric sense, is available. In the absence of the interramal scent-gland, in the structure of the penis, and in the retention of spots on the pelage, *Moschiola* is a more primitive type than *Tragulus*, and resembles the still more primitive West African genus *Hyemoschus*.

Prof. H. MAXWELL LEFROY, M.A., F.E.S., communicated a paper by Mr. K. M. SMITH, on "A Comparative Study of certain

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Sense-Organs in the Antennæ and Palpi of Diptera" (illustrated by lantern-slides).

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The next Meeting of the Society for Scientific Business will be held on Tuesday, March 4th, 1919, at 5.30 p.m., when the following communications will be made:—

Dr. J. A. MURRAY, F.Z.S., Acting Honorary Pathologist.

Report on the Deaths in the Gardens during the Year 1918.

G. A. BOULENGER, F.R.S., F.Z.S.

On a Collection of Fishes from Lake Tanganyika, with Descriptions of Three new Species.

Miss JOAN B. PROCTER, F.Z.S.

On the Skull and Affinities of *Rana subsigillata*, A. Dum.

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The Publication Committee desire to call the attention of those who propose to offer Papers to the Society, to the great increase in the cost of paper and printing. This will render it necessary for the present that papers should be condensed, and be limited so far as possible to the description of new results.

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Communications intended for the Scientific Meetings should be addressed to

P. CHALMERS MITCHELL,  
*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W. 8.  
*February 20th, 1919.*

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

March 4th, 1919.

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

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Dr. J. A. MURRAY, F.Z.S., read a report on the deaths in the Gardens during the year 1918, illustrating his remarks with lantern-slides.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., described a collection of Fishes from Lake Tanganyika, and drew attention to three new species.

Miss JOAN B. PROCTER, F.Z.S., gave a short account of her paper "On the Skull and Affinities of *Rana subsigillata*," drawing attention to several cranial characters either peculiar to this frog or held in common with *R. adspersa*, its nearest ally.

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The next Meeting of the Society for Scientific Business will be held on Tuesday, March 18th, 1919, at 5.30 P.M., when the following communications will be made:—

H. R. A. MALLOCK, F.R.S., F.Z.S.

“Some Points in Insect Mechanics.” (Illustrated with lantern-slides.)

F. MARTIN DUNCAN, F.R.M.S., F.R.P.S.

Exhibition of Photographs and Lantern-slides of Marine Zoology.

H. F. BLAAUW, C.M.Z.S.

“On the Breeding of *Oryx gazella* at Gooilust.”

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The following Paper has been received:—

LANCELOT T. HOGBEN, B.A., B.Sc.

“The Progressive Reduction of the Jugal in the Mammalia.”  
(Communicated by Mr. H. W. Unthank, B.A., B.Sc., F.Z.S.)

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P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,

REGENT'S PARK, LONDON, N.W. 8.

March 11th, 1919.



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## NOTICE.

The 'Proceedings' for the year are issued in *four* parts, paged consecutively, so that the complete reference is now P. Z. S. 1917, p. . . . The Distribution is usually as follows, but on account of war conditions Parts I. & II. were published simultaneously and Parts III. & IV. are similarly issued:—

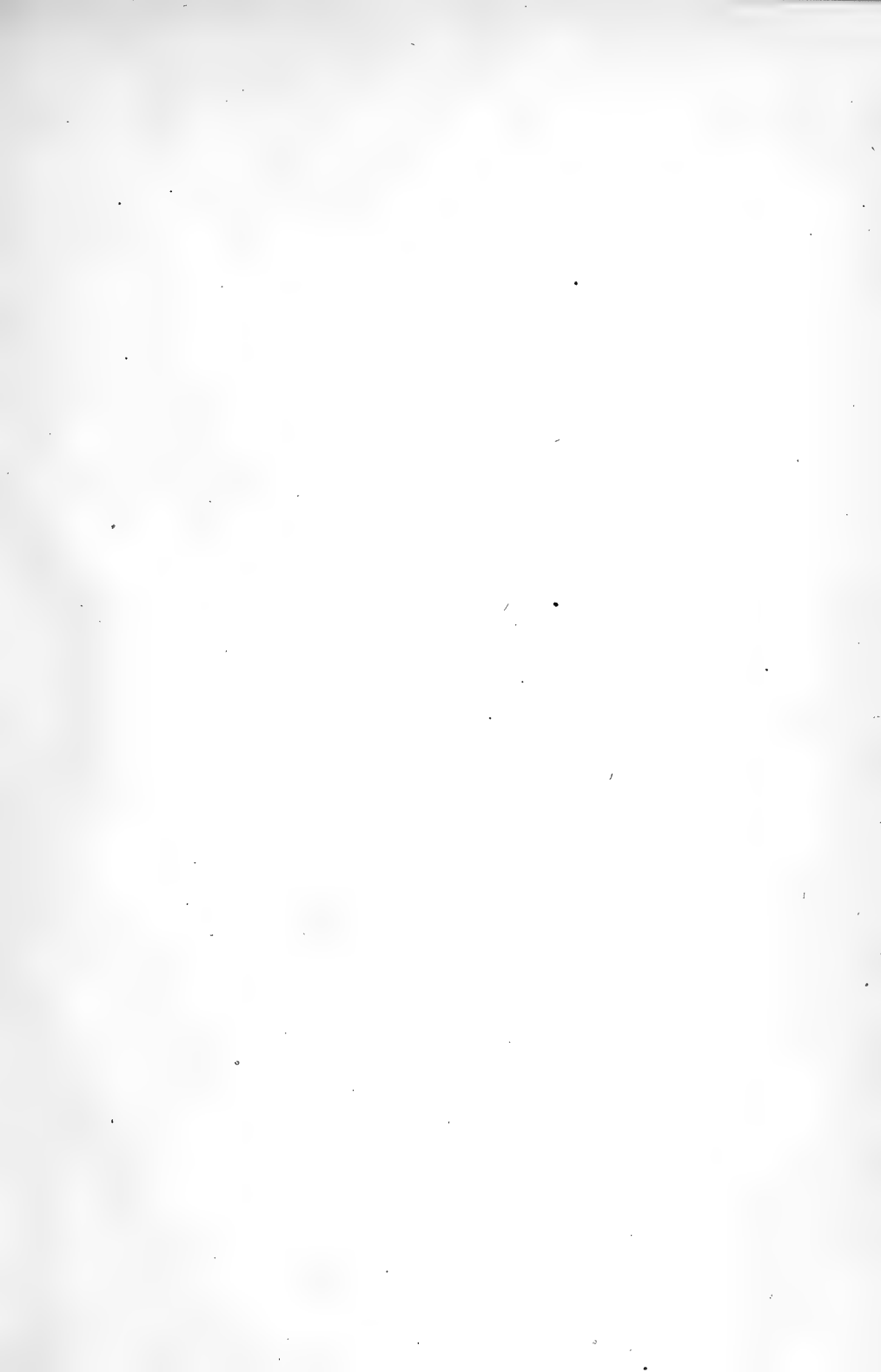
Part	I.	issued in	March.
"	II.	"	June.
"	III.	"	September.
"	IV.	"	December.

