

XXXVI LAND PLANARIANS

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(Plates xxix, xxx.)

INTRODUCTION.

The collection of land planarians to be described will probably rank as one of the most interesting of Mr. Kemp's many collections from the Abor Country. I particularly wish to express my indebtedness to Mr. Kemp for the privilege of working at these planarians; the task has been made much easier by his excellent series of sketches and notes on colour made from the living animals. These notes have been incorporated in the descriptions, the reliability of which has thereby been greatly increased.

The present accounts are the result of external examination only, but it is hoped that at least some of the species will be subjected to full anatomical investigation as soon as possible.

I wish to express my gratitude to the Belfast Natural History and Philosophical Society for assistance which enabled me to examine the land planarians in the British Museum collection; my best thanks are also tendered to Mr. H. A. Baylis for providing me with opportunities and accommodation for the examination of the Museum material.

Bipalium dihangense, n. sp.

(Plate xxix, figs. 1—3.)

Nine specimens of this species are included in the collections. It appears to be the commonest *Bipalium* in the Abor and surrounding country, it having been procured along the whole of the valley of the Dihang River. The animals were found attached to a variety of objects including stones, logs and leaf-stems of plantain, and in districts varying from 600 ft. to 2000 ft. in altitude.

In shape the animals conform to the typical *Bipalium* outline with broadly spread semicircular recurrent head-lobes, which in some cases curve so far inwards as to meet the sides of the neck (see fig. 3). The trunk, rather stoutly built, tapers gradually to a pointed extremity. The smallest specimen measured 53 mm. in length and 4 mm. in breadth, while the largest was 92 mm. and 7 mm. in length and breadth respectively; they present a

comparatively stout build measuring from 3 mm. to 4 mm. in thickness, a measurement which includes the raised ambulacral surface of the ventral side.

It is not easy to assign any definite position in the body for the mouth and genital aperture, but there is very little error in stating that, in the larger animals, the mouth is about half-way along the ventral surface; in the smaller specimens, the mouth is considerably further back, approximately two-thirds from the anterior end. The genital aperture is not very far removed from the mouth and its position is best described as being 7 mm. to 10 mm. behind it. As a rule both apertures were clearly visible, though in two cases the most careful examination failed to reveal more than one aperture.

The ground colour of the dorsal surface in the living animal is described by Mr. Kemp as a 'dull reddish brown'; the preserved animal presents more of a yellowish brown, frequently, however, with a reddish tint at the sides of the body. Occasionally a distinct bluish shade is to be observed; closer scrutiny shows that it is the deeper tissues that are a very dark greenish blue, and this colour can be seen through the brown; where the outer tissue has been removed by injury, the clear greenish blue is well shown. Thus in one or two cases a variety of colour is shown by an indiscriminate distribution of light blue, dark blue, green and various shades of brown.

Along the mid-dorsal line runs a thin dark line from the head to the caudal extremity, which usually widens very slightly above the regions of the mouth and genital aperture. In some specimens there is just a suspicion of a lateral darker band at the edge, much broader than the median line, and only to be seen in certain parts; this, not being constant, must be regarded as a variation. A little distance inwards from the posterior edge of the lobes of the head is a dark line not usually so prominent as the median line (see fig. 1).

The ventral colouration in the living animal is described by Mr. Kemp as brownish pink with a pale ambulacral surface, the head being somewhat dusky. In the preserved animal, the general surface is a light creamy brown or light biscuit colour; at the edges, the reddish (in some cases greenish) tint of the dorsal surface encroaches in the form of a seam. The head is always a little darker than the rest of the ventral surface. From the neck to the extreme posterior, in the mid-ventral line, is the whitish ambulacral surface, forming a prominently raised ridge, rather less than one-third the width of the body; in the region of the pharynx and genital organs it is somewhat wider; anteriorly, it is flat, and the shading gives, as in *B. giganteum*, a remarkable arrow-head appearance (see fig. 6).

Eyes surround the entire fringe of the head and lobes, and are continued round to the sides of the neck where they form a black patch; they are extremely numerous, and at the sides of the neck are much more closely approximated than on the head.

***Bipalium giganteum*, n. sp.**

(Plate xxix, figs. 4—6.)

Eleven specimens of this species were obtained from three different localities, viz., the Rotung district, Kobo, and Dibrugarh in Assam; it thus appears that it has a fairly wide distribution. In many particulars, it bears a close resemblance to *B. dihangense*, and was occasionally found side by side with that species.

The animals are large, the smallest measuring 103 mm. in length and 7 mm. in breadth, while the largest attained the length of 217 mm. and a breadth of 15 mm.; these measurements are those of spirit-preserved animals, and thus the living creatures must be capable of extending to a considerably greater length.

The colour of the dorsal surface resembles that of *B. dihangense* and is an even dull brown; in the majority of cases, however, the brown is considerably altered by the presence of an underlying dark bluish colour; in fact the appearance is strongly suspicious of a dark slaty blue colouration covered by a secreted brown mucus.

Ventrally, the colour is markedly different from *B. dihangense*; it is an unmistakable blue grey, and lighter in shade than the blue of the underlying tissues of the dorsal surface. The under surface of the head is generally a little paler than the trunk. The ambulacral surface is much paler than the rest of the ventral surface, and forms a very prominent ridge to the extreme posterior; the anterior end of the ambulacral surface, which is flat, by reason of the shades of colour, presents very markedly the form of an arrow head (see fig. 6); true, the same thing is shown in other species, but is not nearly so pronounced as in this one.

In the majority of cases, the mouth is situated near the middle of the body, but its position is variable and it may lie nearly two-thirds from the anterior end. In many specimens, the pharynx was protruded through the mouth as a creamy frill, and in some instances had also been forced through the body wall on the dorsal surface; this suggests that the pharynx is of enormous size. The genital aperture is usually about one-third the distance between the mouth and the posterior end of the body, though this distance may be increased to one-half.

Note on *Bipalium smithi* (v. Graff).

With regard to *Bipalium giganteum*, it appeared from v. Graff's description of *Bipalium smithi*, reported from Darjiling, that the two might be identical; but a careful examination of the type specimen in the British Museum disposed of this likelihood. It may not be out of place to add a brief account of this species which refers to the complete specimen in the British

Museum of Natural History, South Kensington. Its measurements are: length 54 mm., breadth 8 mm., breadth of the head 7 mm., breadth of the neck 4 mm., breadth of ambulacral surface 3 mm. The colour dorsally is a velvety bluish black with just a touch of dull brown; the brown is more emphasized anteriorly until on the head the colour is a dirty yellowish brown with touches of rust colour. Ventrally, from the edge, the dorsal colouration passes gradually into a rusty brown, which is then sharply defined from the ambulacral surface; the flat ambulacral surface is made up of two colours (1) a narrow median deep cream, bordered on each side by (2) a light green band. The dorsal surface is much flatter than the ventral, but I would scarcely say that the edges were sharp. The ambulacral surface is not raised above the general surface, and its extreme anterior end has a pale arrow-head form of light biscuit-brown colour. The under surface of the head is a dark rusty brown. The position of the mouth and genital aperture were not to be made out with certainty.

***Bipalium delicatum*, n. sp.**

(Plate xxix, figs. 7 and 8.)

Two specimens from Rotung, at an altitude of 1300 ft., have been included under this name, the form and colour pattern of which are similar; the general colour, however, is markedly different, one being light brown and the other a very dark brown. Both specimens were found under stones.

The light coloured specimen attains a length of 55 mm., a breadth of 5 mm. and a thickness of 3 mm. The head, which appears a little damaged, is semicircular in form and is not a great deal wider than the trunk. The mouth is placed 30 mm. from the anterior end, and the genital aperture 19 mm. behind the mouth. The ground colouration of the dorsal surface is light brown with a median band of a much paler colour extending nearly the whole length of the animal, and not well defined at the edges; this median stripe expands somewhat on the head and loses itself gradually in the general colour of the head (see fig. 7). The ventral surface is pale and about the same shade as the dorsal median band.

The dark specimen measures 39 mm. long and 4 mm. broad; the mouth is situated 15 mm. and the genital aperture 35 mm. from the anterior end. Except for two apparently bleached patches, the whole of the ventral surface is of the same colour as the dorsal. The eyes are distributed indiscriminately round the head, and are continued for a very considerable distance along the sides of the body, approaching half the animal's length. At the sides of the neck they form a well-marked patch. The paler specimen appears to have been dead some time before being preserved, and consequently, except at the neck, the eyes have been removed along with the rather disintegrated outer tissues.

***Bipalium rotungense*, n. sp**

(Plate xxix, figs. 9 and 10.)

One individual only of this species was secured, together with the specimens of *Bipalium delicatum*. It measures 55 mm. in length, 7 mm. in breadth, and 3 mm., including the raised ambulacral surface, in thickness. The head is a little broader than the body, and is followed by a neck 4 mm. wide. The ambulacral surface is 1.5 mm. wide; the mouth is placed 32 mm. and the genital aperture 42 mm. from the anterior end. The animal is thrown into deep wrinkles over the whole of its surface, indicating that it is capable of extending considerably longer than its present length.

The colour of the dorsal surface, in spirit, is a bluish grey with touches of brown here and there. Medially is a pair of narrow dark lines separated only by a narrow pale central band. Anteriorly, both these lines and the middle band gradually merge into the general colour of the head. On the extreme edge of the dorsal surface is a rather indefinite darker line, contrasting sharply with the paler ventral surface, but indefinitely marked off on its inner dorsal side. The eyes appear to be confined to the anterior margin of the head, to which they form a dark seam (see fig. 10).

The ventral surface is paler than the dorsal and of a medium grey colour, except on the head, where the shade is darker. The median ambulacral surface is almost white; in the region of the mouth and the genital aperture it is a little broader than elsewhere.

***Bipalium sordidum*, n. sp.**

(Plate xxx, figs. 11—14.)

This planarian, of which one specimen only was found under a stone on the bank of the Yembung River, agrees in many features with v. Graff's *B. robiginosum*, but the head colouration differs in at least one important feature.

The specimen is 28 mm. long; the greatest breadth, a little beyond the middle of the trunk, is 4.5 mm.; at the neck it is only 2 mm. broad and the head measures 3 mm. across; in thickness the body attains 3 mm. The mouth and genital aperture are respectively 14 mm. and 21 mm. from the anterior end.

The dorsal surface is flat, and the colour in the living animal is described by Mr. Kemp as "very deep umber brown with profuse black mottling, leaving an irregular very pale median band" (see fig. 11). This very narrow pale band extends from the base of the head to the extreme posterior; its boundary is very irregular and its continuity is occasionally interrupted; above the mouth and genital aperture it widens very slightly. The mottling is much denser near the middle line than at the sides, and it is in this latter position that the reddish brown is shown most clearly; the base of the head is the darkest part of

the animal, and here it is practically black. In all these features of pattern this species agrees with *B. robiginosum* (v. Graff); one difference, however, is that in the latter species, there are two prominent patches of clear reddish brown on the head, one on each side, inclined towards the middle line; such patches are not found in *B. sordidum*. Further, *B. robiginosum* is described as having a greenish or yellowish tone in the brown, though the colour seems variable; and the median line is described as stopping short of the extreme posterior.

The eyes are numerous and extend all round the head to the sides of the neck, where they are somewhat more ventral than dorsal. The head itself is not so broad as the body, whereas in *B. robiginosum* it is a little wider; preservation may have effected some contraction, but Mr. Kemp remarks that the head is not broadly expanded.

Ventrally, on either side of the ambulacral surface, the colour, in the living animal, is pale umber with very minute black specks; in the preserved animal it is a dirty brown colour. The ambulacral surface is much paler and in the preserved creature is a dirty white except in the middle line, which has a shade of brown (see fig. 14); this median portion is the only part of the ambulacral surface that is raised; at the mouth and genital aperture, it broadens out a little (see fig. 14). The under surface of the head is darker than the rest of the ventral surface.

Mr. Kemp notes that this planarian is much more sluggish in its habits than other allied species.

***Placocephalus superbus*, n. sp.**

(Plate xxx, figs. 15—20a.)

All the eleven specimens of this species were found in the Rotung district. In length they range from 52 mm. to 18 mm.; the difference in length is due to the state of contraction, the 52 mm. specimen measuring only 2 mm. in breadth, while a 24 mm. specimen measured 4 mm. across. The dorsal surface is flat and the ventral strongly convex; the ambulacral surface is not perceptibly raised above the general surface. The greater part of the trunk is of similar width, though the body tapers for some little distance from the posterior end to a rather pointed extremity.

The head is much depressed dorso-ventrally, has no prominent lappets, and is only marked off from the trunk by a slight constriction. The eyes are not very numerous but extend along the free edge of the head and on the sides of the neck; in some cases they are continued for a short distance along the sides of the trunk.

The dorsal colouration of this beautiful planarian consists of the following elements: an inner pair of black lines, closely approximated, with a narrow median pale buff stripe between; on their outer edges, these thin black lines fade gradually into a pale

umber stripe, which in turn merges into a broader band of dark chestnut colour; outside this, and sharply defined at both edges, is a broad black stripe; beyond this, and at the extreme edge of the body, most specimens show a very narrow pale buff stripe, which, however, may be regarded as an encroachment of the ventral colouration. In general, the posterior end of the body is darker than the rest, the paler bands being much suppressed; the relative breadths of the colours between the broad and narrow black lines also vary frequently; occasionally, too, the inner pale umber is absent and its place taken by the dark chestnut colour which pales on reaching the outer black band.

In the region of the neck all the bands merge into a dusky area, but the head itself has a distinctive colouration, consisting of two semicircular bands, well defined from one another, a black border piece and an inner pale buff band (see fig. 17).

Ventrally, the ambulacral surface, scarcely raised above the general level, is very pale yellow—almost white—its width being about a quarter that of the body. On either side the colour may be described as a warm straw shade, slightly paler anteriorly. The mouth is situated at about the middle of the under surface, though occasionally it is a little beyond the middle. The genital aperture is three or four millimetres behind the mouth.

Appendix I

It has been thought advisable to include a separate description of one specimen (ZEV⁵²⁹²) on the ground of a striking difference in the form and colour pattern of the anterior extremity, as well as minor differences in colour. Future investigation of the internal anatomy of this specimen will finally decide its position, but in the meantime it is probably better to include it here.

The specimen is 52 mm. long with an almost uniform breadth of 24 mm.; its thickness measures only 1 mm. against the 3 mm. of the 24 mm. specimens; and the mouth and genital aperture are respectively 21 mm. and 36 mm. from the anterior end.

The patterns of the dorsal surface of the trunk are almost identical with the other specimens so far as the longitudinal black lines are concerned, except that the inner black stripes are proportionately a very little thicker. The real colour difference in the trunk is that between the inner and outer black lines is a pale lemon shade, chestnut-brown being entirely absent. Such comparatively insignificant a variation is not sufficient justification for separate treatment, but there is a striking difference in the form and colour of the anterior end. Here the specimen conforms to the Geoplanid type; no head-lobes are present and there is no sign of a neck; the eyes are placed laterally and are sparsely distributed (see figs. 18 and 19). In colour there is a complete absence of the broad black seam round the anterior end, and nothing but a general dusky tone indicates the clearly defined head of the other specimens (see fig. 18). It is possible that the

extremely attenuated form of the body has resulted in the obliteration of the head lobe, which is never very prominent: such a striking correspondence of general colour pattern suggests that the difference in form of the head may thus be accounted for. Should the animal prove to belong to the Geoplanidae, the almost identical trunk colouration could only be accounted for by regarding it as an excellent case of mimicry.

The ventral surface colouration agrees with the other specimens.

Appendix II.

