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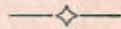
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I. A REVISION OF THE INDIAN SPECIES  
OF THE GENUS *PHYLLOBOTHRIUM*.

By T. SOUTHWELL, A.R.C.S., F.Z.S., Director of Fisheries,  
Bengal, and B. PRASHAD, D.Sc.

(With Plate I.)

During recent years large numbers of Cestoda have been collected in India and Ceylon. Except in a few instances the descriptions of such of these parasites as have been described have been based almost exclusively on external characters, and such characters are often insufficient to identify the parasite. The variability of form assumed by all cestodes during the process of preservation, and the differences due to age and between the mature and immature worms, makes identification by means of external characters alone very difficult. Further, descriptions of parasites which do not include an account of the anatomy cannot be regarded as satisfactory.

The genus *Phyllobothrium* was first defined by Van Beneden in the year 1849. Unfortunately, we have been unable to obtain a copy of the original memoir. In 1850 he published a description of the two species *P. thridax* and *P. lactuca*, while in 1858 he described the species *P. auricula*. A description of two more species, *P. brassica* and *P. fallax*, followed in 1871.

In 1850 the same author (I) defines the characters of the genus *Phyllobothrium* as follows:—

“The four bothridia are sessile; their concavities face externally. They are very mobile and have their edges frilled and puckered like the leaves of a lettuce.”

In 1888 Zschokke (14) published a very careful account of the anatomy of *P. thridax* and *P. dohrni* (*Orygmatobothrium dohrni*). An excellent description of *P. vagans*, Haswell, was given by Haswell (8); and quite recently Yoshida (13) has given a further account of the anatomy of *P. lactuca*, Van Ben. Linton (5) described two species *P. foliatum* and *P. thysanocephalum*, and also added some notes on Leidy's species *P. loliginis*, but he eventually found it necessary to establish the genus *Thysanocephalum* for his *P. thysanocephalum* and changed the name of this species to *Thysanocephalum crispum*, though according to the accepted rules of zoological nomenclature it should be known as *T. thysanocephalum*.

Shiple and Hornell (11) described three new species, viz.—*P. blakei*, *P. minutum* and *P. pammicrum*, from external characters alone, giving no account of their anatomy. Shiple had also

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described previously a species *P. dipsadormorphi* from a snake (10). The genus *Phyllobothrium* usually infests fish-hosts, but the following four species have been described from other animals or without identification of the host.

1. *P. dipsadormorphi* from the "Malagea" snake—*Dipsadormorphus irregularis*.
2. *P. delphini* from the Dolphin—*Delphinus tursio*.
3. *P. inchoatum* from the whale—*Mesoplodon sowerbiensis*.
4. ? *P. crispatisima* and *P. variabile*. Hosts unknown.

The total number of species recorded up till now is 20.

Our collection comprises five species only (viz. *P. blakei*, *P. pammicrum*, *P. foliatum*, *P. lactuca*, *P. compacta*), and represents all the known Indian species except *P. minutum*.

A point worthy of note in connection with the general anatomy of the genus is the presence of supplemental discs on the bothridia in some of the species and their absence in the others. Until the anatomy of the genera closely allied to *Phyllobothrium* has been more fully worked out, it is impossible to discuss the exact relationships of the genus, though it is probable that an elucidation of the anatomy of species belonging to the closely allied genera may necessitate a new grouping of the species.

### ***Phyllobothrium lactuca*, Van Beneden.**

(Plate I, fig. 1.)

Five specimens from the spiral valve of *Galeocerdo tigrinis*, Müll. and Henle, Ceylon Pearl Banks, December 1910.

Van Beneden's account (1) of the anatomy of this species is somewhat meagre. A further account has recently been given by Yoshida (15) which also is incomplete. Johnstone (4) suggests that Van Beneden's figure of this species was drawn from a specimen in which the bothridia had undergone extreme contraction, the head as a result having assumed a spherical appearance and consequently presenting very little indication of the true shape of the bothridia. Johnstone's figure of the head of *P. lactuca* consequently differs somewhat from Van Beneden's figure of the same species.

The worm was recorded from the Ceylon Pearl Banks by Shipley and Hornell (11), who obtained it from the intestine of *Trygon walga*. These authors state that their specimens resemble Van Beneden's figure except that the four bothridia are more distinct. The voluminous head of *P. lactuca* naturally presents different appearances according to the condition of preservation. Our specimens resemble the figure given by Van Beneden in having the head compact and somewhat rounded in shape, though the four bothridia are quite separate.

The specimens, which were preserved in spirit, measure 12 cms., 15 cms., 16 cms., 17.5 cms., and 24 cms., respectively. No measurements of the living worms were taken, but very considerable

contraction was noticed on transferring them to spirit. The greatest breadth of the preserved specimens varies from 3 to 4 mm., and the breadth of the head from 3.5 mm. to 5 mm. In the living condition it was noticed that the worms are capable of very great elongation. The great mobility of the bothridia, noted by Van Beneden, was also observed in the living specimens.

Free proglottides were found in great abundance in the spiral valve of *Galeocerdo tigrinis*. They varied in shape and degree of maturity. The anterior extremity of the mature proglottid is very much reduced, and the sides curve back from it to the broad and ruffled posterior margin.

We have nothing to add to the already existing accounts of the external characters of the worm but certain anatomical features call for remark, as they do not seem to have been noticed before. The reproductive system as seen in a fully mature and detached proglottid is first described, further on the structures as seen in a proglottid still attached to the body of the worm are also considered.

*Male organs.* The testes (T) consist of numerous rounded structures occurring from near the anterior pointed portion of the proglottid to behind the genital opening. They occupy the central field and are situated at a much deeper level than the vitelline glands which lie external to them. Each testes is about .05 mm. in diameter and is much smaller than is shown by Van Beneden; moreover the number of testes in each proglottid is much larger than is shown in his figure. From each of the testes leads a fine duct, and the ducts from the various testes unite together to form a single median vas deferens (v.d). This duct is a very much coiled, elongated, tubular structure, which continues to the cirrus sac; the terminal portion forms the ejaculatory duct and the outer end of the tube is continuous with the outer extremity of the cirrus sac. At the time of protrusion the ejaculatory duct is a double tube, the outer tube being the everted part of the cirrus sac (c), while the inner tube is the terminal portion of the vas deferens. This evertible portion—the penis (P) or the cirrus—is unarmed.

*Female organs:*—The ovaries (ov.) consist of two large lobes, lying one on each side of the centre line, near the posterior end of the segment; they are connected with each other by a median isthmus. Each of the lateral halves is double, as has been described by Haswell for *P. vagans*. The margins of the ovaries are very much crenated. The oviduct (o.d) begins ventral to the isthmus in a pouch-like structure which is known as the "swallowing apparatus." We have not been able to see in our preparations of *P. lactuca* the "plug" described by Haswell, and it appears that this structure is absent in *P. lactuca*. From the "swallowing apparatus" the oviduct runs backwards, ventrally to the shell gland (S.G.) and the receptaculum seminis (R.S), and then curves upwards and to the dorsal surface, it is then continued forwards dorsally to the vagina and the isthmus of the ovary to end blindly. In its course it

receives, just before curving upwards, the fertilising duct from the receptaculum seminis. The vitteline duct opens into it a little further on. The distal portion of the oviduct (which has been designated the ootype (P.U), or primary uterus, opens into the secondary uterus (S.U) by a longitudinal slit on the ventral surface of the secondary uterus. The secondary uterus is a large elliptical chamber, extending from close to the isthmus of the ovary to very near the anterior end of the proglottid. It has no external aperture and the dehiscence of the proglottid probably takes place in the same manner as has been described by Haswell for *P. vagans*. The shell-gland (S.G) is a compact structure surrounding that portion of the oviduct which is situated a little in front of the opening of the vitteline duct into the oviduct. As seen in sections, the shell-gland appears to be connected with the oviduct by minute tubules, through which the secretion is poured into the duct. The vagina (Va) opens immediately in front of the male opening by a fairly broad aperture into the shallow genital pit, which is situated nearer the posterior than the anterior extremity. Its terminal portion is swollen to form a barrel-shaped structure, which probably serves for the storage of spermatozoa until they can find their way to the bag-like receptaculum seminis at the end of the sinuous vaginal duct; from the barrel-shaped dilatation a thin tube leads backwards and upwards. A little above the origin of the main vas deferens this tube curves backwards and is continued, dorsal to the secondary uterus; eventually below the isthmus of the ovary it is dilated to form the vesicula seminalis. From the bay-like receptaculum seminis the fertilising duct leads to the oviduct, as has already been described.