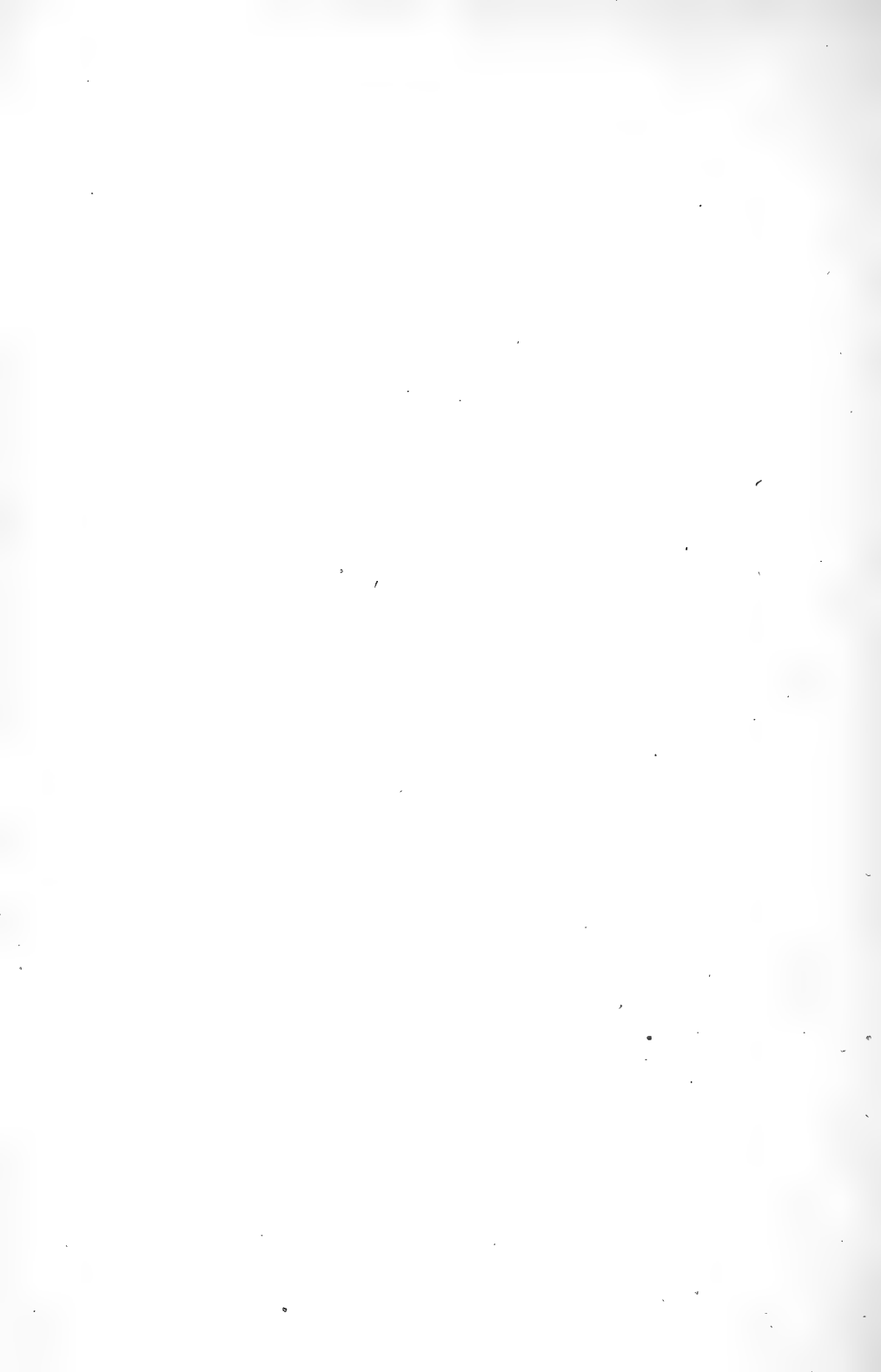
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'Proceedings,' 1918, Parts I. & II. (pp. 1-196), were published together on August 18th, 1918.

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The Abstracts of the 'Proceedings,' Nos. 184-189, are contained in this Part.









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