Special attention should be drawn to one specimen (No. ZEV²³¹⁷, fig. 20a) which shows a distinct variety in dorsal head colouration. The dorsal colours are well defined, consisting of a pale buff median stripe, flanked on either side by a thin well-defined black line, which, on reaching the head, expands into two broad patches. On the outer side of each of these median black lines is a definite chestnut brown band, followed by the rather broad pale buff stripe before reaching the broad lateral black band; the body is edged by a repetition of the pale buff marking. As in the normal specimens, the head is fringed all round with a black seam.

The head markings remind one of *Bipalium diana* with its black edge to the head lobe, and the cephalic expansions of the median pair of black lines; this latter feature is also reminiscent of *Bipalium ceres*. But neither of these species has the same general colours or the lateral black bands in the trunk. The general colour of the animal closely resembles that of some varieties of *Bipalium proserpina*, but this latter species has no black edge to the head lobe. The animal under consideration might, of course, be regarded as a variety of *B. proserpina* in which the black edge to the head is a new feature, and the broad paired central black bands (see v. Graff's Monograph) have differentiated into a thin median pair of black, and an adjacent brown, band. For the present, however, I think it is advisable to include it as a variety of *Placocephalus superbus*.

Pelmatoplana aurantia, n. sp.

(Plate xxx, figs. 21—26.)

Only a single specimen of this species was found, and was taken from under stones at Rotung. It measures 50 mm. in length, 4 mm. across, at its widest part, the region of the genital pore, and 3 mm. in thickness. The mouth is situated 18 mm. and the genital aperture 29 mm. from the anterior end. The body is sub-cylindrical for the first third of its length, beyond which it gradually becomes more depressed, tapering slowly from the genital region to a pointed extremity.

A number of eyes are present and extend round the sides and front of the uptilted head; they are more numerous at the sides

than at the front where they practically form only a single row. The extreme anterior, in this specimen, is slightly insunken, a feature which is due to contraction (see figs. 22—24).

The living animal has, dorsally, a ground colour of orange yellow (brownish yellow in spirit), with a well-defined thin median black line, and a black line, a little distance removed from the edge, on either side, a little broader, and rather less defined, particularly on its inner border (see fig. 25). At the extreme posterior all three merge, forming an almost black extremity (see fig. 26). Between the black lines the tone is somewhat dusky compared with the outer edge which is bright orange yellow. This bright zone is carried to the ventral side with very little difference in shade except at the flat ambulacral surface itself which is much paler, and measures a millimetre or less in width. On the dorsal side of the head the longitudinal markings merge into a dark grey pigmentation (see fig. 22)

The genital aperture is very prominent, but the mouth is much less so.

In many features, this species resembles *P. sondaica* (Loman), but its colour, greater breadth and flat ambulacral surface differ from the latter species.

Cotyloplana pilleata, n. sp.

(Plate xxx, figs. 27—31.)

About thirty specimens of this planarian are included in the collection, all from the Yembung and Rotung districts. The largest specimen measures 105 mm. in length, even in a contracted condition, and the smallest is 50 mm. long; most specimens are a little more than 70 mm. long, 4 to 5 mm. broad and 3 mm. in thickness. Judging from the amount of wrinkling shown, it would appear that some of these planarians are capable of an extension to quite 130 mm., and probably much more.

The dorsal surface is rather flat, while the ventral surface may be strongly convex, though in one collection made in Upper Rotung the ventral surface in all the specimens is nearly as flat as the dorsal. The anterior end is raised at a considerable angle (see fig. 29) and bears, on its upper side, the two eyes, and on the ventral side, practically at the extreme anterior, a single sucker (see figs. 28 and 30). Mr. Kemp remarks that in the living animal the head appears slightly swollen, but this is scarcely noticeable in the preserved specimens.

While the colour-pattern remains constant, the shades of colour vary very considerably. There is a mid-dorsal dark black line running from the extreme anterior (in some few cases starting short of this) to the posterior extremity, widening quite perceptibly above the pharyngeal and genital regions. On either side of this line is a narrow strip of bright lemon yellow, which is not always well defined from a broad lateral brown band,

which completes the dorsal colouration. Occasionally the yellow is absent and the brown meets the black centre line; in other cases, a paler brown takes the place of the yellow. The brown band is liable to much variation in shade; it may be little more than a dusky yellow on the one hand, or a dirty brown on the other, between which are all intermediate shades of bright orange brown and chestnut brown. The upper surface of the head is a dusky grey, with rather lighter patches round the eyes; the general impression is that of a cap on the head. The median line merges gradually into this area.

The dorsal lateral colouration is carried round the sides of the body to the ventral surface, though often paler as far as the ambulacral surface, which is a pale yellow (whitish in spirit); the creeping surface is about a quarter the breadth of the body, but wider at the mouth and genital pore; and in some cases forms a raised ridge, while in others it is quite flat or even depressed. The mouth is placed at less than half way along the ventral surface from the anterior end, and the genital pore at positions varying from midway between the mouth and posterior extremity to two-thirds the same distance.



EXPLANATION OF PLATE XXIX.

Bipalium dihangense, n. sp.

- FIG. 1.—Dorsal aspect, natural size. *e.*, eyes.
,, 2.—Ventral aspect, natural size. *m.*, mouth; *g. o.*, genital opening.
,, 3.—Enlarged view of the head of another specimen showing the strongly recurrent head lobes.

Bipalium giganteum, n. sp.

- FIG. 4.—Dorsal aspect, natural size.
,, 5.—Ventral aspect, natural size. *g. o.*, genital opening; *m.*, mouth.
,, 6.—Enlarged view of the ventral surface of the head, showing the arrow-head form of the anterior end of the ambulacral surface.

Bipalium delicatum, n. sp.

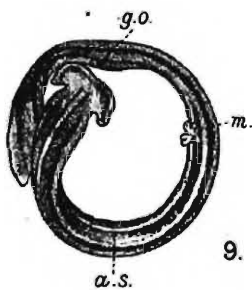
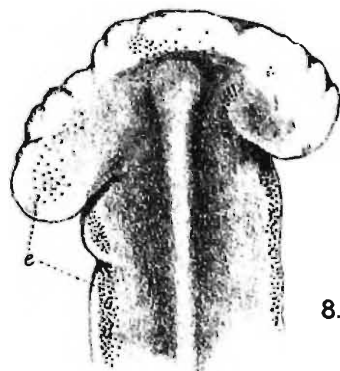
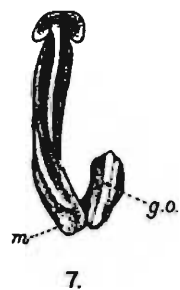
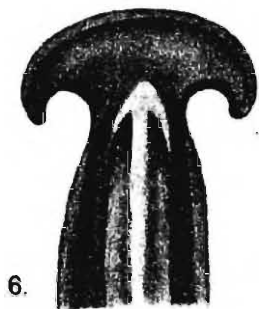
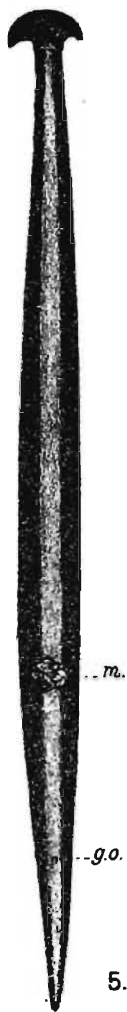
- FIG. 7.—Drawing made from the light coloured specimen. Natural size.
,, 8.—Enlarged view of the dorsal surface of the anterior end of the dark specimen, showing the distribution of the eyes, which, however, extend nearly half the animal's length.

Bipalium rotungense, n. sp.

- FIG. 9.—The entire animal, natural size. *a. s.*, ambulacral surface; *g. o.*, genital opening; *m.*, mouth.
,, 10.—Enlarged dorsal view of the head, showing the distribution of the eyes.

Bipalium sordidum, n. sp.

- FIG. 11.—Dorsal aspect, enlarged twice natural size. The positions of the mouth and genital opening are indicated by a slightly expanded area in the median pale line.
,, 12.—Enlarged dorsal view of the head, showing the distribution of the eyes. *e.*, eyes.
,, 13.—Enlarged ventral view of the head, showing the eyes in the region of the neck. *e.*, eyes
,, 14.—Enlarged view of the ventral surface in the region of the genital opening.



EXPLANATION OF PLATE XXX.

Placocephalus superbis, n. sp.

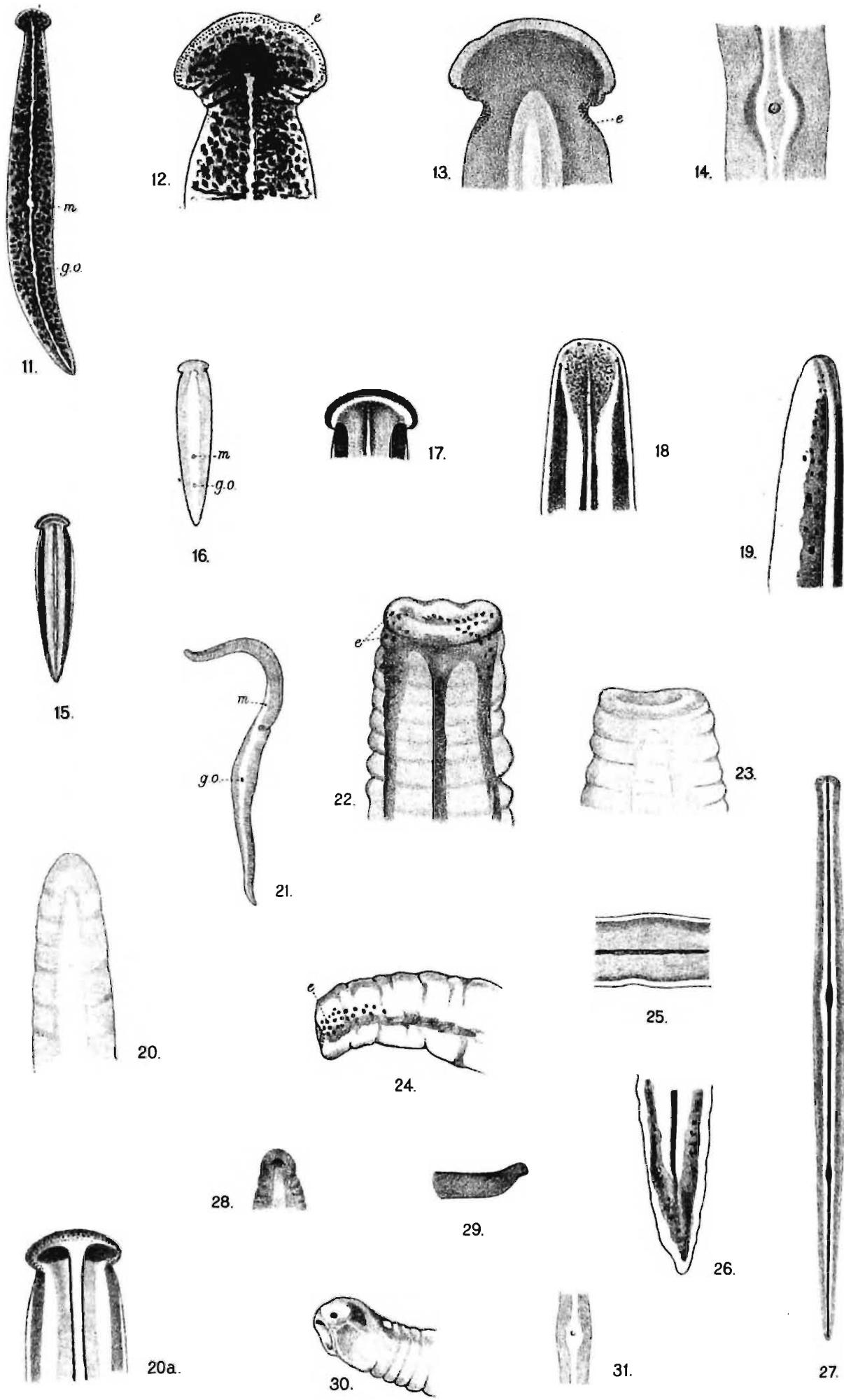
- FIG. 15.—Dorsal aspect, natural size.
,, 16.—Ventral aspect. *g.o.*, genital opening; *m.*, mouth.
,, 17.—Enlarged dorsal view of the head.
? *Placocephalus superbis*. (See appendices, pp. 461 and 462.)
FIG. 18.—Enlarged dorsal view of the head of specimen No. ZEV $\frac{5299}{7}$ (see p. 461).
,, 19.—Enlarged lateral view of anterior end.
,, 20.—Enlarged view of ventral side of the anterior end.
,, 20a.—Enlarged dorsal view of head of specimen No. ZEV $\frac{5242}{7}$ (see p. 462).

Pelmatoplana aurantia, n. sp.

- FIG. 21.—The entire animal, natural size. *g. o.*, genital opening; *m.*, mouth.
,, 22.—Enlarged dorsal view of the head. *e.*, eyes.
,, 23.—Enlarged ventral view of the head.
,, 24.—Enlarged lateral view of the head. *e.*, eyes.
,, 25.—Enlarged view showing markings on the mid-dorsal surface.
,, 26.—Enlarged view of the extreme posterior end of the body.

Cotyloplana pilleata, n. sp.

- FIG. 27.—Dorsal view, natural size. The positions of the mouth and genital opening are shown by the expansions of the mid-dorsal line.
,, 28.—Enlarged ventral view of the head, showing the sucker.
,, 29.—Sketch to show the raised anterior end.
,, 30.—Enlarged antero-lateral view of anterior end showing the sucker.
,, 31.—Ventral surface in the region of the genital opening.



XXXVII TERRESTRIAL ISOPODA

By WALTER E. COLLINGE, *M.Sc.*, *F.L.S.*, *F.E.S.*

(Plates xxxi-xxxiii.)

The small collection of Terrestrial Isopoda collected by the Abor Expedition in the foot-hills of the Eastern Himalayas and by Mr. F. H. Gravely in Tenasserim have been placed in my hands for identification and description. Unfortunately the number of individual specimens is with one exception small and most of them are imperfect, so that their identification has not always been easy.

The *Philoscia* spp. 1 and 2 are in all probability new. I have previously seen an imperfect specimen of No. 1 from Saharanpur, U. P. Budde-Lund in 1894 (*Ann. Mus. Civ. Stor. Nat. Genova*, s. 2, vol. xiv, p. 612) described a species, *Philoscia coeca*, without figures, from the Farm Caves, Moulmein. The fragmentary condition of all the examples is, however, such that I do not feel justified in describing them from this material. The cosmopolitan species *Porcellionides pruinosus* (Brandt) occurs in four of the localities collected in. An interesting addition to cave fauna is the new genus *Burmoniscus*. Most of the specimens of *Cubaris* are immature, one from Sadyia, N. E. Assam, No. 8083/10, and another from the Dawna Hills, No. 8078/10, are undoubtedly new and these are here described and figured.

Porcellionides pruinosus (Brandt).

This species has previously been recorded by Stebbing¹ from Kurseong, 5,000 feet, E. Himalayas, 15-vii-07. In the present collection the localities are as follows:—

- Rotung, Abor Country, 1,300 feet. Under stones. 25-xii-11.
No. 8080/10. Two specimens.
Kobo, 400 feet. In rotten wood. 30-xi-08. No. 8081/10.
Two specimens.
Kobo, 400 feet. In rotten wood. 30-xi-08. No. 8086/10.
One imperfect specimen
Sadyia, N. E. Assam. Under logs. 25-xi-11. No. 8083/10.
Two specimens.

Philoscia, sp. 1.

An interesting form, but unfortunately all the specimens are imperfect. Specimens were obtained from the following localities:—

¹ *Rec. Ind. Mus.*, 1911, p. 189.