The vitteline glands (V) are situated laterally throughout the length of the proglottid. They are ovoidal structures .4 mm. in diameter. A fine duct leads from each glandular unit, these tubules then unite into two ducts, one on either side, and the pair further unite to form a median duct, which opens into the oviduct a little below the shell-gland.

In the last attached segment the whole of the anatomy was made out in two cases. The secondary uterus is, however, in segments still attached, only a tubular structure without any eggs. In other details they resemble the free proglottides. In the more anterior segments all the structures are not developed and cannot be seen.

### *Phyllobothrium foliatum*, Linton.

(Plate I, figs. 2, 3.)

Four specimens from *Rhynchobatus djeddensis* (Försk.), Ceylon Pearl Banks, February 3rd, 1911.

Linton (5) described the species in 1890. His specimens were obtained from *Trygon centura* caught at Woods Hole, Mass., in 1887. He subsequently recorded the species from *Carcharinus obscurus* at Beaufort, North Carolina, July 11th, 1902. The spe-

cies has not been recorded since. His description is somewhat incomplete and his figures are not quite clear. We, therefore, figure the essential features of the anatomy of the worm again.

Three of our specimens, which were preserved in spirit, measure 5 cms. in length and the fourth measures 6 cms. The breadth of the posterior segments is 2 mm. and the length 3 cms.

All the four specimens have four supplemental discs in each case. These suckers appear to be formed by the fusion of a portion of the edge of the bothridium, and, in a casual examination, the frilled edge may occasionally be mistaken for a sucker, but in the specimens before us there are distinct suckers in each case. Linton (5) states that his *P. foliatum* has the bothridia pedicelled, in marginal pairs, a feature which would require a modification of the generic characters for including this peculiarity. In our specimens the bothridial pedicel is very short, and the bothridia may be described as practically sessile. No observations are available regarding these structures in the living specimens.

The anatomical details of a ripe proglottid of this species are exactly similar to those given for *P. lactuca* except that the vitteline glands in *P. foliatum* are confined to the lateral fields lying external to the excretory tube. Linton described the cirrus of *P. foliatum* as being echinate. In none of our worms was the cirrus protruded, but we were able to ascertain that no spines occur on the cirrus in these specimens. This character, therefore, appears to be variable in *P. foliatum*, although usually it is a constant feature in other species.

### ***Phyllobothrium pammicrum* Shipley & Hornell.**

(Plate I, fig. 4.)

Over a dozen immature specimens from *Urogymnus asperrimus*, Ceylon Pearl Banks, February 16th, 1911.

Thirteen specimens from *Hypolophus sephen*, main area of Chilka Lake, December 1911.

Shipley and Hornell described this species from the intestine of *Carcharias melanopterus* caught at Dutch Bay, Ceylon, in 1905. They had only two specimens. In the original description only the external anatomy was dealt with.

One of us (14) recorded the occurrence of the same species in the intestine of *Hypolophus sephen*, whence 13 specimens were obtained. At the same time a short account of the anatomy was also given. We have, besides, specimens from the intestine of *Urogymnus asperrimus* from the coast of Ceylon.

The length of the various specimens varies from 4 to 5 mm., the maximum breadth up to 3 mm., and the last segment is nearly 1 mm. long.

The head, which we figure, bears four sessile bothridia which have slightly thickened and crisped edges. There are no accessory suckers, and the neck is short.

There are a large number of testes of a fair size disposed on either side of the longitudinal axis of the proglottid. The cirrus-

sac, though provided with a stout musculature, is not very conspicuous. The cirrus has no spiny armature. The vitelline glands are, as in *P. lactuca*, distributed on either side of the testes. The position and structure of the ovary, shell-gland, and the other female generative organs is the same as in *P. lactuca*.

***Phyllobothrium blakei*, Shipley & Hornell.**

(Plate I, fig. 5.)

Thirteen specimens from the intestine of *Trygon kuhli* trawled from Periya Paar.

Shipley and Hornell described this species in 1906 from about half a dozen specimens (half the number of which were without heads) from the intestine of *Trygon kuhli*.

The head, which we figure, bears four frilled sessile bothridia without accessory suckers. There is no neck. The proglottides do not show any overlapping at the posterior margins. The last segment is about three times as long as broad.

The disposition and arrangement of the reproductive organs is the same as in the other species of the genus. The secondary uterus is comparatively large for the size of the proglottid, and the cirrus-sac is well developed; the cirrus, however, is not echinate.

***Phyllobothrium compacta*, sp. nov.**

(Plate I, figs. 6, 7.)

In our collections we found five specimens of a *Phyllobothrium* which cannot be assigned to any of the previously described species. We have named it *P. compacta* in view of the compact appearance of the head. The specimens were obtained from the intestine of *Trygon kuhli* trawled from Anaivilundun Paar, Ceylon (4-5 fathoms deep) on the 19th February, 1911.

The largest specimen measures 51 mm. but the others do not exceed 40 mm. The greatest width is 4 mm., and this point lies about the middle of the worm; the proglottides decrease in width posteriorly. The head has a very compact appearance owing to the sessile nature of the large and well-developed bothridia. The edges of the bothridia are slightly crumpled and there are no accessory suckers.

The specimens unfortunately are not fully mature but the anatomy as far it can be made out resembles that of *P. lactuca*.

The species may be characterised as:—Length about 51 mm., greatest breadth 4 mm., gradually decreasing to a little more than 2 mm. posteriorly. Head with four compact and sessile bothridia, without accessory suckers; neck long. There is only a slight overlapping of the proglottides. Reproductive pores lateral on alternate sides.

*Habitat.* Intestine of *Trygon kuhli*. November 19th, 1911.

*Type-specimen* in the collection of the Zoological Survey of India, Number ZEV 1343.

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#### EXPLANATION OF PLATE I.

- FIG. 1.—*Phyllobothrium lactuca*, van Ben., a mature free proglottid showing the anatomy.  
,, 2.—*P. foliatum*, Linton, surface view of the head.  
,, 3.—*P. foliatum*, a mature proglottid showing the anatomy.  
,, 4.—*P. pammicrum*, Shipley and Hornell, surface view of the head.  
,, 5.—*P. blakei*, Shipley and Hornell, surface view of the head.  
,, 6.—*P. compacta*, sp. nov., entire worm.  
,, 7.—*P. compacta*, surface view of the head.

#### REFERENCE LETTERING.

C.=Cirrus-sac. O.D.=Oviduct. Ov.=Ovary. P.=Penis. P.U.=Primary uterus. R.S.=Receptaculum seminis. S.G.=Shell-gland. S.U.=Secondary uterus. T.=Testis. V.=Vitelline glands. Va.=Vagina. V.d.=Vas deferens.



D. Hingohi del et lith.

PHYLLOBOTHRUM.

II. NOTES ON THE GENUS *CHLORITIS*,  
BECK, WITH THE DESCRIPTION OF THE  
ANIMAL OF A NEW GENUS (*BURMO-  
CHLORITIS*).

By LT.-COLONEL H. H. GODWIN-AUSTEN, F.R.S.

(With Plate IV).

In preparing contributions to the Zoological Results of the Abor Expedition my attention has been called to genera of the Helicidae, and I have come across in my collection of spirit specimens several species of much interest as regards the classification of the Land Mollusca. In this paper I take the genus *Chloritis* and species appertaining to it, and here I must not miss the opportunity of mentioning the work of Henry A. Pilsbry, who has done so much towards our knowledge of very many families and offer him my thanks for the assistance his work has been to me.

The genus *Chloritis* was created in 1837 by Beck; in 1847 Gray took as the type of it *Helix unguina*, Linn., and is followed in "Die Heliceen," pp. 161 and 162 (1860). This shell figured in Pilsbry's Manual of Conchology, plate 29, figs. 1, 2 and 3 is a very distinctive one in form. Apparently the animal has never been examined, and it would appear that the widening of the group to contain forms with a convex spire, unless supported by anatomical characters, was a retrograde step.