- Sadyia, N. E. Assam. Under logs. 25-xi-11. No. 8083/10.
Two specimens.
Sadyia, N. E. Assam. 28-xi-11. No. 8087/10. Seven im-
perfect specimens.
Kobo, Abor Country, 400 feet. In rotten wood. 30-xi-08.
No. 8086/10. Three imperfect specimens.
Near Parong, 3,300 feet. 27-i-12. No. 8088/10.

Philoscia, sp. 2.

One imperfect specimen from Sadyia, N. E. Assam. 28-xi-11.
No. 8087/10.

Burmoniscus, n. gen.

Burmoniscus moulmein, n. sp.

(Pl. xxxi, figs. 1-8.)

Body (fig. 1) oblong oval, dorsal face strongly convex, perfectly smooth and shining. Cephalon small, flanked laterally by the lateral plates of the 1st segment of the mesosome. Eyes absent. Antennulae (?). Antennae (fig. 2) slender and elongated with 3-jointed flagellum. Mandibles (fig. 3) small, beneath the teeth is a single palp terminating in setose bristles. 1st maxillae (fig. 4): outer lobe terminates in eight spines, the four innermost of which are bifurcated; the inner lobe terminates in a number of fine spines. 2nd maxillae (fig. 5) thin and flexible, on the outer side it is produced into a tooth-like plate and a smaller tooth on the inner side, between which is a palp terminating in setose bristles. The segments of the mesosome are strongly convex, the lateral plates of 1-4 overlap one another slightly, whilst those of 5-7 are produced backwardly, especially the 7th. Maxillipedes (fig. 6) poorly developed. Thoracic appendages (fig. 7) elongated, with simple and plumose spines on the protopodite. Metasome narrow, lateral plates small and slightly incurved. Uropoda (fig. 8): basal plate flattened, extending beyond the telson, exopodite long and pointed, endopodite similar in shape, but smaller. Telson triangular, with peculiar lateral bosses. Colour deep brown. Length 9 mm.

Habitat.—Farm caves near Moulmein, in depths of large cave. No. 8079/10. (F. H. Gravely).

Type.—In the collection of the Indian Museum

Unlike any other cave-inhabiting species I know of, this species has a very distinct colour. Packard¹ in his account of the cave fauna of North America states, "As regards change of colour, we do not call an exception to the general law, that all cave-animals are either colourless or nearly white, or, as in the case of Arachnida and insects, much paler than their out-of-door relatives."

¹ Packard, Nat. Acad. Sci., 1887, vol. 4, pp. 3-156, pp. i-xxvii.

In the form of the uropoda, *Burmoniscus* somewhat approaches that present in *Brackenridgia cavernarum*, Ulrich¹, from Ezell's Cave and Beaver Cave, near San Marcos, Texas.

[This species, which is the one referred to in the recent paper on the cave-fauna² of Burma and Malaya by Dr. Annandale and myself, was found among wood that appeared to have been washed by a flood into one of the deepest recesses of the large Farm Cave.—F. H. G.]

***Cubaris caeruleus*, n. sp.**

(Pl. xxxii, figs. 1-10.)

Body (fig. 1) oblong oval, dorsal face convex, slightly rugose, first segment almost twice the length of any other. Cephalon small (figs. 2 and 3), lateral lobes not well-developed, median lobe faintly indicated, epistoma with triangular-shaped depression immediately below median lobe. Eyes prominent. Antennulae longer than usual and 3-jointed. Antennae (fig. 4) slender, with the last peduncular segment long, 2-jointed flagellum, the distal joint being the longer. Mandibles (fig. 5) small, variable in three examples examined. 1st maxillae (fig. 6): the outer lobe terminates in four stout, curved spines and six more slender and almost straight ones, with numerous setae distally on the outer side, inner lobe terminally rounded, thin and with two setose spines. 2nd maxillae (fig. 7) terminating in an outer, blade-like lobe and an inner one with a dense mass of fine setae. The segments of the mesosome are fairly convex and well separated from one another laterally, with the posterior angles of the lateral plates somewhat pointed. Maxillipedes (fig. 8) well-developed, the outer lobe terminates in a large curved spine with a series of minute spinous processes, there are two small spines at the base of this on the inner side and a large one more internally, the inner lobe has a slightly flattened surface with three small marginal spines. Thoracic appendages (fig. 9) comparatively short, setaceous and fringed on the inner side with numerous strong spines, the distal extremity terminating in a prominent incurved claw. Uropoda (fig. 10): basal plate stout and not extending beyond telson; exopodite articulating in a groove on the dorsal side, endopodite large and triangular in section, fringed with numerous setae and terminating distally as three hair-like setae. It articulates on the inner side of the extreme inner dorsal border. Telson (fig. 1) compressed laterally, strongly convex, posterior margin rounded. Length 12.2 mm. Colour (in alcohol) deep blue with irregular whitish patches.

Habitat.—Thingannyinaung to Sukli, Dawna Hills, 900-2,100 ft., Tenasserim, 23-27-xi-11. No. 8078/10. (F. H. Gravely.)

Type.—In the collection of the Indian Museum.

¹ Ulrich, Trans. Amer. Micros. Soc., 1902, vol. 23, pp. 90-93, figs. 1-9.

² Journ. As. Soc. Bengal (N.S.), IX, pt. 10, 1913.

[In life this species is slate-grey with bright lemon-yellow markings. It is common on exposed banks and on the leaves of bushes, where its colours render it a conspicuous and striking object.—*F. H. G.*]

***Cubaris robusta*, n. sp.**

(Pl. xxxiii, figs. 1-9.)

Body (fig. 1) oblong oval, convex, with lateral margins of the segments slightly revolute, mesosomatic segments marked mid-dorsally with a broken white line and laterally with raised longitudinal tubercles. Cephalon (figs. 2 and 3) small with deep epistoma and small triangular lateral lobes, median lobe absent; the dorsal surface exhibits a slight median depression whilst posteriorly it is slightly raised. Eyes (figs. 2 and 3) prominent, sub-dorsal. Antennulae 3-jointed. Antennae (fig. 4) short, setaceous, flagellum 2-jointed, the distal joint two-and-a-half times longer than the proximal one. Mandibles variable. 1st maxillae (fig. 5): the outer lobe terminates in four stout, incurved spines and five more slender ones; numerous long hair-like setae on the outer margin. 2nd maxillae (fig. 6) small, terminating in a thin blade-like outer lobe with numerous setae, inner lobe tooth-like with dense mass of long setae. The segments of the mesosome are convex, the 1st strongly so; lateral plates of anterior segments well separated and slightly revolute. Maxillipedes (fig. 7): outer palp terminates in a strong spinous process with a multispinous termination, there are two smaller spines on the inner border and a fourth basally; the inner palp has a single spine and a small tooth-like process on the inner border. Thoracic appendages (fig. 8) elongated, with numerous strong spines mostly on the inner border. Uropoda (fig. 9) somewhat robust, with triangular basal plate not extending beyond the telson; exopodite small and articulating in a groove on the inner dorsal margin, endopodite a little larger, articulating with the under side of the extreme inner border, and not extending beyond the basal plate. Telson strongly convex, contracted laterally, posterior margin almost straight. Length 8.5 mm. Colour (in alcohol) horny brown.

Habitat.—Sadyia, N.E. Assam. Under logs. 25-xi-11. No. 8083/10. (*S. W. Kemp*.)

Type.—In the collection of the Indian Museum.

This interesting species finds its nearest ally in *Cubaris fragilis*, Cllege,¹ a species I have recently described from the Andamans. It differs, however, from that species in the much stouter and stronger build of the first mesosomatic segment, the lateral plates of which, ventrally, are much thickened, dorsally the mid-dorsal portion of the segment anteriorly has a raised triangular area. In the form of the telson and uropoda there are also important differences and the antennae are rather shorter. The

¹ Rec. Ind. Mus., 1914, vol. x, p. 209, pl. xxv.

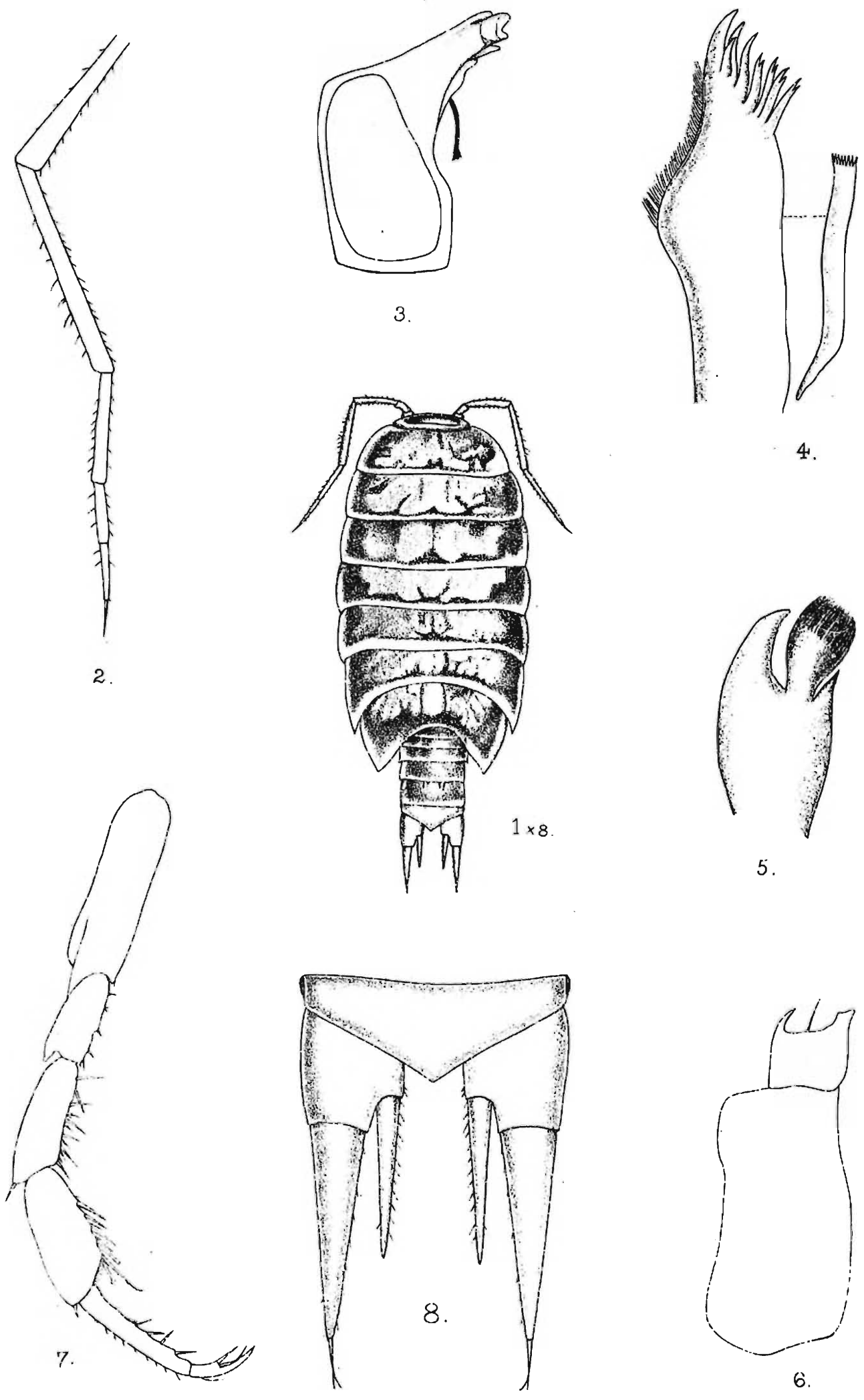
mouth parts were found to be exceedingly variable, thus four different variations were noted in the mandibles and in one specimen the outer lobe of the 1st maxilla had four stout spines and nine more slender ones, instead of five.



EXPLANATION OF PLATE XXXI.

Burmoniscus moulmeinus, gen. et sp. nov.

- FIG. 1.—Dorsal view. × 8.
,, 2.—Antenna.
,, 3.—Mandible.
,, 4.—First maxilla, inner and outer lobes.
,, 5.—Second maxilla.
,, 6.—Maxillipede.
,, 7.—Second thoracic appendage.
,, 8.—Telson and uropoda.



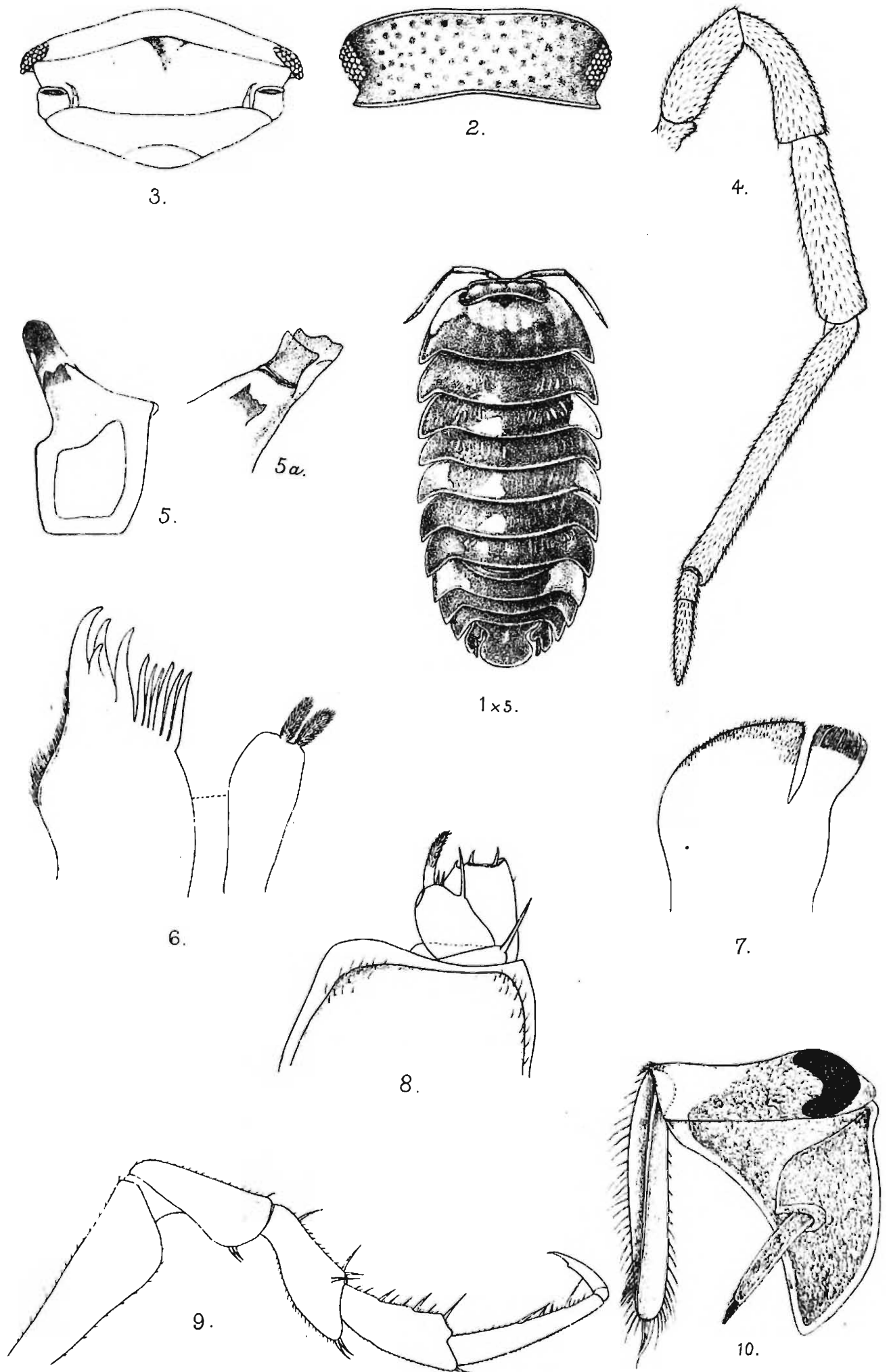
A. Chowdhary, lith.

BURMONISCUS MOULMEINUS, gen. et sp. nov.

EXPLANATION OF PLATE XXXII.

Cubaris caeruleus, n. sp.

- FIG. 1 —Dorsal view. × 5.
,, 2.—Dorsal view of the cephalon.
,, 3.—Anterior view of the cephalon.
,, 4. Antenna.
,, 5.—Mandible. 5a. Outer side.
,, 6 —First maxilla, inner and outer lobes.
,, 7.—Second maxilla.
,, 8.—Maxillipede.
,, 9.—Second thoracic appendage.
,, 10.—Right uropod.



CUBARIS CAERULEUS, n. sp.

A. Chowdhary, lith.

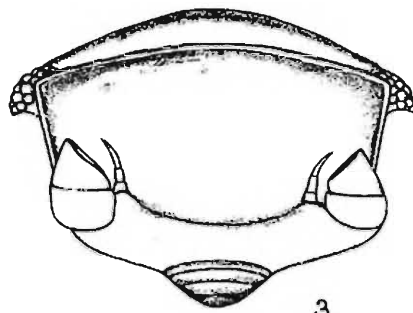
EXPLANATION OF PLATE XXXIII.

Cubaris robusta, n. sp.

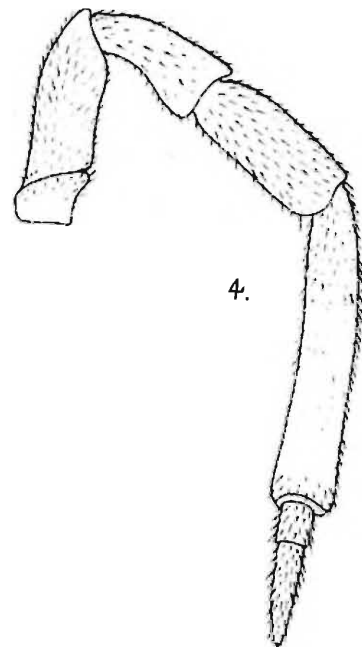
- FIG. 1.—Dorsal view. × 6.
,, 2.—Dorsal view of the cephalon.
,, 3.—Anterior view of the cephalon.
,, 4.—Antenna.
,, 5.—First maxilla, inner lobe.
,, 6.—Second maxilla.
,, 7.—Maxillipede.
,, 8.—Third thoracic appendage.
,, 9.—Right uropod.



2.



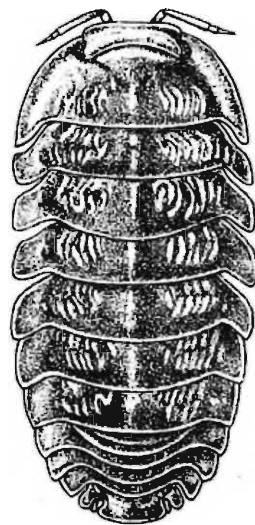
3.



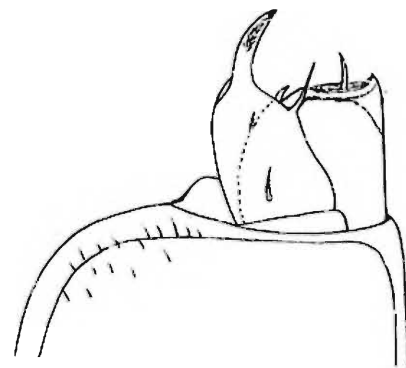
4.



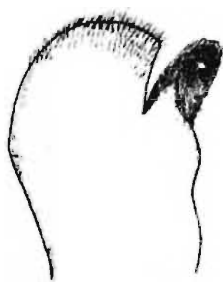
5.



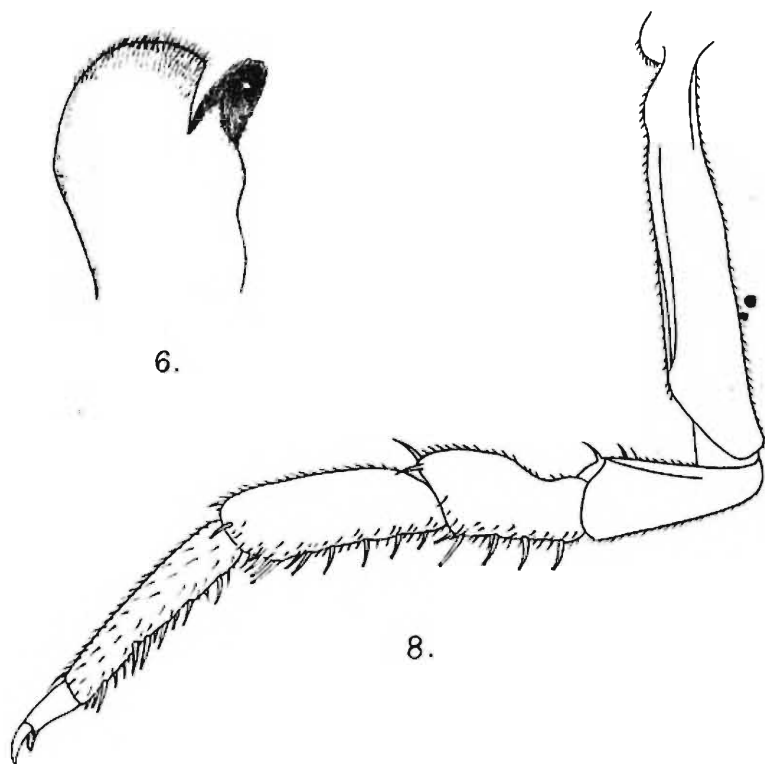
1x6.



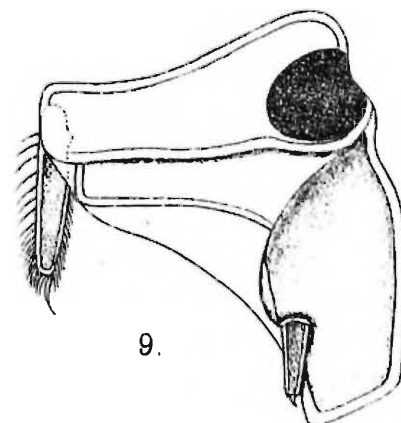
7.



6.



8.



9.

CUBARIS ROBUSTA, n. sp.

A. Chowdhary, lith.

XXXVIII ONYCHOPHORA

By STANLEY KEMP, B.A., Assistant Superintendent,
Indian Museum.

(Plates xxxiv-xxxvii.)

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INTRODUCTION.

The discovery of a species of *Peripatus* on the north-east frontier of India at the foot of the Eastern Himalayas, must be reckoned as one of the most interesting zoological results of the Abor expedition. The Abor country lies far to the north of the nearest point at which specimens have previously been obtained, and no member of the group was hitherto known to occur within the limits of the Indian Empire. The single species found is, moreover, highly peculiar in many respects and, though showing traces of alliance with *Eoperipatus*, which occurs in Sumatra and the Malay Peninsula, differs sufficiently in regard to the characters employed by Bouvier, Evans and other authors to entitle it to separate generic rank; in the absence of any external trace of eyes it appears to be unique.

In describing this form it is not my intention to deal at length with the status of the different genera of Onychophora which have been proposed, or to support either of the systems of nomenclature upheld respectively by M. E. L. Bouvier and the late Dr.

Sedgwick. The species, as both authors have clearly shown, fall into groups comparatively well-defined both structurally and geographically and it seems convenient to recognize such groups by either generic or subgeneric titles. But the arrangement of these groups in separate families, as suggested by Bouvier and other authors, implies adherence to a particular view of the line which evolution has taken, and any such view, though it may ultimately prove correct, seems at present to be based on insufficient evidence.

I am therefore inclined to regard the existing species of *Peripatus* as constituting a single family, the Peripatidae, leaving the difficult problem of the descent of the various subgenera and genera until further information is available.

For the Abor species the name *Typhloperipatus williamsoni* is suggested. The specific name is given in honour of the late Mr. Noel Williamson, one time Assistant Political Officer at Sadiya, who was treacherously murdered by Minyong Abors on March 30th, 1911, at Komsing, a village not many miles distant from the spot where the specimens were obtained. It was owing, chiefly, to the murder of Mr. Williamson and of his companion, Dr. Gregorson, that the expedition of 1911-12 was undertaken.

***Typhloperipatus williamsoni*, Kemp.**

1913. *Typhloperipatus williamsoni*, Kemp, Rec. Ind. Mus. IX, p. 241.

The camp at Rotung, where the majority of the specimens were found was situated at an elevation of 1320 ft. on a small plateau about 600 ft. above the Dihang River, one of the few approximately level pieces of ground seen in the Abor country. The site was at one time occupied by a village of Minyong Abors; but this was demolished in the latter half of 1911 and the villagers put up temporary dwellings half a mile further to the north at a considerably greater elevation.

The country in the vicinity of the camp was overgrown with dense scrub-jungle interspersed with stones and large trees, mostly jack-fruit. Here, as in so many parts, the ground had at one time been cleared for cultivation and the scrub, which as a rule was not more than ten feet high, probably represented some eight or ten years' growth.

It was on the eastern side of the camp on dry, gently sloping ground immediately above the edge of the great gorge of the Dihang River that *Peripatus* was found. In this particular spot the scrub is lower than elsewhere, exceptionally dense and interspersed with large stones and boulders. On December 29th, 1911, the first specimens, three in number, were found by my assistant, Mr. R. Hodgart, and a considerable number was subsequently obtained in the same locality.

Early in January 1912, only a few days after the capture of the first examples, it was decided to cut and burn the scrub in the vicinity of the stockade and the services of Nagas belonging

to one of the carrier corps were utilized for the purpose. Capt. T. Timbrel, who was in command of the carrier corps concerned, kindly allowed the coolies to assist in the collection of specimens, and it is entirely owing to the interest which they evinced that so large a number was obtained.

The specimens were all found under stones and this is a point of some interest seeing that all the Malayan species were found in dead wood. There was an abundance of rotten wood in the vicinity of Rotung and from it large collections of insects were made, but no *Peripatus* were ever discovered in such a situation. The majority of the specimens were found in chinks and crannies under comparatively large stones among the roots of jungle plants: we found it useless to search under small stones or those that were very large and deeply rooted. It needed considerable effort to obtain any number of examples, though several were often found under a single stone. Solitary individuals were occasionally met with, but more usually two to four adults accompanied by a number of young (sometimes as many as six) were collected together.

The Abor country has a very high rainfall and the expedition was undertaken during the driest months of the year. Many animals appeared to be seeking wet places in order to tide over this period of comparative drought, and the closed chambers behind the leaf-stems of plantains, where the air must always have been saturated with water-vapour, were inhabited by a large community of beetles, earwigs, slugs, snails, planarians, earth-worms and frogs; *Peripatus*, however, was never found in this situation.

The area in which the great majority of the specimens was obtained was very limited in extent, being about 200 yds. in length by 100 yds. in breadth. Subsequently a close search in a somewhat similar locality, situated to the N. E. near the mouth of the Sireng stream, resulted in the discovery of a few more individuals. In addition, a solitary example was found at a higher altitude by the 32nd Sikh Pioneers, while cutting a road between Upper Rotung and Renging. The distance between the two furthest points at which specimens were obtained did not exceed four and a half miles, the altitude ranging from about 1200 to 2000 ft.

Specimens were kept alive for some time in boxes; but the breeding season appeared to be over and no observations on the reproduction of the species were made. The young ones found with the adults appeared to be more or less of an age and it seems probable that reproduction takes place only during the wet season.

When touched, the specimens, as is usual in the *Onychophora*, ejected a semitransparent viscous fluid from the oral papillae. The discharge was directed with considerable accuracy towards the objects by which it was irritated, and was at first abundant in quantity: on succeeding occasions it was much less copious and, after a day or so of captivity, it was only by violent

stimulation that the specimens could be induced to perform the action at all. The viscous fluid rapidly solidified and formed long strings of a rubber-like consistency which adhered to everything with which they came in contact. That they never stuck to the animal itself was doubtless due to the special skin processes which, in life, give it such a deep velvety appearance.

We were never able to observe *Peripatus* feeding; but insects placed in the same box with it were afterwards found dead, in nearly all cases overwhelmed by the viscous secretion and firmly adherent to the earth with which the bottom of the box was covered.

When walking the antennae diverged and were held in the same horizontal plane as the body with the tips flexed a little outwards. Moving leisurely, the limbs of a single pair act in unison, having an opposite motion to those of the pairs immediately in front and behind: the claws of one pair almost touch those of the adjacent pair at each step. When moving more hurriedly the limbs of four or five adjacent pairs act together, waves of contraction and expansion pass from behind forwards, and a whole series of limbs is simultaneously lifted clear of the ground, so that the body of the animal has an undulating appearance and is only in contact with the ground in two or three places. The species walks backwards with great facility, employing the more rapid type of movement in so doing.

The limbs of the first four or five pairs are rather irregular in their motions. Those of the first pair are frequently held clear of the ground and this is generally the case with those of the last two pairs. At every step the claws are rapidly raised upwards, so that their dorsal surface touches the side of the limb. It seems that the pads are the most important organs in ordinary locomotion, the claws being of little apparent use in progression on a level surface.

EXTERNAL FEATURES.

Colour.

Living specimens of adults were dorsally of a deep and rich raw umber brown colour, with the apices of the antennae for a distance of about 1 mm. of a very pale brown tint. When fully extended a small pale brown lenticular area situated dorso-laterally at the base of each antenna is exposed and on close examination the tips of all the larger dorsal skin-papillae are seen to be pale. The ventral surface, both of the body and its appendages was wholly pale brown.

In a few adults in which the dorsal colouration was somewhat lighter than that most usually met with, a very narrow black mid-dorsal stripe was perceptible and in preserved specimens, in which most of the original colour has disappeared¹, this is often a conspicuous feature. Microscopic examination shows

¹ The specimens have become quite pale after two years in alcohol.

that there is, in the middle of this stripe, an exceedingly fine pale line.

The young specimens obtained with the adults differed from them noticeably in colour. They were invariably of a pale, warm, buff tint, with the apices of the antennae pure white.

Skin.

The skin is thrown into the customary transverse folds bearing papillae. In dorsal view from 12 to 14 such folds may be counted between each pair of limbs. Towards the posterior end of the animal the interspaces between the appendages are reduced in size; the skin-folds are, however, as numerous here as elsewhere, being crowded together. The folds do not anastomose with one another and appear at first sight to be continuous across the mid-dorsal region; they are, in reality, cut by the fine unpigmented longitudinal line referred to above. Laterally 7 or 8 skin-folds pass between each pair of limbs.

In the anterior part of the animal the skin-folds are separated by wide interspaces, which, in well-extended specimens are as broad as the ridges themselves: in this part of the body the primary papillae are small, the largest occurring laterally and on the appendages. Posteriorly the skin-folds are closely adjacent to one another, leaving practically no interspaces and in this region the papillae are considerably more numerous and frequently much larger than those on the anterior part of the animal.

The primary skin-papillae bear a close resemblance to those of *Eoperipatus*; but the round apical portion is, as a rule, less clearly separated from the basal portion than is shown in Evans' figures. In dorsal view the primary papillae have a rounded basal outline; they are confined to the skin-folds, but secondary papillae are not infrequent in the interspaces.

Antennal region.

The antennae (pl. xxxiv, fig. 1) are ringed in the usual manner. There are 27 or 28 large annulations and, except at the apex, intercalated between them, are secondary annulations, 18 to 20 in number and often incomplete. The antenna tapers from the base up to about the tenth primary annulation and from this onwards is parallel-sided. The apex is not swollen or club-shaped; but the five or six rings of which it is composed are closely packed together and are not separated by the interspaces which in the middle portion are conspicuous.