Pilsbry with very little material in spirit to deal with, did his best with the genus, and states that only two species of the typical group of *Chloritis* have been investigated anatomically, viz. *C. dinodeomorpha*, Tap. Can. and *C. leei*, Cox, the last by C. Hedley. The figures of the generative organs reproduced on pl. 28, fig. 10 and pl. 32, fig. 42, respectively, differ very much one from the other, so much so that the two species can hardly fall into the same genus.

Pilsbry very truly has said (p. 122) with regard to conflicting opinion as to generic value in this widely distributed group of the Helicidae: "Controversy respecting the generic position of certain species known by the shells alone is idle, for the anatomy only can give a true answer to our questioning."

***Burmochloritis kengtungensis*, n. gen., n. sp.**

*Locality*.—Hills north of Kengtung State, S. Shan States (Col. R. G. Woodthorpe, R.E.); four specimens were obtained.

Shell deeply umbilicated, conoid; sculpture, hair scars visible on 3rd whorl arranged in oblique lines; surface under high power

rather rough, the first three whorls finely and transversely striate, becoming regularly ribbed on the two last, this ribbing is indistinct on basal side. Colour deep ochraceous, with a narrow ruddy brown band, just above the periphery. Spire moderately conoid, apex blunt. Suture impressed. Whorls  $5\frac{1}{2}$ , rounded on the periphery. Aperture semilunate. Peristome white, sinuate above, near upper inner angle, thickened and reflected, a callous on the parietal wall, columellar margin oblique.

Sizes.—Major diameter 32.0; alt. axis 16 mm.

I at first took this species to be *C. theobaldi* of Gude, originally described and figured in Pro. Malac. Soc. 1914, p. 55, also in Fauna British India, 1914, p. 177, but on my recently comparing it with the type specimen in the British Museum, although a close ally, it differs in several characters, being much larger, differently sculptured, and having the peristome sinuate. It comes from the eastern side of the Shan States.

Colonel R. G. Woodthorpe made a very fine collection of land mollusca on the Siam boundary when he was laying it down, and among the species preserved in spirit this is one and I am able to describe the animal.

Foot extremely long, extending to a very fine point: right dorsal lobe small, the left inconspicuous in two small lobes (fig. 1); visceral sac closely mottled with black. The generative organs (figs. 2 and 3) are complicated, the penis elongate and much coiled from the generative aperture to the retractor muscle which is close to a very sharp bend (*p*) at the end of the sheath, epiphallus (*ep*) very long and an extremely long flagellum (*f*). The vas deferens is also of great length. The spermatheca rises from the free oviduct, has one sharp bend, and towards the albumen gland its duct is imbedded in the oviduct, terminating in a globose sac as dotted in the figure; this was seen in course of dissection but got broken off. The free oviduct opens into an ample atrium (*a*) with strongly plicate internal walls (fig. 4).

Close above the atrium and opening into it there is an oblong somewhat flattened sac (fig. 6) with leathery walls, the distal end produced into a short cylindrical tube, which is retractile. On cutting this open upon the dotted line (in fig. 6) a cylindrical dart was disclosed, having a spiral structure, but soft and leathery, not as usually calcareous; along the side of this dart sac (fig. 7) there are numerous strong muscles (*m*), many of which have their attachment on the side of the body wall. The radula (fig. 9) differs from all described by Pilsbry in this group, the teeth are all plain straight sided from the central to margin, the laterals becoming narrower and longer and but slightly curved; the marginals are very minute unicuspid, only the very last bicuspid. The radula is unusually long, having as many as 146 rows. Stoliczka describes that of *Trachia delibrata* to be very long with 125 rows.

The formula is 47. 9. 1. 9. 47 or 56. 1. 56.

The jaw (fig. 8) is very solid, well arched, with some 9 strong broad ribs.

The shell of this species (*Burmochloritis kengtungensis*) I have now described in detail comes very close to *Chloritis theobaldi*, Gude<sup>1</sup> and to *Anserina*, Theobald,<sup>2</sup> all three from the same country, the Shan States, east of the Irrawady River.

The most remarkable distinctive character in *B. kengtungensis* is the presence of a dart sac, and next the form of the teeth of the radula. With regard to the first, in the description of the genus *Chloritis* by Pilsbry (*Man. Conch.*, p. 117) we find "Genital system characterized by the lack of dart sack or other accessory organ on the female side"; with regard to the second,—Basal cusps are present on the lateral teeth (pl. 28, fig. 4).

I have already referred to the two species of which the anatomy is known, viz. *dinodeomorpha* and *leei*. Fig. 42 on plate 32 of the last-named is very interesting in connection with the anatomy of *B. kengtungensis*. On the female side a large sac is depicted much in the same position as the dart sac of the Shan States specimen; it may possibly be a dart sac, it is not alluded to in the description but I have not seen Mr. Hedley's original one and figures. The penis with the very long flagellum is wonderfully alike in the two species. Pilsbry places *C. leei*, Cox, in the group of *C. eustoma*, Pfr. I must here note the section *Sulcobasis* of Taparoni Canefri, with the type *sulcosa*, Pfr. (pl. 29, figs. 9, 10, shell). This in shape is not unlike that of *B. kengtungensis* and he has described another species *beatricis* and shows the central and inner lateral teeth to lack side cusps.

The characters of this Shan species differ so distinctly from those hitherto accepted for *Chloritis* I consider there are sufficient grounds for the creation of a new genus which I name *Burmochloritis*, in which I place *theobaldi* and *anserina*; should *leei* of Australia possess a dart it may possibly be included.

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<sup>1</sup> *Faun. Brit. Ind.*, Moll. II, p. 177, fig. 81.

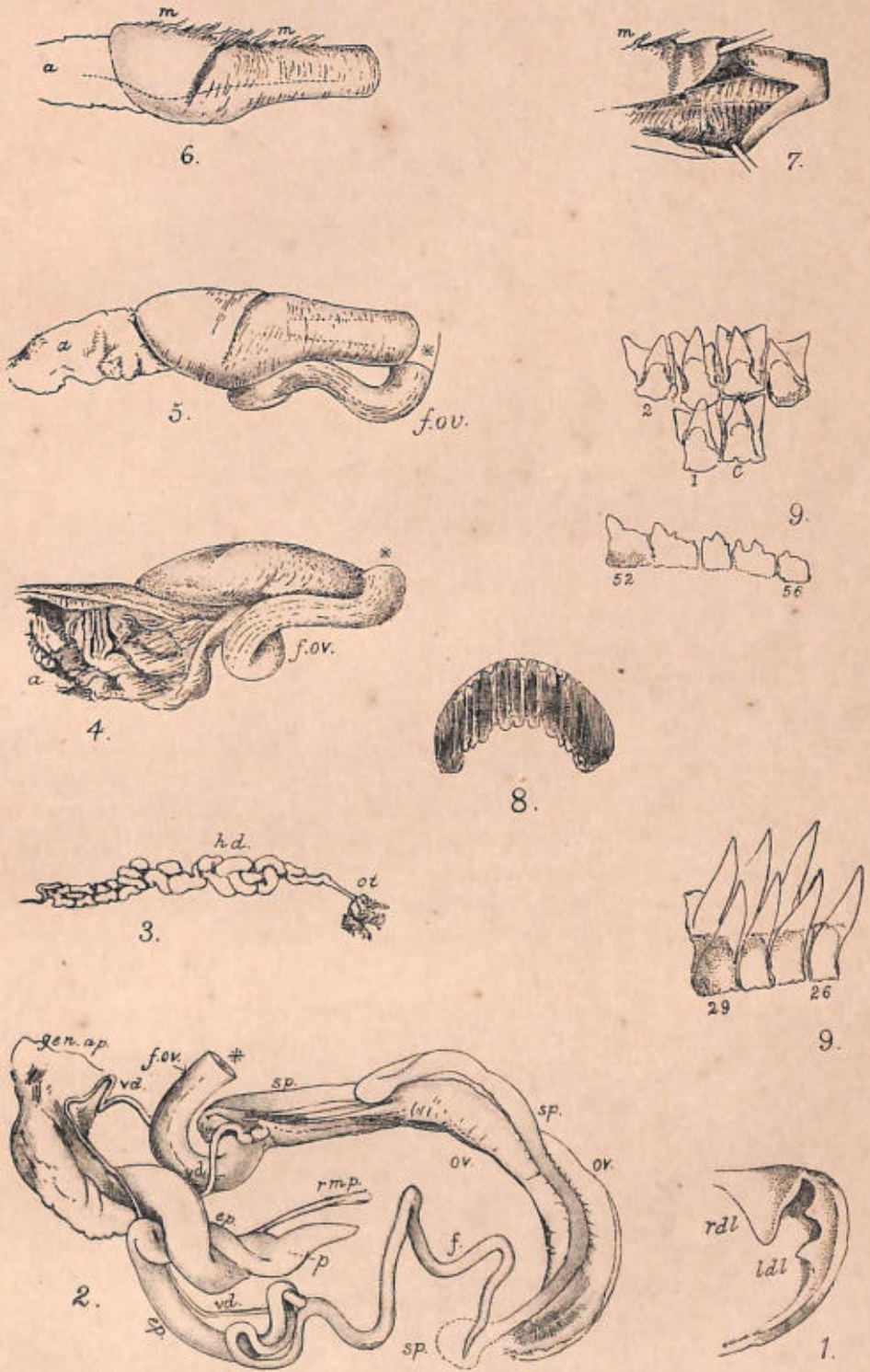
<sup>2</sup> *Ibid.*, p. 175.