On the dorsal surface of the antenna the annulations bear small spine-tipped papillae of the usual form and larger papillae, similar in structure, are also to be found on the ventral surface in its distal half. On the proximal part of the ventral surface, however, a well-defined area, lanceolate in shape and extending from the base to about the middle of the antenna, is closely set, on both primary and secondary annulations, with papillae of a

curiously modified type. The basal portions of these papillae are round and well elevated above the general surface and their apical spines, usually very fine and slender, take the form of large broad scales with their apices directed forwards. The tips of one row of scales overlap the bases of the row immediately in front. Each scale is flat about .25 mm. in length, lanceolate in outline and finely pointed distally; the margin is slightly roughened at the base of the apical portion (pl. xxxiv, fig. 3). There are very frequently two secondary annulations on the ventral aspect of the antenna between those of the primary series. These additional annulae, which are apparently developed in order to increase the number of scales, are restricted to the ventral surface and do not extend round to the dorsal side (pl. xxxiv, fig. 2).

The appearance of this scale-bearing patch is shown in pl. xxxiv, fig. 1, and in more detail in fig. 2, which represents a portion of the antenna viewed laterally; it constitutes one of the more striking external features of *T. williamsoni*, for a similar structure has not, I believe, been observed previously in any species of *Peripatus*.

The closest examination of the area at the base of the antenna and of the row of papillae which Bouvier terms the "*arceau oculaire*" fails to reveal any trace of the eye. I have also been unable to detect the "*organe frontale*." It seems not improbable that the patch of scales on the under surface of the antenna is tactile in function, compensating in some degree for the complete loss of sight.

Buccal region.

The mouth (pl. xxxiv, fig. 1) is surrounded by large whitish lobes or tips. The lobes of the outer ring are sixteen in number, the pairs at the anterior and posterior extremities being sometimes fused. Those of the four anterior pairs bear a single spinule, while on those situated further back there may be one, two, or more rarely three such spinules. The inner ring only exists in the anterior part of the buccal opening and consists of six lobes, three on each side; the posterior pair is usually concealed by the adjacent lobes of the outer ring. The anterior lobe is the largest and bears three spinules, while the middle lobe has two. The "tongue" is longitudinally ridged and bears a single row of spinules.

The jaws are similar to those of *Eoperipatus*. On the outer blade (pl. xxxiv, fig. 4) there are two, less commonly three, accessory teeth close to the main tooth. On the inner blade (pl. xxxiv, fig. 5) there are, apparently always, three accessory teeth and a series of from eight to ten small denticles separated from the accessory teeth by a short diastema.

Oral tentacles.

The oral tentacles or papillae are short and bear skin-papillae only on the lateral portions of their distal extremities. The open-

ing is surrounded by four whitish lips similar to those round the mouth.

Legs.

Of legs there are nineteen or twenty pairs. Apparently there are usually nineteen in the male and twenty in the female. I have found one male, however, with twenty legs. In the female the legs at the posterior end of the body are, as a rule less widely separated than those at the anterior end. In the male this feature is less pronounced.

The crural grooves, or openings of the coxal organs, are usually conspicuous on all the legs except those of the first and of the last two pairs. In several specimens, of both sexes, the margins of the grooves are revolute at their distal ends, forming thick, white, Ω -shaped lips.

Owing perhaps to the somewhat contracted condition of the majority of the specimens, I have found it impossible to detect the papillae observed by Evans in connection with the crural grooves. The apertures of the crural glands are visible in one individual only, a male. In this example a single, prominently exerted, white papilla, bearing the orifice of the gland at its apex, is found at the base of the two pre-genital appendages (pl. xxxiv, fig. 7).

The pads on the sole of the limb are of the usual crescentic shape and are closely covered with fine setae. On the last pair of legs there are only two pads, both small and rudimentary; on the penultimate there are three. On all the remaining legs there are four pads. On appendages in the anterior and middle portions of the body the papillae of the first transverse row below the proximal pad, though not fused together, are often transversely elongated and are beset with fine setae in all respects similar to those of the pads (pl. xxxiv, fig. 6). This row of papillae thus constitutes, in effect, a fifth pad of a rudimentary character, incomplete and much narrower than those which form the true sole of the appendage.

The renal apertures on the fourth and fifth pairs of legs are found in the third pad counting from the base of the claw. On these limbs the pad in question is completely divided into two portions, and near this division at the end of the longer and anterior of the two portions of the pad the renal orifice is situated (pl. xxxiv, fig. 6).

The foot (pl. xxxv, figs. 3, 4) is similar to that of *Eoperipatus*. On either side of the curved claws is situated a single primary papilla: one papilla being, therefore, anterior and one posterior. The papillae are conspicuous in dorsal view by reason of their large size and each is furnished with a slender apical spine. Behind the papillae the lower surface of the foot exhibits four extremely slight elevations, two, on each side, each bearing a few longish setae (pl. xxxv, fig. 4); a lateral view of the foot consequently

differs noticeably from that of *Eoperipatus*¹ in which two secondary papillae are found on each side behind the primary papilla. The elevations mentioned above do not seem to represent vestigial secondary papillae.

Ventral organs.

In the young specimens the ventral organs are distinctly seen in external examination, occurring as small whitish areas, in some of which a minute aperture is visible, in the mid-ventral line between the leg-bases. In the adults I have been unable to discover any trace of them, either on external examination or in sections.

Genital apertures.

The genital aperture in both sexes is found between the limbs of the penultimate pair. The orifice is frequently cruciform in shape and is surrounded by the customary tumid, papillose lips. The accessory glands of the male open separately, in this respect differing from those of *Eoperipatus*. The two orifices are very inconspicuous; they are provided with small whitish lips and are placed side of side behind the base of the last pair of limbs (pl. xxxiv, fig. 7).

INTERNAL ANATOMY.

The internal anatomy of *Peripatus* has been so minutely investigated that it is only necessary to discuss a few points in any detail.

Nervous system.

Although no trace of the eye is visible externally the optic ganglion is well-developed and has the form of a spherical mass situated laterally at the base of the antennary nerve (pl. xxxv, figs. 1, 2, o.g.). The skin overlying the ganglion is wholly undifferentiated and bears papillae precisely comparable to those of the surface in the near vicinity. The epidermis is not specialized to form a cornea, the lens is entirely absent and there is no black retinal pigment.

The optic ganglion comprises a large number of ganglionic cells, but does not form a solid mass. Sections passing through it show that in the centre there is a cavity which ramifies irregularly throughout the ganglion and is lined by a loosely compacted non-cellular structure. On comparison with the fully developed eye in *Peripatoides novae zealandiae* (Hutton), it is evident that the structure which lines the cavity represents the remains of retinal rods, and it appears that the ganglionic cells which originally formed a cup-shaped mass round the base of the retina have grown round the base of the rods and have completely enveloped them. The optic nerve is well-developed and is broadly expanded within the

¹ See Evans' fig. of *E. horsti*, Quart. Journ. Microsc. Sci., XLIV, pl. xxxiv, fig. 17, 1901.

ganglion. It extends backwards through the ganglionic substance of the brain, but decreases rapidly in diameter; at its actual point of attachment with the white matter it is exceedingly slender (pl. xxxv, fig. 2).

The antennary nerve appears to be considerably stouter than usual. Possibly, as some compensation for its blindness, the antennae are more sensitive in *Typhloperipatus* than in other forms. The curious scale-bearing patch on the lower surface may well be tactile in function.

The brain differs rather noticeably in shape from those of the species figured by Balfour and Bouvier. Fig. 1, plate xxxv represents a dorsal view of the entire brain in its grosser detail, reconstructed from serial sections, the white matter being indicated as a solid mass lying within the ganglionic substance, which is shown in partial transparency.

Salivary glands.

These glands are well-developed in *Typhloperipatus*, but vary considerably in length in the specimens in which I have examined them. They may extend only to the twelfth pair of legs or may reach to a point between the fifteenth and sixteenth pairs. In sections they are sometimes, but by no means always, found lying in a cavity which may have considerable dimensions. In one instance a cavity is found surrounding the posterior end of the gland; but, as far as I am able to detect, there is no communication between it and the gland: there is no such cavity on the other side of the body.

Evans writes of "coelomic end-sacs of enormous size" in *Eoperipatus* which form a most conspicuous feature in transverse sections. I presume that the asymmetrical cavity found in the Abor specimens must be homologous with these "coelomic end-sacs", but it is evident that the resemblance between the two genera is by no means close in this respect, unless the spaces should prove in both cases to be artificial. Bouvier does not seem to regard the presence of these sacs in *Eoperipatus* as a feature of any importance, since he has omitted all reference to them in his memoir.

Renal glands.

A typical renal gland from the ninth leg-bearing segment is shown in pl. xxxv, figs. 5 and 6. It consists of the customary five parts, namely the ectodermal duct, the bladder, the coiled tube, the funnel and the coelomic end-sac. There is, of course, no renal gland at the base of the legs opposite the genital opening and that of the last leg-bearing segment is but little developed in the female and, apparently, wholly absent in the male. In the male, too, the renal glands of the two pregenital segments are poorly developed, the bladder being much reduced in size and the coiled tube practically non-existent (pl. xxxv, figs. 7-10). The gland of the third pregenital segment is, however, well formed.

Crural glands.

A single crural gland is found in the male at the base of each of the two pregenital pairs of appendages. Each gland is tubular in form, often much convoluted, and placed in close juxtaposition with the renal organs of the same segment. The glands at the base of the seventeenth legs are much longer than those of the preceding segment; as will be seen from pl. xxxv, figs. 8-10, they may show considerable differences in length. Their external openings are situated a little behind those of the renal organs.

Male Reproductive Organs (pl. xxxvi).

The testes have the form of slender tubes which arise from the dorsal aspect of the seminal vesicles and extend forwards as far as the interspace between the ninth and tenth pairs of legs. They run together throughout the greater part of their length and, in the specimen figured (pl. xxxvi, fig. 1), the distal ends turn downwards towards the ventral surface, the actual apices being directed backwards.

The seminal vesicles are large sacs, sometimes 4 mm. in length; they are placed one behind the other, overlapping slightly at their point of contact, and occupy almost the whole of the body cavity between the tenth and thirteenth pairs of legs.

The vasa deferentia arise from the inferior surface of each seminal vesicle and extend backwards as a closely convoluted mass of tubes as far as the seventeenth pair of legs. At this point, in the specimen figured, the left vas deferens, that supplied by the anterior vesicle, passes beneath both nerve-cords before running forwards to join its fellow; in a second specimen one vas deferens passes under the right nerve-cord only. The two vasa deferentia, running forwards, lie close together and become enveloped in a common sheath¹, their lumina not joining until they reach the level of the eighth or ninth legs.

The common duct is of very great length, as long as the entire animal; it passes forwards from the junction of the two vasa deferentia and in one specimen reaches the fifth, in another the interspace between the seventh and eighth legs before turning backwards. The common duct has a single loop in its downward course and runs throughout the posterior part of its length on the left side of the animal. At its termination, however between the eighteenth or penultimate pair of legs, it passes, in both specimens examined, to the right of the two nerve-cords.

The testes are in an active state of spermatogenesis. The lumen, which is not sharply defined, contains quantities of sperm-mother-cells, mostly in the spireme phase. Only quite close to the seminal vesicle is any trace of the subsequent development found, the formation of the spermatozoa taking place for the most part within the vesicle. I have been unable to detect a muscular layer in the wall of the testis near its junction with the seminal

¹ They are separated in the figure.

vesicle. The vesicles themselves are full of spermatozoa in various stages of development and among them considerable numbers of sperm-mother-cells are to be found.

The structure of the vas deferens is, in one respect, peculiar. At the point where it leaves the seminal vesicle it has thick walls, the small and sharply-defined lumen being surrounded by long columnar cells with nuclei at their bases (pl. xxxvi, fig. A). It continues backwards in this character for a short distance and then rapidly changes to a thin-walled tube with a vastly larger lumen surrounded by flattened cells (pl xxxvi, fig. B). Further backwards still it returns to its original form and again becomes a thick-walled duct, while finally, before reaching the posterior limit of its length, it reverts once more to a thin-walled condition, wholly similar in structure to that found further forwards, and in this condition passes upwards and eventually joins its fellow from the other vesicle.

That two types of structure are to be found in the vas deferens is well known and sections through the thin- and thick-walled portions of the Abor species bear a close resemblance to figures given by Gaffron and Evans. But that the duct should revert to its previous condition after once having changed to the thin-walled type has not, I believe, been noticed previously in any species of *Peripatus*, and it is extremely difficult to suggest any reasons for such a modification.

The thick-walled portions of the duct are distinguished by oblique hatching in the central figure on plate xxxvi. In preparing this figure I was obliged to have recourse to reconstruction from serial sections, a task which, owing to the great length of the system (2500 sections were made) proved somewhat tedious: the vasa deferentia form such an intricately convoluted mass that it was found impossible to unravel them in dissection.

When the curious change in the character of the ducts was first noticed, it was natural to conclude that some error had been made in tracing their course; but a repetition of the process led to the same result and precisely similar phenomena were observed in tracing the vas deferens on the other side of the animal. It may also be pointed out that, in sections passing through the interspaces between the fifteenth and sixteenth pairs of legs, the walls of all coils of both ducts seen in cross-section are of the thin type, whereas the thick type is to be found both in front of and behind this region. This, in itself, is sufficient to prove that the thick-walled part of each duct at the posterior end of the animal must be separated by a thin-walled interval from the portion of the duct of similar structure that opens from the seminal vesicle.

The common duct, at its point of origin, is composed of an inner layer of cells of considerable depth provided with numerous nuclei and an outer muscular layer of no great thickness (pl. xxxvi, fig. C). The inner layer, which is doubtless glandular in function and is concerned with the formation of the spermatophore, increases gradually in thickness until the anterior limit of the loop of

the common duct is reached at the level of the fifth pair of legs and is at this point very densely nucleated (fig. D). On the downward course of the duct the inner layer gradually becomes thinner, the muscular coat at the same time thickening, and after looping across from the right to the left-hand side of the animal between the tenth and eleventh pair of legs the muscular envelope is very greatly developed, and from this point onwards the duct is doubtless used for expelling the spermatophores. The lumen of this ductus ejaculatorius has at first the form of a four-rayed star (fig. E), further down it changes and becomes slit-shaped, while for some distance in front of the genital aperture its outline is conspicuously lobose (fig. F).

In the material which I have examined I have not been able to find any spermatophores completely developed, but their formation in the spermatic duct is sufficiently far advanced to enable the more characteristic features to be recognized.

In every male I have examined the mass found in the lumen of the common duct is continuous, i.e. is not divided into separate spermatophores. In the case of the male figured on plate xxxvi the coating of the mass is very distinctly thickened at four points and it is clear that three separate spermatophores are in process of development. The appearance of the contents of the duct is diagrammatically indicated in fig. 2 in optical section. The mass is at several points attached to the wall of the duct by mucus.

The spermatophore would appear to be about 2 mm. in length when fully formed. Posteriorly is a large thin-walled sac in which the bulk of the sperm products are situated. The contents consist of spermatozoa, apparently embedded in a structureless matrix together with a few large pale yellowish granules. In transverse sections such granules may often be observed, along with the cut heads and tails of spermatozoa arranged in a haphazard fashion and not radiating from a central core as in *Eoperipatus* (pl. xxxvi, fig. D).

In the younger spermatophores the wall of the main sac is at several points longitudinally pleated in a somewhat irregular manner¹ and this is also the case with the most fully developed spermatophore, which, however, possesses in addition a thin and smooth horny coat (fig. H).

At the distal end of the main sac the diameter of the spermatophore is slightly lessened and the wall thickened, the lumen being in consequence considerably reduced; further forward a small expansion with a thinner wall is to be found. Beyond this again the wall is very thickly chitinized and the lumen gradually disappears, giving place to a long conical cap formed entirely of chitin (fig. J). At the anterior end of the spermatophore at least four coats are to be found.

¹ This appearance is not, I believe, due to shrinkage in preservation.

Transverse sections through the anterior ends of the two less fully developed spermatophores at the point where the walls are thickening preparatory to the formation of the cap present the very characteristic appearance shown in fig. G. In the case of the most fully developed spermatophore only the faintest indications of this structure can be made out, the star-shaped central portion having been obliterated in the further thickening which has taken place.

It seems that the spermatophore of *Typhloperipatus* differs from that of *Eoperipatus* in possessing a chitinous coating throughout its length and in the fact that the spermatozoa are not arranged radially round a central core. The coat is evidently a great deal thinner than that of *Peripatus*, as typified by "*P. edwardsii*" and studied by Gaffron¹, and the three to five swellings or chambers described by that author—separate receptacles in which masses of spermatozoa are accommodated—do not appear to have their counterpart in the Abor genus. The spherical globules found by Gaffron on the surface of the spermatophore do not seem to exist in *Typhloperipatus*.

But the most noteworthy feature of the male reproductive system of *Typhloperipatus* is the extremely great length of the unpaired duct. Evans in his account of *Eoperipatus* lays stress on this character and makes use of it in maintaining the close affinity of the Malayan genus with the neotropical *Peripatus*, a conclusion also accepted by Bouvier. In *Typhloperipatus* the common duct is about as long as the entire animal, much longer than in *Eoperipatus* and, in its proportional development, at least equalling that of any neotropical species.

The male accessory glands (pl. xxxvi, fig. 1, *m.a.g.*) open by separate openings placed side by side close behind the last pair of legs. They consist of simple tubes, which, however, are much convoluted. They run directly upwards from the openings and lie for the most part near the dorsal aspect of the animal, terminating blindly when they have reached the middle of the interspace between the sixteenth and seventeenth pairs of legs. In structure the glands agree with those of previously described forms; near the aperture the lumen is lined for a short distance with a thin investment of chitin.

In the possession of separate openings to the male accessory glands *Typhloperipatus* resembles *Peripatus* (American species only), the Australasian species (*Peripatoides* and *Ooperipatus*) and the S. African *Peripatopsis cinctipes*² (Purcell) and differs from *Eoperipatus* and all other species.

¹ Gaffron, Zool. Beiträge (Schneider), I, pp. 152-157, pl. xxiii, figs. 62-76 (1885). According to Bouvier, Ann. Sci. nat. Zool. (9), II, p. 292 (1905), the specimens used by Gaffron for his study of the genital organs should properly be referred to *Peripatus sedgwicki*, Bouvier.

² According to the views expressed by Sedgwick (Quart. Journ. Microsc. Sci., LII, p. 379, 1908) this species belongs to the group "Capo-peripatus" or to

Female reproductive organs (pl. xxxvii).

It is extremely difficult to dissect out the female reproductive organs in a satisfactory manner, for the uteri, laden with the large heavily-yolked eggs and embryos are coiled within the body-cavity in such fashion that they cannot be separated in their entirety from one another or from the intestine. folds of which completely fill all space superfluous to their development. The coats of the embryos and eggs, though they rupture at the slightest touch during dissection, are very impervious and I have consequently found it impossible to obtain satisfactory serial sections of the entire animal in this part of the body.

The ovary of *Eoperipatus* is described by Evans as being attached to the floor of the pericardium "not by a single ligament, but by an extensive surface, thus differing from all the genera as yet described. It spreads itself out over the rectum and uteri like a saddle and pushes itself into any space that may be unoccupied, both between as well as outside the uteri." The ovary in *Typhloperipatus* is similar (pl xxxvii, figs. 1, 2). It lies closely pressed against the pericardium in the latitude of the sixteenth and seventeenth pairs of legs, its shape being determined entirely by the space available between the adjacent coils of the uteri and intestine. But though lying close against the pericardial floor, it does not appear to be attached immovably to it. I have found it easy to raise it from the surface and the fact that at the posterior end a well-marked funiculus is found, fused to the pericardial floor at the level of the eighteenth legs suggests that the ovary itself is in reality unattached. Evans did not find any structure resembling a funiculus in the specimens he examined, but Bouvier's account and figure of the ovary of *E. weldoni*¹ seems to show that the method of attachment in the Malaysian genus is sometimes precisely similar to that of *Typhloperipatus*: Bouvier found that the ovary was closely pressed against the pericardial floor, but was separable from it, and that it was attached posteriorly by a large funiculus.

The ovary varies from about 1.5 to 2.5 mm. in length: on external examination the follicles in which the maturing ova lie are conspicuous. Anteriorly it narrows and leads into a long oviduct which is unpaired for a distance equal to more than half the length of the ovary. It divides, in the specimen figured, before reaching the level of the fifteenth legs and one branch soon afterwards bears a small receptaculum ovarum on its inner side and a large receptaculum seminis on its outer side, the latter, though it is in reality fed by two ducts, appearing practically sessile (pl. xxxvii, figs. 1, 3, 4). Similar structures are visible in the

the genus *Peripatopsis* of Bouvier's terminology. Bouvier himself regards it as the type of a separate genus *Opisthopatus*, in which he also includes *O. blainvillei*, a Chilean species in which the openings of the male accessory glands have not been described. Sedgwick places this form in a separate group "Chilioperipatus."

¹ Bouvier, Ann. Sci. nat. Zool. (9), II, p. 365, text-fig. 34, p. 32 (1905).

other branch, the receptacula ovarum and seminis being situated, however, (in all the specimens examined) somewhat further forwards; in the individual figured they lie between the legs of the fourteenth pair. From this point onwards the uteri may be twisted together or more or less straight and soon exhibit large swellings through the thin walls of which developing embryos are visible. In the specimen figured (fig. 1) the coils of the uteri reach to the eleventh legs before turning backwards; in other examples they extend further, as far as the ninth or tenth pairs. The uteri are in all cases almost filled with developing embryos and are so closely coiled together that I have found it impossible to dissect them out in a satisfactory manner. At the posterior end of the body the uterus of each side passes round the nerve cord¹; the two join together in an extremely short vagina and open on the ventral surface between the penultimate legs.

Transverse sections show that the ovary bears a close resemblance to that of *Eoperipatus*. The walls are very deeply folded and bear follicles containing ova in various stages of development as in the species described by Evans. The right and left ovaries are completely fused and enclose a single large cavity.

The walls of the oviduct are, in structure, closely similar to those of the ovary; they do not seem to possess a muscular layer either in the unpaired portion or when they first separate. The walls are thickened, with a consequent reduction in the size of the lumen, shortly before the receptaculum ovarum is reached and in this region a narrow muscular layer is visible. Beyond this point the ducts may more properly be termed uteri; the muscular layer becomes thicker and the cells of the inmost layer are very deep and apparently take on a glandular function.

The receptacula ovarum, except for the fact that they are situated at a considerable distance from the ovary, resemble those of *Eoperipatus*. They have the form of small pouches in the wall of the oviduct and are found a little behind the receptacula seminis. They are, indeed, so inconspicuous that I was at first inclined to regard them as accidental, due to some injury or malformation of the specimen. The fact that they occur in all the specimens examined proves, however, that this is not the case. As in *Eoperipatus* there is great doubt if they ever perform the function implied by their name; no eggs have been found in them and their development, compared with that found in the neotropical species, is insignificant.

The receptacula seminis are of normal structure and are completely filled with spermatozoa. The two ducts, which each possesses, are applied to the wall of the vesicle and open close together into the oviduct.

The female reproductive organs are, on the whole, closely comparable to those of *Eoperipatus*; in the complete fusion of the

¹ In all specimens examined.

ovaries they agree with this genus and differ from all other known forms of Onychophora.

The most remarkable feature of the system is the extremely great length of the unpaired portion of the oviduct. It is clear that the fusion between the right and left portions of the system, well seen in *Eoperipatus*, is still further developed in *Typhloperipatus* and this fact points to the conclusion, also indicated by other characters, that the Abor genus has reached a higher degree of specialization than its Malaysian relative.

Development.

Uterine ova in which no traces of the blastopore have yet appeared are completely filled with yellowish yolk and are from 1.5 to 1.6 mm. in length and about 1 mm. in breadth; they are consequently larger than those found in any genus with the exception of the Australasian *Peripatooides*.

The ova and embryos in any one female show a certain range of variation in age; but it seems that the whole cycle of development is not to be found in the uteri of any one individual. In one female the uteri are filled with ova in which no trace of structure is apparent. In another similar ova are to be found along with others in which some of the primitive segments are differentiated, the blastopore being either open or completely closed¹. In other specimens only comparatively well developed embryos, bent double with the anterior and posterior ends in contact, are to be seen and but little difference in age is to be found between the embryo nearest the receptaculum seminis and that nearest the genital opening. I imagine that the subsequent stages will only be found in material collected at a later period of the year than that in which my material was obtained; I have not found any embryos which exhibit ring-like markings, nor any in which the feet are at all well developed.

It is clear that for purposes of classification on the lines adopted by Sedgwick it may safely be asserted that the uterine embryos of *Typhloperipatus* are nearly of the same age, in contradistinction to the condition found in *Peripatus*, *Eoperipatus*, *Mesoperipatus*, *Paraperipatus* and in some species of *Peripatooides* in which almost the entire cycle of development may be found in the uterus of a single female.

The distinction is perhaps not a very important one, for it appears probable that it is, in a large measure, due to climatic conditions. It seems likely that in the Abor country, with seasons well-defined both as regards temperature and humidity, young are produced at one period of the year only, probably in the wet season. In such a country as the Malay Archipelago, on the other hand, the climate is far more equable and the conditions are con-

¹ It was an examination of these specimens that led me, in my preliminary diagnosis (Rec. Ind. Mus., IX, p. 242, 1913), to make the erroneous statement that the embryos are of all ages.

sequently favourable for the production of young throughout the year.

Evans has noted that in the case of *Eoperipatus* it is difficult to imagine how the receptacula seminis obtain fresh supplies of spermatozoa, seeing that the uteri are completely filled with developing embryos and that young are apparently produced throughout the year. He concludes that in *Eoperipatus* fertilization can only take place once during life; but it is not altogether clear that such an assumption is necessary. When the stock of spermatozoa in the receptacula is either exhausted or, through age, has become powerless, the production of embryos must perforce cease, giving opportunity in due course for the admission of a fresh supply. Naturally the same difficulty does not arise in the case of *Typhloperipatus*, in which fertilization can be effected annually at the close of each breeding season.

The development of the external form in the embryo does not, so far as I have been able to determine from an examination of a limited number of stages¹, offer any very striking peculiarities.

In the manner of formation of the primitive somites there appears to be a considerable resemblance to *Peripatoides novæ-zealandiæ*². The germ-bands develop in a curved line on either side; they are widely separated from one another and between them a ventral protrusion of the yolk-mass is visible (pl. xxxvii, figs. 5, 6). I have not found any embryo at all similar to the second stage in the development of *Eoperipatus weldoni* figured by Evans (Quart. Journ. Microsc. Sci., pl. V, fig. 2, 1902).

A number of females were found to contain embryos in a comparatively advanced stage, with annulate antennae and all, or nearly all, the limbs differentiated. Two of these are figured in pl. xxxvii, figs. 7-9, illustrating the two different ways in which the embryo may be folded.

AFFINITIES

Following the method adopted¹ by Sedgwick in his concise account of the distribution and classification of the Onychophora (Quart. Journ. Microsc. Sci., LII, p. 379, 1908) the principal characters of the genus *Typhloperipatus* may be thus summarized:—

1. Number of legs, nineteen or twenty, variable in the same species.
2. Inner jaw with a diastema and saw of denticles.
3. Legs with four complete spinous pads.
4. Nephridial openings of the fourth and fifth legs situated on the third pad.

¹ In my material the embryos which are well preserved (fixed in hot corrosive) represent only comparatively late stages. The early stages are not in very good condition and, being exceedingly brittle, it was extremely difficult to remove them from the uteri in an entire state. I am thus not able to figure as many stages as I wished.

² Sheldon Quart. Journ. Microsc. Sci., XXVIII, XXIX, 1888-9.

5. Feet with two distal papillae, one anterior, one posterior.
6. Genital opening between the legs of the penultimate pair.
7. Receptacula seminis present, with two ducts opening into the oviducts.
8. Receptacula ovarum present
9. Oviducts united for some distance in front of ovary.
- 9a. Ovaries completely fused, with a single cavity. They lie closely pressed against but not directly attached to the floor of the pericardium, to which, however, they are connected posteriorly by means of a funiculus.
10. The ovary is exogenous, i.e. it is studded with follicles in which the maturing ova lie.
11. The ova are large and heavily charged with food-yolk; they measure about 1.5 mm. in their longest diameter.
12. Embryo without a trophic vesicle.
13. Uterine embryos of about the same age.
14. Unpaired part of vas deferens of very great length.
15. Spermatophores long, with horny coat and cap.
16. Skin-pigment brown, disappearing in course of time in alcohol.
17. Legs with well-developed coxal glands.
18. A single crural gland in the male in each of the two pre-genital pairs of legs.
19. The accessory glands of the male open separately on the ventral surface between the genital opening and the anus.

To these it must be added that there is no external trace of eyes and that there is a patch of highly modified scales, probably sensory in function, on the lower surface of each antenna.

The absence of eyes and the curious modifications in the antennae are doubtless to be regarded as evidence of specialization. They are not shared by any other genus of Onychophora and have consequently been omitted in the table below¹ which is intended to give a general idea of the manner in which the various genera are related.

¹ In this table I have employed the division of species, based on geographical distribution, advocated by Sedgwick (*loc. cit.*), following Bouvier's monograph in the matter of nomenclature so far as it is consistent with Sedgwick's scheme. I follow Sedgwick in placing *Opisthopatus cinctipes*, Purcell, in the S. African group, the name *Chilioperipatus* being available for the species which Bouvier refers to as *Opisthopatus blainvillei*. Sedgwick has already pointed out that *Ooperipatus*, Dendy, here merged with *Peripatoides*, is, according to Bouvier's own showing, a polyphyletic genus. Since Sedgwick's paper appeared a species of *Peripatus*, *P. ceramensis*, has been recorded from Ceram (Muir and Kershaw, Quart. Journ. Microsc. Sci., LIII, p. 737, 1909). This form is unquestionably to be referred to *Paraperipatus* and two additional species, also belonging to the same genus, have been described from New Guinea (Sedgwick, Nature, LXXIII, p. 369, 1910, and Horst, Notes Leyden Mus., XXXII, p. 217, 1910).