EXPLANATION OF PLATE IV.

*Burmochloritis kengtungensis*, n. gen., n. sp.

- FIG. 1.—Mantle zone, with right and left dorsal lobes (*rdl* and *ldl*)  
× 3.  
,, 2.—Part of the generative organs, free oviduct point where  
severed; × 3.  
,, 3.—The ovotestis (*ot*) and hermaphrodite duct; × 3.  
,, 4.—The dart sac viewed from the side and atrium (*a*) opened  
out; × 3.  
,, 5.—Do., dorsal surface showing position of dart, inside dotted  
line; × 3.  
,, 6.—Do., dorsal surface and side, showing retractor muscle  
attachments (*m*), dotted line where cut open; × 3.  
,, 7.—Do., interior exposed, showing the retractile dart; × 3.  
,, 8.—Jaw; × 30.  
,, 9.—Teeth of radula at different parts of the row; × 245.

*ep.* epiphallus; *gen. ep.* generative aperture, position of; *ov.*  
oviduct; *f. ov.* free oviduct; *p.* penis; *rpm.* retractor muscle penis;  
*vd.* vas deferens.



H.H. Gedwin-Austen del.

A. Chowdhary lith.

*Burmochloritis kengtungensis*, G.A.

### III. ON THE PROPER NAME OF THE RED JUNGLE FOWL FROM PENIN- SULAR INDIA.

By HERBERT C. ROBINSON and C. BODEN KLOSS.

Examination of a large series of Red Jungle Fowl from East Java has raised an interesting point in connection with the proper names of the various races of Red Jungle Fowl which extend from Western India to Cochin-China, Hainan and the Philippines in the East and to Java in the South, reappearing in the higher islands of the Pacific, where possibly it owes its introduction to man.

For those who use the 12th edition of Linnaeus, the first name available is *Phasianus gallus* Linnaeus, Syst. Nat. 1, 1766, p. 270; after specifying several varieties ( $\alpha$ ,  $\beta$ ,  $\gamma$ , etc.) Linnaeus proceeds to quote a locality as *Habitat* in India Orientale; Pouli candor, etc. We consider that this paragraph refers to the species as a whole and not to the variety *Gallus pusillus* which immediately precedes it. The type locality of *Gallus gallus* may therefore be taken as the island of Pulau Condor off the southernmost mouth of the Mekong, and Cochin-China birds may therefore be assumed to be typical. Linnaeus certainly had access to specimens from this island which were contained in the Mus. Carlsonianum at Göthenburg, as is evidenced by the description of *Larus polo-condor* by Sparrman hitherto known as *Sterna dougalli*. However, many people refuse to accept "gallus" as a specific name as it was applied to the domestic bird in the *Fauna Svecica*. The Pulau Condor bird was also probably a domestic fowl as we have recently received a collection from the island, which does not include it. Should this objection be upheld, the next binomial name is *Tetrao ferrugineus* Gmelin, Syst. Nat. 1, pt. 2, 1788, p. 761, *vide* Hartert (*Nov. Zool.* IX, 1902, p. 218).

This name is founded jointly on the "Grande Caille de la Chine", Sonnerat, Voy. Ind. Orient., ii, 1782, p. 171, and on Latham's "Hackled Partridge," Gen. Syn. Av., ii, 1783, p. 766, pl. 66, which latter gives an excellent figure of the female from a bird in the Leverian Museum, probably now in Vienna, said to come from the Cape of Good Hope. If Sonnerat's bird did not actually come from China it must have come from the Philippines or from some place east of the head of the Bay of Bengal. He visited no area in Peninsular India whence the Red Jungle Fowl is known to occur.

It is evident, therefore, that whether the specific names *gallus* or *ferrugineus* be used, they must both be applied to the Eastern and not to the Western race, if utilised for wild birds.

The next name applied is *Gallus bankiva*, Temm., Fig. et Gall., ii, 1813, pl. 87; this is obviously founded on Javan birds; "bengkiwo" being the Javanese (East Java) name for the species, vide Horsf., Trans. Linn. Soc. XIII, 1821, p. 185.

So much for the synonymy.

We have examined a series of birds—indubitably wild—shot on the slopes of the Idjen Volcano, Banjoewangi, E. Java, at a height of 5,700 feet, at a distance of more than ten miles from any human habitation. Both the males and the females of this series are distinguishable at a glance from any continental birds we have examined by the dark colour of the neck hackles in the male and by their truncate terminations in both sexes. In the female also the black central areas of the neck hackles are much wider than in the continental birds and the lateral edgings much paler; the heads of the males are also much darker.

We have no hesitation in considering that these specimens are typical of *Gallus bankiva* and in restricting the subspecies to the island of Java. Young males and females, and males in eclipse plumage present exactly the same relative differences as the full-plumaged birds.

The birds inhabiting N. E. Sumatra, on the other hand, are quite indistinguishable from those from Annam, Cochin-China, E., S.W., S.E., and Peninsular Siam and the Malay Peninsula.

From the large number of specimens we have examined in the flesh we do not believe that there is any consistent character to be found in the colour of the lappets. Our large series from S.W. and Peninsular Siam, which we are certain are truly wild birds, has them mostly "red" or "pinkish red," while one is whitish pink and another white; the Annamese birds were bluish white, East Siam red and S.E. Siam pink or red, and birds from Koh Mesan, a little island off the coast of S.E. Siam, bluish white. Mr. Siemund, who has shot very large numbers in the neighbourhood of Kuala Lumpur and Taiping, states that the lappets are usually bluish white. The whole of our series have the posterior portion of the neck hackles rich straw yellow and strongly acuminate, showing no signs of the rounded feathers typical of the Javanese birds.

The races will therefore stand as:—

1. *Gallus ferrugineus ferrugineus* (Gm.).

*Gallus bankiva bankiva*, Stuart Baker (part.), *Journ. Nat. Hist. Soc., Bombay*, XXV, 1917, p. 18 et seq.

Sumatra, Malay Peninsula to Hainan, Westward to Burma.

2. *Gallus ferrugineus murghi*, subsp. nov., postea p. 15.

*Gallus bankiva ferrugineus*, Stuart Baker, *op. cit.*, p. 3.

Peninsular India, North and East to Assam.

3. ***Gallus ferrugineus bankiva*** (Temm.).

*Gallus bankiva bankiva*, Stuart Baker (part.), *op. cit.*, p. 18.

Java, Lombok.

It is obviously impossible to accept Mr. Stuart Baker's nomenclature as he uses as a parent name one which is 25 years later in date than his later subspecies.

Accepting Mr. Baker's views on the distinctness of the Eastern and Western races in regard to the paler hackles possessed by the latter, and in view of the facts which we have here drawn attention to, we consider that the Western bird has no name.

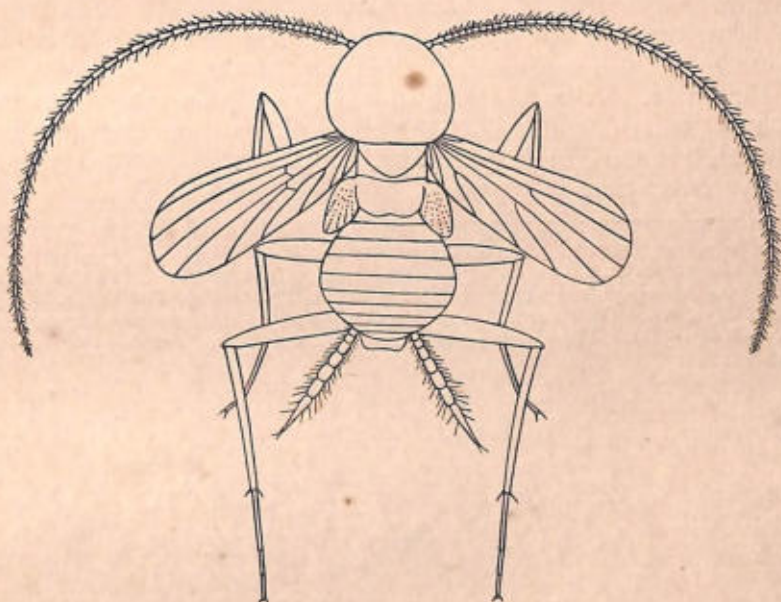
We therefore name it *Gallus ferrugineus murghi*, subsp. nov.

*Type*: Adult male (Zool. Survey of India, No. 18921) from Chirala, Gya District, Bihar (Museum Collector).

#### IV. THE FEMALE OF THE COCKROACH *ALLUAUDELLA*.

By F. H. GRAVELY, D.Sc., *Asst. Superintendent, Zoological Survey of India (now Superintendent, Government Museum, Madras)*.

The genera *Alluaudella* and *Cardax* contain minute cockroaches of such unusual form that Shelford remarked when describing the latter: "It is difficult to discover the affinities of a genus so aberrant as this. . . it cannot be regarded as closely related to any known genus."<sup>1</sup> Only two species of *Alluaudella* and one of *Cardax* are known, and these from male specimens only. The discovery



*Alluaudella himalayensis* ♀, × 15.

of a female is therefore of considerable interest. It was found by Mr. L. C. Hartless in his bungalow at Pashok, *ca.* 3,500 ft., in the Darjiling District of the Eastern Himalayas. Its tegmina are small and its wings vestigial, so that it is obviously incapable of flight; but the tegmina presumably function as a protection to the body, for they are sufficiently developed to show that the venation

<sup>1</sup> *Ann. Mag. Nat. Hist.* (8) I, p. 162 (1908).

is practically identical with that of the male of *Alluaudella himalayensis*, which was described<sup>1</sup> from a single specimen collected at Kurseong, 4,700 ft., in the same district by Dr. Annandale in June 1910.

The total length is 2.5 mm., but the abdomen has evidently shrunk greatly in drying, as it does not now extend much beyond the ends of the hind coxae.

The general colour is dull yellowish, distinctly paler than that of the browner male. The head is scarcely exposed by the pronotum and appears larger than in the male on account of the much smaller and rather narrow eyes. There are no ocelli. The large basal joint of each antenna is succeeded, as in the male, by two joints each about twice as long as broad; these are succeeded by a number of joints which are broader than long. Distally the joints become gradually longer and thinner, those of at least two thirds of the antenna being fully twice as long as broad.<sup>2</sup>

The pronotum is somewhat more rounded than in the male and is not pubescent, though there are a few spiny hairs on the margin.

The tegmina are short, probably too short to cover the abdomen in fresh specimens. Their venation is identical with that of the male. A comparison of the two tegmina shows that the venation varies slightly as in the male. The wings are very much reduced, but show indications of similar venation. The styles are much stouter than in the male.

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<sup>1</sup> *Rec. Ind. Mus.* V, pp. 309-311, pl. xx (1910).

<sup>2</sup> The antennae of the male resemble those of the female. They are about as long as the wings, not shorter as shown in the figure (*Rec. Ind. Mus.* V, 1910, pl. xx, fig. 5 A). Their second joint is as long as the third, not shorter as shown (*loc. cit.* fig. 5 B). The antennae of *Cardax* as shown on the same plate are also too short.

V. A NEW *CHLAMYS* FROM DARJILING.

By S. MAULIK, *Professor of Zoology in the University of Calcutta.*

Family CHRYSOMELIDAE.

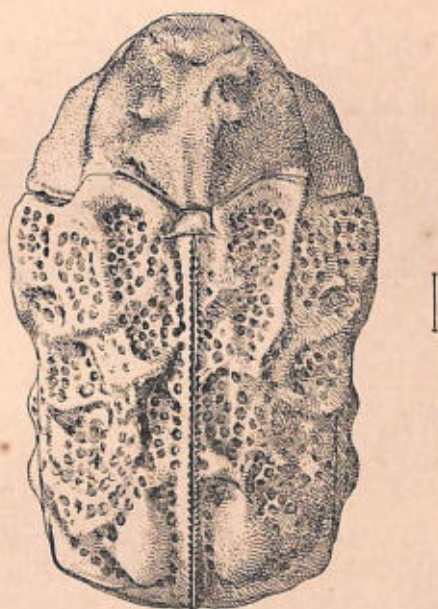
Division CAMPTOSOMATA.

Subfamily CHLAMYDINAE.

Genus *Chlamys*, Knoch.

*Chlamys pashokensis*, sp. n.

Body subquadrate, broadest at the base of the elytra, narrowed anteriorly and more or less parallel posteriorly; dark reddish-brown, with the eyes, the mandibles, some area on the elevated surface of the pronotum, the posterior edge of the prothorax and

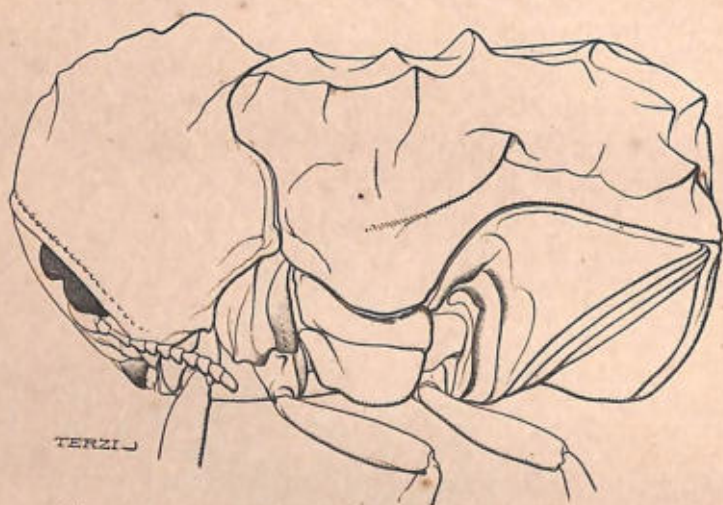


TEXT-FIG. 1.—Upper side of *Chlamys pashokensis*, sp. n.

the anterior edge of the elytra, the depressed areas on the elytra, edges of the episterna and those of the excavations in which the posterior femora are inserted, black or piceous; the antennae, a large area on each side of the prothorax, a tubercle on the protho-

rax in the middle of the base, two tubercles on the posterior edge of the elytra, a large lateral area of the first abdominal segment and the pygidium beneath, light brown. The insect is completely covered with coarse and shallow punctures, in some parts the punctures are shallower, in some they are deeper.

*Head* deeply inserted in the prothorax, viewed from the underside flat and closely punctate. There is a lighter triangular area on the interantennal space, and a black longitudinal streak in the middle branching to a certain extent on the interocular space. The eyes are deeply and triangularly notched on the inner margin. The first joint of the antennae is the thickest and longest, the second small and rounded, the third elongate, the fourth transverse but smaller than the following joints which are all transversely expanded. When the antennae are extended forwards the lateral expansions of the eight apical joints are on the outer side, in repose



TEXT-FIG. 2.—Side view of *Chilamys pashokensis*, sp. n.

they lie in deep channels, the lateral expansions being on the inner side. *Prothorax* bisinuate on either side at the base which is as broad as that of the elytra; broadest at base, narrowed in front, the anterior margin circular, lateral margin oblique and straight. The pronotum is elevated in the middle, the boundary of this elevated surface being marked by black. It has four small tubercles surrounded by black, a lighter and larger tubercle behind, channelled in the middle. The rest of the pronotal surface is uneven having elevations and depressions. *Scutellum* trapezoidal, about twice as broad as long, the two apical outer angles produced posteriorly, the surface rough. *Elytra* broadest at the base, constricted in the middle, coarsely and deeply punctate; suture serrate throughout; humeral callus raised into a tubercle. On each elytron the basal area along the anterior margin is raised, from the middle of which runs obliquely an indistinct costa on the outer

side of which there are four or five irregularly disposed small and large tubercles all of which are not well defined; on the inner side there are four tubercles; on the posterior edge there are two large light brown tubercles.