<i>Typhloperipatus</i> . Foot-hills of N.-E. Himalayas.	<i>Eoperipatus</i> . Malaysia.	<i>Peripatus</i> . Tropical America.	<i>Mesoperipatus</i> . Tropical Africa.	<i>Peripatoides</i> . Australasia.	<i>Paraperipatus</i> . New Britain, New Guinea, Ceram.	<i>Peripatopsis</i> . S. Africa.	<i>Chiloperipatus</i> . Chili.
Number of legs 19 or 20 pairs	23—25	23—43	23—27	14—16	21—29	16—25	19—
Number of legs variable ...	±	+	+	—	+	±	+
Inner jaw with a diastema and saw of denticles...	+	+	+	—	—	—	—
Legs with 4 complete spinous pads ...	4	4—6	3	3	3	3	3
Nephridial openings of 4th and 5th legs on 3rd pad ...	—	+	+	+	+	+	+
Feet with two distal papillae, one anterior, one posterior ...	+	—	—	—	—	—	—
Genital opening between pen- ultimate legs ...	+	+	+	—	—	—	—
Receptacula seminis present with two ducts ...	+	+	± ¹	+	+	—	—
Receptacula ovarum present ...	+	+	+	—	—	—	—
Oviducts united in front of ovary ...	+	+	—	+	+	+	+
Ovaries completely fused with a single cavity ...	+	—	—	—	—	—	—
Ovary attached to pericardial floor ...	+	+	—	+	—	±	—
Ovary exogenous ...	±	—	— [?]	+	+	±	—
Ova large ...	+	—	—	+	—	—	—
Embryo without trophic vesicle	+	—	?	+	+	— ²	—
Uterine embryos of nearly the same age ...	—	—	—	±	—	+	+
Unpaired part of vas deferens of great length...	+	+	+	+	—	—	—
Spermatophore large, with horny cap ...	+	+	?	+	—	—	—
Skin-pigment brown, evanes- cent in alcohol ...	+	+	+	—	—	—	—
Legs with well-developed coxal glands ...	+	+	+	—	—	±	—
Crural glands of male in two pre-genital pairs of legs only	+	—	+	±	—	—	?
Accessory glands of male opening ventrally between genital opening and anus ...	+	+	+	+	—	±	?
Accessory glands of male open- ing separately ...	—	+	—	+	—	±	?

It is clear that the affinities of *Typhloperipatus* are primarily with its nearest geographical neighbour, *Eoperipatus*, with which, except for the unique characters mentioned above, it agrees in all important structural details but four, viz.—(i) the position of the renal openings of the fourth and fifth legs which, as in most genera

¹ It is not known if two ducts are present.

² According to Bouvier a tendency towards the formation of a trophic vesicle is found in certain species.

of Onychophora, are situated on the third pad, (ii) the presence of a horny coat, as well as a cap, on the spermatophore, (iii) the separation of the openings of the male accessory glands, and (iv) the similarity in age between the embryos found in a single female. It may also be noted that in *Typhloperipatus* the oviducts are united for a long distance in front of the ovary and that in the male there is only a single crural gland in each of the two pre-genital pairs of limbs in place of the two found in *Eoperipatus*. In the number and position of the leg papillae and in the complete fusion of the ovaries, the Abor genus agrees with *Eoperipatus* and differs from all other known forms. It can scarcely be doubted that *Typhloperipatus* is an offshoot from the original Malaysian stock and that it is, on the whole, much more highly specialized than its allies in the Malay Archipelago and in Sumatra.

In other respects the affinities of *Typhloperipatus* seem to lie with the neotropical forms (*Peripatus*) and with those found in Australia and New Zealand (*Peripatoides*).

Evans lays stress on the points of resemblance between the Malaysian species and *Peripatus*, separating these two genera, along with *Mesoperipatus*, in a distinct subfamily. Bouvier goes still further and places them in a separate family, while Sedgwick holds the view that it is premature and inconvenient even to establish separate genera.

In *Typhloperipatus* the affinity with the neotropical species is even more pronounced than in the case of *Eoperipatus*, for it possesses several characters in common with *Peripatus* which are not shared by the Malaysian forms. Thus, the unpaired portion of the vas deferens is of much greater length than in *Eoperipatus*, being fully as long as in any neotropical species; the spermatophore is provided with a horny coat and the male accessory glands have separate openings. It also agrees with *Eoperipatus* in all the characters which that genus shares with the neotropical forms.

It seems probable, therefore, that the structure of the Abor genus will be adduced as further evidence that the views advanced by Evans and Bouvier are correct, though it is, I think, reasonable to hold that the belief in the close genetic relationship of the four genera *Peripatus*, *Mesoperipatus*, *Eoperipatus* and *Typhloperipatus*—the only interpretation that can be placed on Bouvier's classification—is not sufficiently well substantiated by the evidence available. As Sedgwick has shown; the characters of the different geographical groups or genera intermingle in a most intricate way and, in attempting to assess the value of the various combinations which are met with, it is, in the present state of our knowledge, almost impossible to determine which indicate affinity and which are merely examples of convergence.

Though agreeing in the segregation of the four genera mentioned above Bouvier and Evans hold diametrically opposed views as to the question, which is the most primitive genus now existing. A small and yolkless egg, which Bouvier holds to be the primitive condition, Evans regards as evidence of specialization,

Peripatus, according to the former author, *Eoperipatus*, according to the latter, comprising the least modified known species. In effect, Bouvier maintains that the heavily-yolked eggs found in *Eoperipatus* and in *Peripatooides* are examples of convergence and for the discrimination of the "families" relies on other characters which at first sight seem less important.

Although it appears at present that the points in which the Abor and Malaysian genera show affinity with the neotropical species outweigh the characters which might be adduced as evidence of relationship with any other genus, it is possible that future research may indicate that a preponderant value should be assigned to characters based on development and in this respect the widest differences exist between the neotropical species and those found in the Abor country and Malaysia. In this event the possibility of relationship with the Australasian forms cannot be overlooked. *Peripatooides*, in the manner of its development, shows a close resemblance to *Eoperipatus* and *Typhloperipatus* and also agrees with them in many important anatomical details.

It is interesting to note that a line of migration such as would be implied in this last view is not altogether without support when the known distribution of other groups of animals is considered. Michaelsen¹ has shown that certain genera of Megascolecid Oligochaetes are found in New Zealand and India and not, apparently, elsewhere and that abundant evidence exists in this group of a faunistic connection between Australia and New Zealand on the one hand and India and Ceylon on the other. Another instance of this connection is afforded by the small freshwater prawn, *Xiphocaridina curvirostris* (Heller), which is at present known only from N.-E. Assam and from New Zealand². *Xiphocaridina* belongs to the Atyidae, and is one of the most primitive genera in a family whose ancestral characters have long been recognized.

On the other hand there is a large body of evidence in favour of a faunistic connection between India and the neotropical region, traced in most cases, so far as land and freshwater forms are concerned, by way of tropical Africa. As instances of this the Aetheriidae among freshwater Lamellibranchs³, the Cichlidae or Chromides in freshwater fish⁴ and the Caecilians⁵ may be cited.

It seems then that the existence of lines of migration between India and Australasia on the one hand and between India and the neotropical region, *viâ* Africa, on the other hand is in some measure established. From a geographical point of view it would therefore be possible that *Eoperipatus* and *Typhloperipatus* might

¹ Michaelsen, Mem. Ind. Mus., I, pp. 118-129 (1909) and Abhandl. Naturwiss. Verein Hamburg, XIX, 5, pp. 21-26 (1910).

² Kemp, Rec. Ind. Mus., VII, p. 113 (1912).

³ See Annandale, "The African Element in the Freshwater Fauna of British India," IX Congrès Internat. Zool., Monaco, 1913, p. 583 (1914).

⁴ Gunther, "Introd. to Study of Fishes," p. 534 (1880).

⁵ Alcock, "Ann. Mag. Nat. Hist. (7)," XIV, p. 267 (1904).

be genetically connected either with *Peripatoides* or with *Peripatus* with both of which it also possesses morphological affinities

As the question stands at present the evidence for a neotropical connection seems to outweigh that for a migration from the Australasian region, and if we accept the view that the former has occurred, some support is given by what is known of the structure of the tropical African *Mesoperipatus*, which both Evans and Bouvier associate with *Peripatus* and *Eoperipatus*. A further study of the tropical African species may be expected to prove of considerable interest from this point of view and if any Onychophore should be discovered in S. India or Ceylon results of great importance may be anticipated.



EXPLANATION OF PLATE XXXIV

Typhloperipatus williamsoni, Kemp.

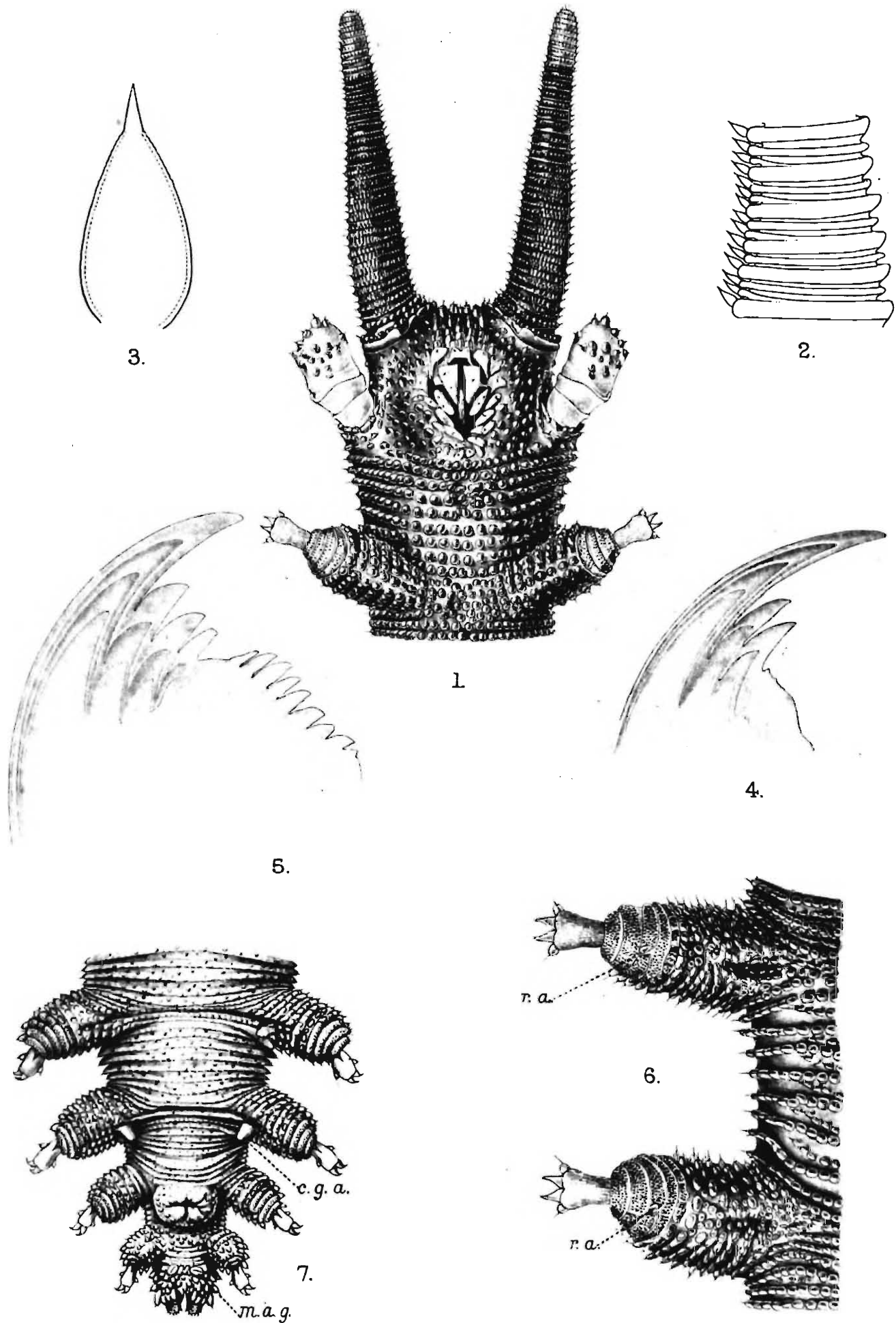
- FIG. 1.—Cephalic region and first pair of legs in ventral view.
,, 2.—Lateral view of antenna, showing the scales and additional secondary annulations on the ventral surface.
,, 3.—One of the scales from the lower surface of the antennae, further enlarged.
,, 4.—Outer jaw-blade.
,, 5.—Inner jaw-blade.
,, 6.—Fourth and fifth legs, seen from below, showing the spinous pads and the positions of the renal apertures.
,, 7.—The posterior end of a male with the last four pairs of legs, showing the genital orifice and the crural glands at the base of the two pre-genital pairs of limbs.

REFERENCE LETTERS.

c.g.a., apertures of crural gland.

m.a.g., apertures of male accessory glands.

r.a., renal aperture.



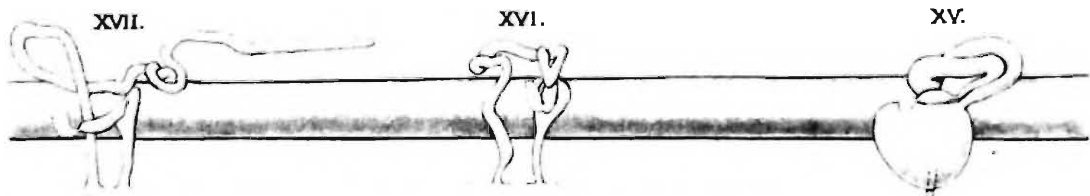
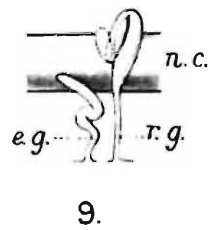
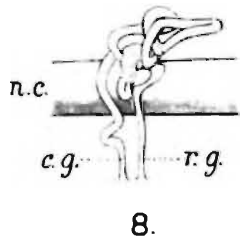
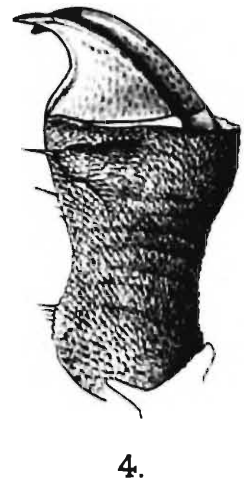
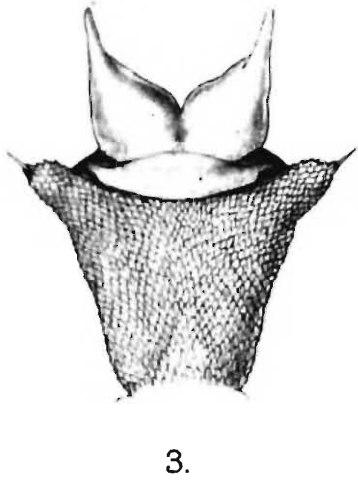
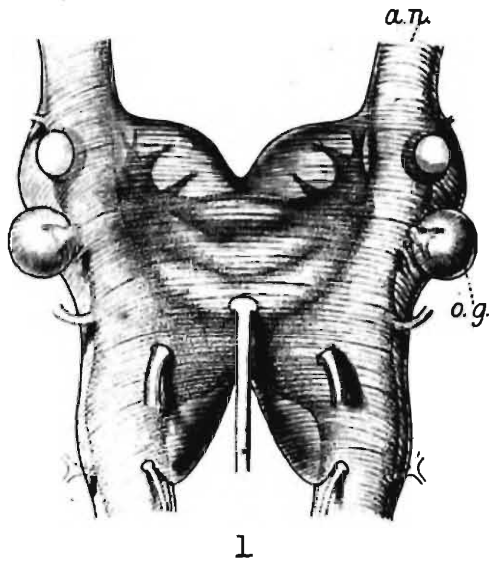
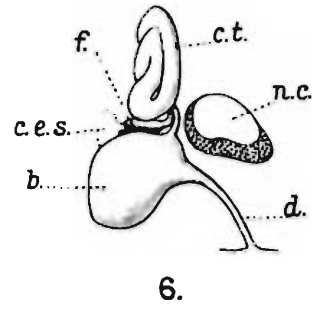
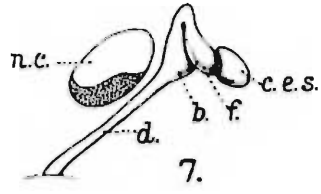
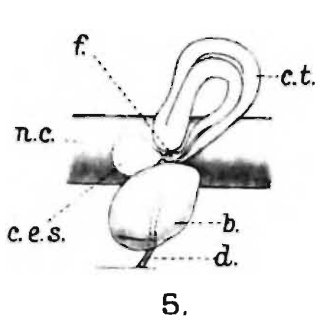
EXPLANATION OF PLATE XXXV.

Typhloperipatus williamsoni, Kemp.

- FIG. 1.—Brain in dorsal view. The white matter is indicated as a solid mass lying within the ganglionic substance which is shown in partial transparency.
- „ 2.—Portion of a longitudinal horizontal section of the brain passing through the antennary nerve (*a.n.*) and the optic ganglion (*o.g.*). The optic nerve is expanded within the ganglion, but is completely surrounded by ganglionic cells. A loosely compacted structure within the ganglion (*r.r.*) apparently represents the remains of the retinal rods.
- „ 3.—A foot in dorsal view.
- „ 4.—Lateral view of another foot.
- „ 5.—Lateral view of a renal gland from the ninth leg-bearing somite, the coelomic end-sac indicated diagrammatically.
- „ 6.—Anterior view of the same gland.
- „ 7.—A renal gland from the sixteenth leg-bearing somite of a male, seen from in front.
- „ 8.—Crural and renal glands from the seventeenth leg-bearing somite of a male in lateral view.
- „ 9.—Crural and renal glands from the sixteenth leg-bearing somite of the same specimen in lateral view.
- „ 10.—Crural and renal glands of the three pregenital somites of another male, seen in lateral view, the nerve cord being indicated diagrammatically in the background. The somites are numbered in roman numerals (XV-XVII).

REFERENCE LETTERS.

<i>a.n.</i> , antennary nerve.	<i>f.</i> , funnel.
<i>b.</i> , bladder.	<i>n.c.</i> , nerve cord.
<i>c.e.s.</i> , coelomic end sac.	<i>o.g.</i> , optic ganglion.
<i>c.g.</i> , crural gland.	<i>o.n.</i> , optic nerve.
<i>c.t.</i> , coiled tube.	<i>r.g.</i> , renal gland.
<i>d.</i> , duct.	<i>r.r.</i> , remains of retinal rods.



EXPLANATION OF PLATE XXXVI.

Typhloperipatus williamsoni, Kemp.

Male Reproductive Organs.

FIG. 1.—The entire system seen from above, displayed semidiagrammatically, magnified about 7 times. In order to show the various parts clearly a certain amount of lateral displacement has been necessary. The testes, separated in the figure, run together for the greater part of their length; the right seminal vesicle slightly overlaps its fellow and the vasa deferentia form an intricate mass in the hinder part of the body.

The dotted lines in the background indicate the position, in relation to the reproductive organs, of the body-wall and legs, the latter being numbered (V–XIX) in roman numerals. The thick-walled portions of the vasa deferentia are distinguished by oblique hatching.

The position of the sections shown on either side is indicated by horizontal lines and reference letters A–F.

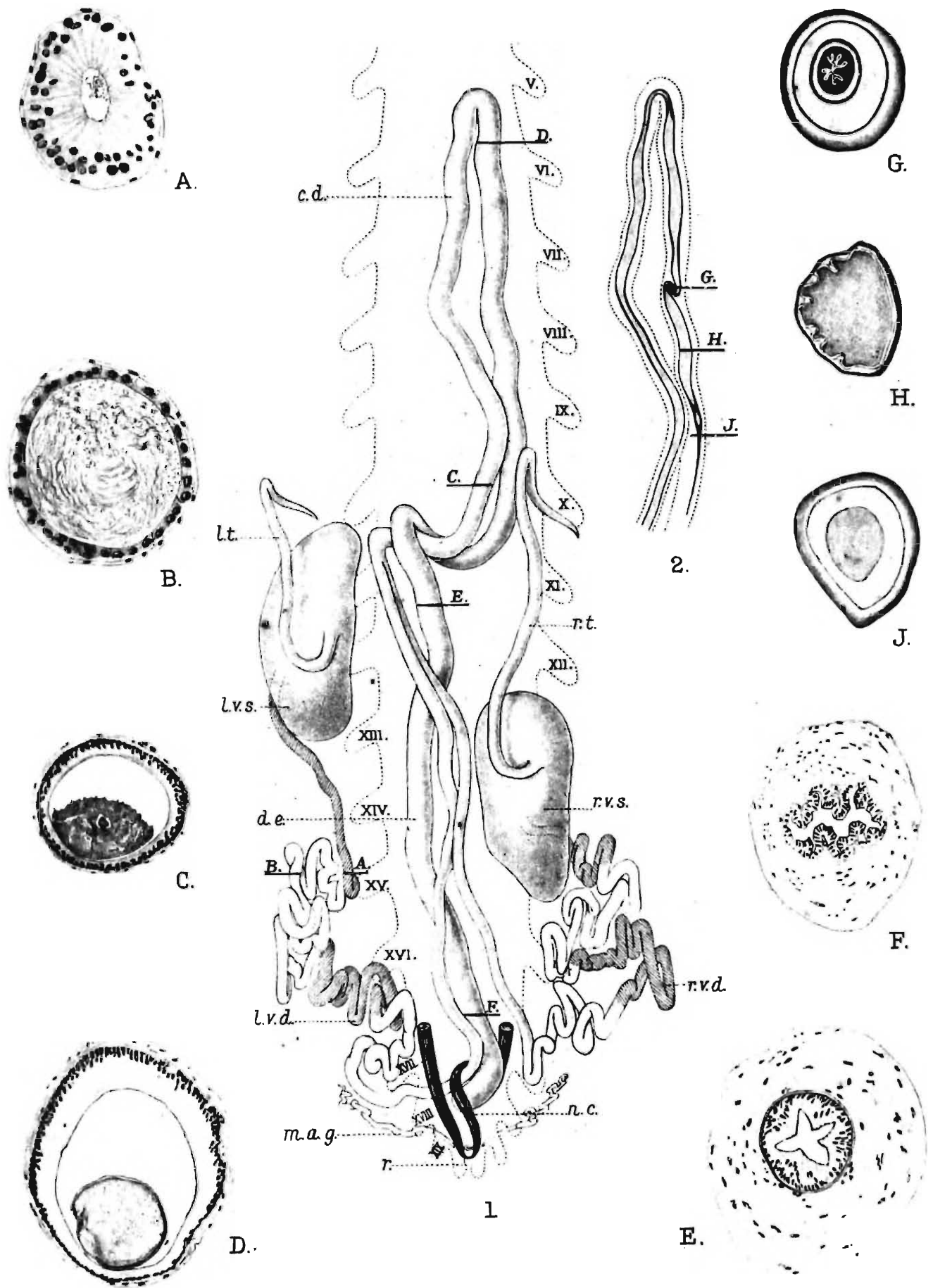
- A. Section through one of the thick-walled portions of the vas deferens.
- B. Section through one of the thin-walled portions of the same duct.
- C. } Sections through the common duct. In C and D
- D. } sections of partially formed spermatophores are
- E. } shown. E and F pass through the ductus ejacula-
- F. } torius.

„ 2.—The anterior loop of the common duct of the same specimen indicated by dotted lines, with the spermatophore shown diagrammatically in optical section. It will be noticed that the walls are thickened at various points and that the mass comprises three partially formed spermatophores. The position of the sections shown to the right is indicated by horizontal lines and reference letters G–J

- G. Section through the thick-walled portion joining two partially formed spermatophores. The lumen almost obliterated and characteristically star-shaped.
- H Section through the main sac of a spermatophore: the inner wall irregularly fluted and surrounded by a smooth chitinous coat.
- J Section through the chitinous cap.

REFERENCE LETTERS.

<i>c.d.</i> , common duct.	<i>m.a.g.</i> , male accessory gland.
<i>d.e.</i> , ductus ejaculatorius.	<i>n.c.</i> , nerve cord.
<i>l.t.</i> , left testis.	<i>r.</i> , rectum.
<i>l.v.d.</i> , left vas deferens.	<i>r.t.</i> , right testis.
<i>l.v.s.</i> , left vesicula seminalis.	<i>r.v.d.</i> , right vas deferens.
<i>r.v.s.</i> , right vesicula seminalis.	



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TYPHLOPERIPATUS WILLIAMSONI, KEMP.

EXPLANATION OF PLATE XXXVII.

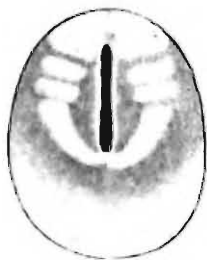
Typhloperipatus williamsoni, Kemp.

Female Reproductive Organs and Embryos.

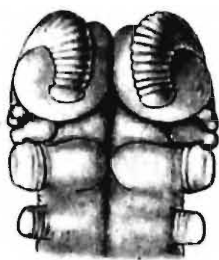
- FIG. 1.—The female reproductive organs, seen from below, magnified about 8 times. A considerable portion of the embryo-laden uterus is omitted. The ovary, which is laid over on the right side, is attached posteriorly to the pericardial floor in the mid-dorsal line by means of a funiculus. The dotted line in the background indicates the position, in relation to the reproductive system, of the body-wall and legs, the latter being numbered (XI-XX) in roman numerals.
- „ 2.—Ovary of the same specimen more highly magnified : ova are seen developing in follicles.
- „ 3.—A portion of the oviducts and uteri, with receptacula seminis and ovarum, of the same specimen seen from the other side (dorsal view), showing the double ducts leading from the receptacula seminis.
- „ 4.—The same portions of another specimen ; in this case an incision was made in the animal before fixation with the result that the ducts and receptacula extruded themselves from the body-cavity and in so doing became straightened. The first embryo in one uterus is shown and it will be noticed that it is well developed : the embryo found nearest the vagina in this specimen was practically the same age.
- „ 5.—An early stage in the development. The blastopore is open and two primitive segments are differentiated.
- „ 6.—A somewhat later stage. The blastopore is closed in the middle and the germ-bands on either side are separated by a ventral protrusion of yolk.
- „ 7.—A more fully developed embryo, bent double.
- „ 8.—The anterior portion of the same embryo in ventral view.
- „ 9.—Another embryo, scarcely more advanced than that shown in fig. 7, but folded in a different manner.

REFERENCE LETTERS.

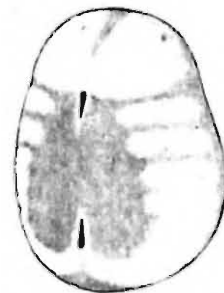
<i>em.</i> , embryo.	<i>o.</i> , ovary.
<i>f.</i> , funiculus.	<i>ovd.</i> , oviduct.
<i>g.a.</i> , genital aperture.	<i>r.o.</i> , receptaculum ovarum.
<i>n.c.</i> , nerve cord.	<i>e.s.</i> , receptaculum seminis.
	<i>ut.</i> , uterus.



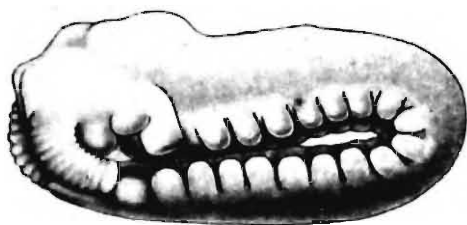
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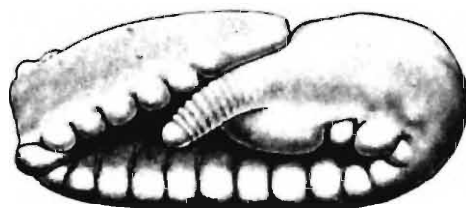
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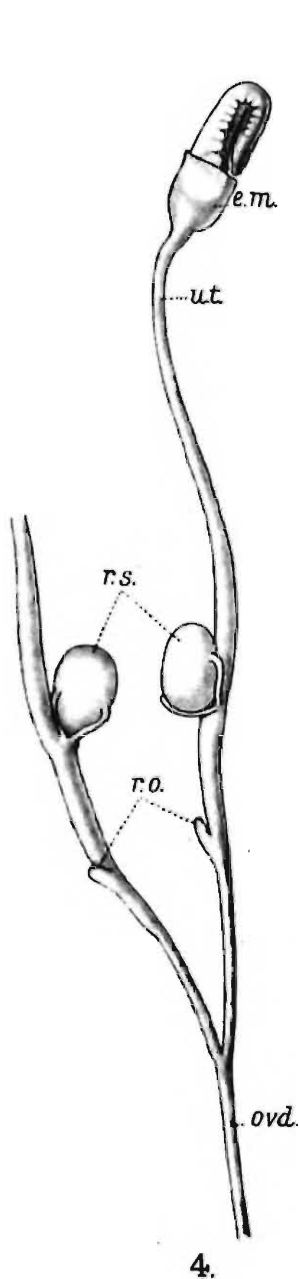
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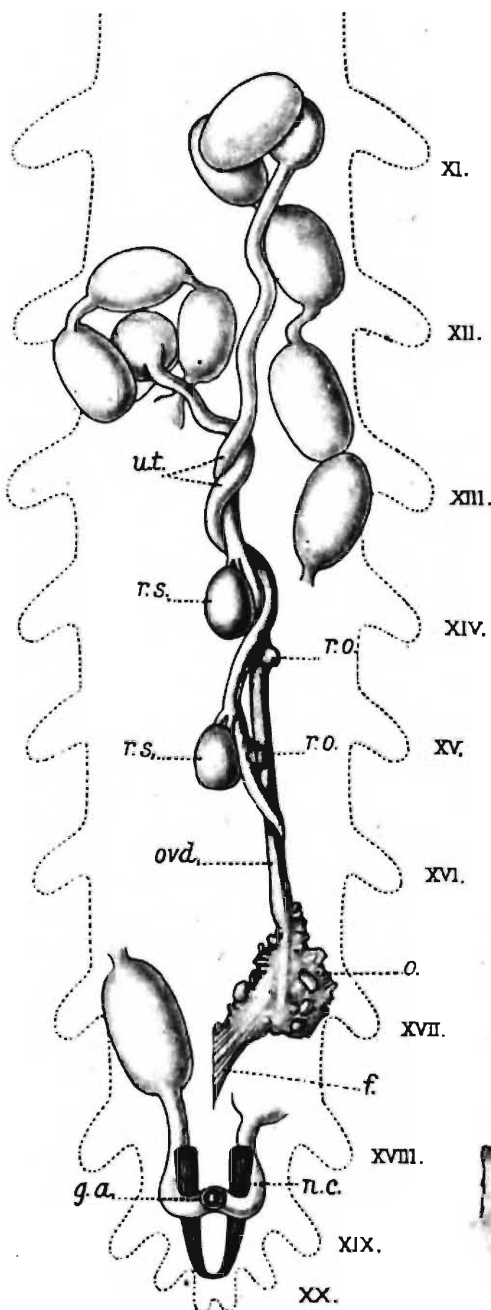
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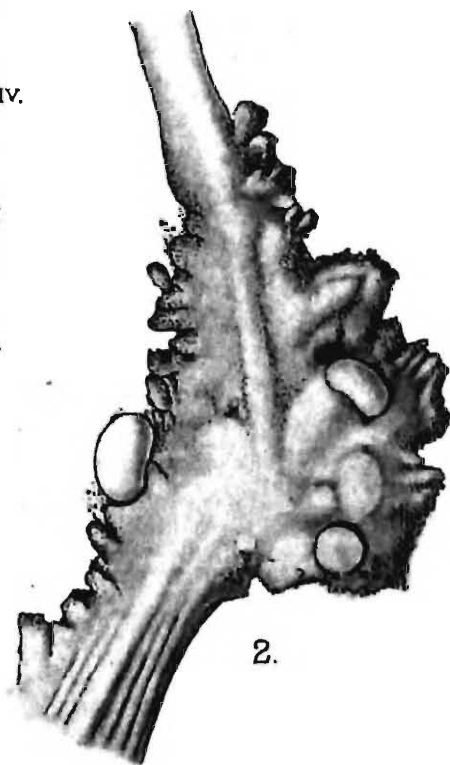
4.



1.



3.



2.

NOTE.

Plate XL, will be issued later.