On each side of the oblique costa in the middle of the elytron the surface is deeply depressed. Pygidium finely punctate with an indistinct cross in the raised middle portion; areas along the sides depressed; a small area near the elytral edge black.

Length 5 mm., breadth  $3\frac{1}{2}$  mm.

Pashok, alt. 2,500 ft., Darjiling District, 26-v—14-vi-1916  
(*F. H. Gravely*).

VI. DESCRIPTION OF A NEW SPECIES  
OF THE GENUS *PSEUDOPHAEA* (= *EUPHAEA*, SELYS) FROM WESTERN  
INDIA WITH SOME REMARKS ON THE  
SECTION *DISPAR* OF THE GENUS.

By F. F. LAIDLAW, M.A.

*Pseudophaea fraseri*, sp. n.

- ♂ Talewadi, near Castle Rock, N. Kanara Dist., Oct. 3-10, 1916.  $\frac{4300}{H1}$   
S. Kemp.  
♂♂ (One of these is the type ♂) Castle Rock, N. Kanara Dist.,  $\frac{4374}{H1}$   
Oct. 1916. S. Kemp.  
♀ (Allotype) Castle Rock, N. Kanara Dist., Oct. 1916.  $\frac{4350}{H1}$   
S. Kemp.

♂ *Wings* relatively long and narrow, the hinder-wing markedly shorter than the fore-wing, and with its apex very regularly rounded. That of fore wing by comparison more pointed (see text-fig.). Length of fore-wing 35 mm., greatest breadth 6.5 mm. at a point just mid-way between pterostigma and nodus.

Length of hinder-wing 32 mm., greatest breadth 6.5 mm. attained at level of proximal end of pterostigma, which is about 4 mm. long on both wings. Both pairs of wings have a yellowish tinge, deepest at the base of the hinder pair; most marked in the type ♂ which is apparently the most mature of the specimens.

The apical third or thereabouts of the hinder wing is opaque, brownish-black, with rather a violet reflex. The inner margin of the opaque area runs transversely straight across the wing at right angles to the long axis of the wing. The transition from the opaque to the transparent is almost abrupt, in the type there is a shading off of colour over a width of about 1 mm. The opaque area of the type is about 10 mm. long. In another specimen it is about 8.5 mm., and in this individual the total length of the hinder-wing is 31 mm.

Pterostigma 4 mm., nodal indicator  $\frac{18}{12} \frac{23}{17}$ .

*Head*: Upper and posterior surfaces black, except the base of the labrum, genae and bases of the mandibles which are bluish-white. Labial structures white tipped with black.

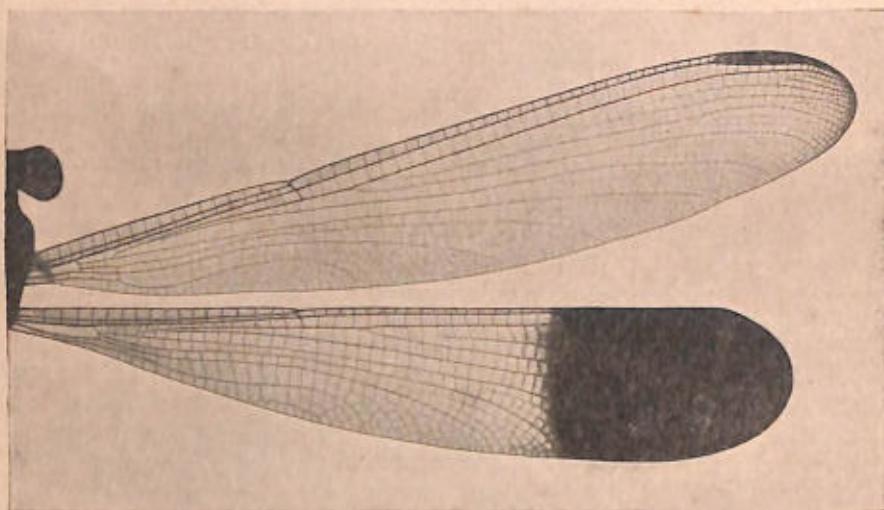
*Prothorax*: Black with a pair of transversely oval, bluish-white spots on either side of the pronotum.

*Synthorax*: Mesepisterna and dorsal surface generally rich velvety black. On either side of the mid-dorsal carina is a bluish-

white line, shaped like a long thin wedge, its base resting rather obliquely on the anterior margin of the synthorax. In addition there are traces of a second line of the same colour close in front of the humeral suture, most readily distinguished at its upper end. The mesepimeron, bordered with black along the humeral suture, is brown-orange in colour with a large oblong-oval island of black enclosed. The mesepisternum and metepimeron are also brown-orange, the suture between them marked with black at its upper end.

Ventral surface reddish-brown.

*Abdomen*: The first six segments are reddish-brown, the last four black. The anterior segments are darker above than on the ventral side, they deepen also in colour distally, 2, 3, 4 have a very fine longitudinal line of yellowish-green dorsally. The anterior



Wings of *Pseudophaea fraseri* sp. n. ♂ (type).

half of 7 is a very dark brown shading into black. The mid-dorsal carina of 10 is raised apically to form a small tubercle which projects beyond the distal margin of the segment. Length of abdomen 38 mm.

*Legs*: Anterior pair black, the two posterior pairs reddish-brown with black articulations, cilia and tarsi.

*Anal appendages*: Upper pair stout, about as long as the 10th segment of abdomen, divaricate with slight inward curve; in profile digitiform, superior pair about one-quarter the length of upper pair, closely approximated and parallel; distant from the upper pair, slightly curved upwards. Both pairs black.

♀ (Allotype). *Wings* unfortunately much frayed, so that it is impossible to give exact measurements. The length of the forewing is about 34 mm., and of the hinder-wing about 31 mm., the latter does not show the specialization in shape found in the male,

its greatest breadth, a little over 6 mm., appears to be mid-way between the nodus and pterostigma.

The wings are colourless, and the length of the pterostigma is 4 mm.

*Head* more extensively marked with bluish-white than is that of the male. The coloured area of the upper lip is broader, the mark on the genae ascends to the level of the anterior ocellus, and there is a bluish-white spot in the centre of the post-clypeus, and a small square mark on either side of the ocelli of the same colour.

*Prothorax*: As in the male, but the coloured spots a trifle smaller relatively than in that sex.

*Synthorax*: Mesepisterna and dorsal surface black, on either side of the mid-dorsal carina is a bluish-white line narrower than that seen in the male, a little widened anteriorly. Just in front of

#### ERRATUM.

P. 25, line 12 from bottom, *for* Major F. C. Fraser, R.A.M.C.  
*read* Major F. C. Fraser, I.M.S.

small postero-lateral spot, and on 9 to antero-lateral and postero-lateral spots.

*Legs*: Black, excepting the coxae and anterior surfaces of the femora which are yellow.

*Anal appendages* equal in length to segment 10, acute-conical.

This fine new species, which I have much pleasure in dedicating to Major F. C. Fraser, R.A.M.C., belongs to a small section of the genus *Pseudophaea*, which may be called the section *dispar*, after its first described species, named by Rambur.

One other species referable to the section has been described. This is *Pseudophaea impar*, Selys, from Malacca, with the race *inaequipar*, Selys, described by its author as a distinct species from Borneo. Krüger has reported *Pseudophaea impar* from Soekaranda, Sumatra (*Stett. Entomol. Zeit.* 1898, p. 78), but I do not know whether it differs to any extent from the Peninsular form or not.

*Pseudophaea fraseri* and *Pseudophaea dispar* are much more nearly related to each other than either of them is to *Pseudophaea*

white line, shaped like a long thin wedge, its base resting rather obliquely on the anterior margin of the synthorax. In addition there are traces of a second line of the same colour close in front of the humeral suture, most readily distinguished at its upper end. The mesepimeron, bordered with black along the humeral suture, is brown-orange in colour with a large oblong-oval island of black enclosed. The mesepisternum and metepimeron are also brown-orange, the suture between them marked with black at its upper end.

Ventral surface reddish-brown.

*Abdomen*: The first six segments are reddish-brown, the last four black. The anterior segments are darker above than on the ventral side, they deepen also in colour distally, 2, 3, 4 have a very fine longitudinal line of yellowish-green dorsally. The anterior

Wings of *Pseudophaea fraseri* sp. n. ♂ (type).

half of 7 is a very dark brown shading into black. The mid-dorsal carina of 10 is raised apically to form a small tubercle which projects beyond the distal margin of the segment. Length of abdomen 38 mm.

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♀ (Allotype). *Wings* unfortunately much frayed, so that it is impossible to give exact measurements. The length of the fore-wing is about 34 mm., and of the hinder-wing about 31 mm., the latter does not show the specialization in shape found in the male,

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*Prothorax*: As in the male, but the coloured spots a trifle smaller relatively than in that sex.

*Synthorax*: Mesepisterna and dorsal surface black, on either side of the mid-dorsal carina is a bluish-white line narrower than that seen in the male, a little widened anteriorly. Just in front of the humeral suture is a second line rather of a yellow hue, this anteriorly almost meets the more median line.

The mesepisternum is dull yellow, bordered with black along the humeral suture, the yellow colour enclosing a large oblong-oval island of black. The first and second lateral sutures are marked with black along their whole length; the rest of the side and the ventral surface of the synthorax is dull yellow in colour.

*Abdomen*: Shining black above and at the sides, ventrally dull yellowish brown. Segments 1-4 have a very fine, yellow line marking the dorsal, longitudinal carina; the line is present but barely perceptible on segment 5, and reappears on segments 8, 9.

Laterally segments 1 and 2 have a broad, pale-yellow band; a similar band occurs on segments 3-6, not quite reaching the distal border of the segment, but widened at the base of each to form an incomplete pale ring. On segment 7 the band is diminished, extending only one-half the length of the segment, and the basal widening is less marked. On segment 8 the band is reduced to a small postero-lateral spot, and on 9 to antero-lateral and postero-lateral spots.

*Legs*: Black, excepting the coxae and anterior surfaces of the femora which are yellow.

*Anal appendages* equal in length to segment 10, acute-conical.

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*Pseudophaea fraseri* and *Pseudophaea dispar* are much more nearly related to each other than either of them is to *Pseudophaea*

*impar*. I have examples of the males of all the four forms before me. For the females I have seen only the allotype of *P. fraseri*, Selys description and wing-figure of *P. dispar* (*Mon. Calopt.*, p. 168, pl. v, fig. 3) and the same writer's very brief description of the female of *P. impar* (*Bull. Acad. Belg.* (2) VII, p. 441 (1859)).

I have been able to compare the males with those of a number of other species of the genus in my own collection. Of females, which are rare in collections, I have seen only two specimens of *P. brunnea*, Selys, from Burma, and a figure of the wing of *P. formosa*, Selys, given by Dr. Ris (*Supplementa Entomol.* 1, p. 53, fig. 5). On the evidence before me I can say that whilst the males of the genus show very remarkable differences in colouring and wing shape as between species and species the females are all (so far as I know) very much alike. For example, the males of *P. fraseri*, *P. formosa*, and *P. brunnea* are so different in appearance that at first sight one would think them to belong to three different genera, whilst the females require a tolerably careful scrutiny for their separation.

Hence in defining the section *dispar* it is obvious that the male characters must be entirely relied on, and especially those of the hinder-wing.

When de Selys in his "Monographie des Caloptérygines" characterized the group *dispar* of his genus *Euphaea* he was not acquainted with either of the other species here included. So that I am able to offer a fuller definition of the group or section, at the same time removing from it his *E. decorata*, which as Ris (*loc. cit.*) has noted falls into a distinct group, *decorata-compar-formosa*.

I suggest then the following amended definition for the section *dispar* of the genus *Pesudophaea*.

The section comprises species of *Pesudophaea* in which the fore-wing of the male is entirely hyaline (save that mature specimens may have the apical margin outlined with brown beyond the pterostigma).

Hinder-wing gradually increasing in breadth almost to the level of the basal end of the pterostigma; its apex very regularly rounded.

Its greatest breadth bears the proportion to its greatest length of between 1 : 4 and 1 : 5.

Its apical part rather abruptly opaque, brown or black; the opacity covers from one-quarter to three-sevenths of the wing length and its inner margin lies transversely at right angles to the long axis of the wing. There is no metallic green or blue colouring on the wing.

The regular curving of the apex of the hinder-wing exists only in the males. Its character is well shown in the accompanying text-figure for which I am indebted to Messrs. H. and F. E. Champion.

The apex of the fore-wing is of the shape more usually seen and differs but little from that of allied genera such as *Bayadera* or *Anisopleura*.

The males of the section may be differentiated as follows:—

- A. Large species, hinder-wing exceeding 30 mm. in length ;  
its length bearing the ratio to its greatest breadth of  
about 5 : 1.
- a. Length of hinder-wing nearly 40 mm. Syntho-  
racic colour pattern similar to that of female.  
No longitudinal dorsal mark on segments 2-3  
of abdomen ... .. *P. dispar*,  
Ramb. Nilgiri  
Hills.
- b. Length of hinder-wing about 32 mm. Syntho-  
racic colour pattern shows specialization when  
compared with that of the female. A light  
longitudinal line on segments 2-3 of abdomen. *P. fraseri*, n. sp.  
W. Coast of  
India.
- B. Smaller form. Hinder-wing less than 25 mm. in length.  
Its length bearing the ratio 4 : 1 to its greatest breadth.  
Colour pattern of synthorax specialized<sup>1</sup>; black  
above, blue at the sides ... .. *P. impar*, Selys.
- a. Apical mark of hinder-wing about three-sevenths  
of wing-length ... .. Sub-sp. *impar*,  
Selys, Malacca.
- β. Apical mark of hinder-wing about two-fifths of  
wing-length ... .. Sub-sp. *inae-*  
*quipar*, Selys.  
Borneo.

Measurements of hinder-wings of species belonging to the  
section.

	Base of hinder- wing to nodus.	Nodus to apex.	Greatest breadth.
<i>P. dispar</i> , Ramb. ...	17.5 mm.	22.5 mm.	8 mm.
<i>P. fraseri</i> , n. sp. ...	12 mm.	20 mm.	6.5 mm.
<i>P. impar</i> , Selys ...	10 mm.	14 mm.	6 mm.

<sup>1</sup> The colour pattern of the synthorax of the females of the two species I have examined is, as will have been inferred, very much alike. It resembles also that found in *Bayadera*. I regard this pattern as probably primitive for the genus.



## VII. NOTES ON INDIAN DRAGONFLIES.

By MAJOR F. C. FRASER, I.M.S.

### I. A DESCRIPTION OF THE DIMORPHIC FEMALES OF *RHODISCHNURA NURSEI*, MORTON.

#### *Rhodischnura nursei*, Morton.

*Ischnura nursei*, Morton, *Trans. Ent. Soc. Lond.*, 1907, pp. 306-307, pl. xxiv, figs. 4, 5, 6.

Dr. Laidlaw in *Rec. Ind. Mus.*, Vol. XVI (1919), has described a female of *Rhodischnura nursei*, Morton, which differs entirely from those which I have seen myself and which may therefore be dimorphic forms.

Dr. Laidlaw's female is of the normal type with enclosed humeral bands, whilst the new females are firstly one of the normal type with unenclosed bands, and secondly an andromorph and a heteromorph.

(i) Normal type with unenclosed humeral bands.

*Head*.—Labrum pale green with the base finely black; post-clypeus bronzed black; frons pale green to just beyond the level of the origin of the antennae. Vertex black bronze, no postocular spots present.

*Prothorax* black with a narrow collar anteriorly and the sides low down, pale green.

*Thorax* pale green with a broad, dorsal, black bronze fascia. No humeral bands but the sides of the thorax at this level with a reddish brown tinge which fades imperceptibly into the pale green.

*Legs* pale greenish yellow with black stripes on the extensor surfaces of the femora.

*Abdomen* pale greenish yellow, deepening to a brighter yellow on the dorsum. Each segment with a very broad, dorsal, black bronzed stripe with the exception of the first where the band is a warm brown. On the 10th the band does not reach the apical end of the segment and there are pale green, apical rings to the 8th and 9th.

Length of abdomen 16 mm., of the hind-wing 13 mm.

Two specimens taken *in cop* at the Sewage Farm, Karachi, Sind, 18-9-19.

(ii) Andromorph form.

Almost exactly similar to the male, differing in the following particulars:—The black band crossing the vertex is narrower and therefore displays a postocular space coloured yellow. The black tends to encroach on this to partly enclose a spot externally, which is ochreous in colour.

The black on the dorsum of thorax external to the humeral bands is incomplete posteriorly where it changes to ochreous.

The black on the abdomen is more diffuse and is set in a background of reddish orange. Lastly, the stigma has not the reddish tinge.

One specimen taken by Dr. N. Annandale on Barkuda Island, Chilka Lake, Ganjam District, Madras Presidency, among herbage, 20-8-1919.

(iii) Heteromorph form.

Very similar to the foregoing from which it differs in the following particulars:—The postocular space is bright ochreous, the eyes are greenish, the humeral bands are unenclosed but as the sides of the thorax are ochreous, the yellow of the humeral bands is well displayed. The abdomen of the same ground colouring as in the male but the black marks differing considerably. The black marking on the first segment in the form of a **V** with its apex at the base of the segment, that on the 2nd segment, wedge-shaped with its broadest part at the base of the segment; the bands on the last four segments narrow, incomplete basally on the 7th and 8th and apically on the 9th and 10th, the sides of these four segments being reddish. A very fine, black, mid-dorsal line runs from the 2nd to the 6th segment and this is crossed on each segment, near the apex, by another fine, black line, the points of intersection defined as tiny, black spots, largest on the 6th segment.

This last form is of interest in that it closely resembles *Ischnura rufostigma*, Selys, and thus forms a connecting link between the genus and the true *Ischnuras*. Were it not for the great disparity in the size of this single specimen, it might easily be taken to belong to the above-mentioned species.

The specimen mentioned by Dr. Laidlaw as taken by Dr. N. Annandale on the Cooum River, Madras, is, I believe, a female of *Agriocnemis pygmaea*, dimorphism in this species being almost infinite. I have collected in the neighbourhood mentioned almost continuously for four years and have never once come across *R. nursei*, which I believe to be a purely Northern species. I have seen a painting of a male specimen taken at Pusa by Mr. T. Bainbrige Fletcher, 26-3-19, and another specimen from Nagpur, so that the distribution, as at present known, stretches as a belt across Northern India, from Karachi to the Chilka Lake, *via* Nagpur, Deesa, Pusa, Agra, and Dehra Dun.

## II. DESCRIPTION OF A NEW INDIAN ODONATE.

### *Enallagma insula*, sp. nov.

1 ♀ Barkuda Island, Chilka Lake, Ganjam District, Madras Presidency, 5-10-19. Coll. N. Annandale.

*Head*.—Labrum whitish green, the base finely black; frons and clypeus a whitish green, with a black streak across the anteclypeus; a broad, black streak across the vertex; the postocular

and included spaces pale blue. A small, black projection into this latter, almost enclosing a blue spot.

*Prothorax* black with a narrow, anterior collar and two fine, mesial points blue. The free border of the posterior lobe finely blue.

*Thorax* black on the dorsum, blue at the sides. A narrow, blue humeral line on both sides.

*Legs* whitish, the distal ends of the femora black.

*Abdomen* greenish blue, the last three segments sky blue. Marked on the dorsum with black as follows:—A subquadrate spot on the 1st segment connected to a black apical ring, broad streaks on all segments from 2 to 8 which are incomplete basally and connected apically with black annules. The streaks dilated near the apical end on segments 2 to 6. Two small, tongue-like spots at the base of the 9th segment which are situated subdorsally and extend for about half the length of the segment. The 10th segment immaculate. A spine on the ventral surface of the 8th segment.

*Wings*.—Petiolation ceases before the level of *Ac*; *arc* at the 2nd antenodal nervure; postnodals 10 in the forewing, 9 in the hind.

Length of hind-wing 17 mm., of abdomen 24 mm.

VIII. ON A NEW SPECIES OF *THALASSEMA*  
FROM THE GULF OF MANAAR WITH  
NOTES ON THURSTON'S SPECIES  
*T. FORMULOSUM*.

By B. PRASHAD, D.Sc., Offg. Director of Fisheries,  
Bengal, Bihar and Orissa, Calcutta.

Thurston in his account of the Fauna of the Gulf of Manaar<sup>1</sup> records the occurrence of a species of the genus *Thalassema*, Lamarck,<sup>2</sup> as the only representative of the Gephyrea Chaetifera in this region. Regarding the exact locality from which the specimens were obtained, he adds the following note—"Of the four species dredged off Raméshwaram Island, only *Dendrostoma signifer* was abundant."

On the authority of Dr. Selenka, who identified the collection of Gephyrea, the name of the species in the Bulletin is given as *Thalassema formulosum*. Curiously enough, though the authorities for the other names are cited in all cases, the name of the author of *T. formulosum* is omitted. Selenka, so far as I have been able to ascertain, did not describe any species as *T. formulosum*, nor has any other author described one of this name. Probably the species was *T. formosulum*, Lampert,<sup>3</sup> and the name in Thurston's work is only a *lapsus calami*, or Selenka meant to describe a new species under this name, though he never did so. In his revision of the genus *Thalassema*,<sup>4</sup> Shipley does not make any reference to Thurston's record and was probably not acquainted with it. According to him *T. formosulum* had been obtained from Cavitte near Manila and Shanghai. Sluiter<sup>5</sup> has since recorded the same species from Labuan Tring and Sapeh-Bai, Sumbawa, from the material collected by the Siboga Expedition in the Dutch East Indies. If my interpretation regarding the name of the species recorded by Thurston is correct, then the species *T. formosulum* has a very wide range of distribution in the Pacific and the Indian Ocean. No specimens of the genus *Thalassema* were obtained during Herdman's investigations<sup>6</sup> of the Fauna of

<sup>1</sup> *Bull. Madras Mus.*, III, p. 116 (1895).

<sup>2</sup> In my previous papers I followed Annandale and Kemp (*Mem. Ind. Mus.*, V, p. 58 and *Rec. Ind. Mus.* XVI, pp. 399-402) in assigning the authorship of *Thalassema* to Gaertner; this, however, as Shipley had pointed out, was not quite correct, as the real author is Lamarck.

<sup>3</sup> *Zeitschr. Wiss. Zool.*, XXXIX, p. 339 (1883).

<sup>4</sup> *Willey's Zool. Results*, p. 348 (Cambridge, 1889).

<sup>5</sup> *Siboga-Expeditie*, XXV, p. 48 (1902).

<sup>6</sup> *Rept. Ceylon Pearl Fisheries and Marine Biology*, pt. 1, p. 169 (1903).

the Pearl-banks round Ceylon. During the past few years the Madras Fisheries Department has been making extensive collections of the marine animals occurring on the chank-beds at Tuticorin, in the Gulf of Manaar, but no specimens of Echiuroids had ever been obtained. Recently (November, 1918) while on deputation to the Madras Fisheries for a short time, I was fortunate enough in obtaining two specimens of *Thalassema*. The specimens were brought up from the bottom by a chank-diver, who found them crawling round the burrows of the chank—*Turbinella pirum*, Lam., about five miles from the mainland. The bottom of the sea in these parts consists of fine sand mixed with some mud and large quantities of dead shells, coral pieces and tubes of Polychaete worms.

The specimens belong to a very interesting new species, which I propose to describe as *Thalassema hornelli*, associating it with the name of Mr. J. Hornell, F.L.S., Director of Fisheries, Madras, to whom I am greatly obliged for making my short stay in the Madras Presidency both interesting and useful.

***Thalassema hornelli*, sp. nov.**

The body in this species is elongate, cylindrical; in one of the specimens, owing to contraction at the time of preservation, the posterior end appears of a much less diameter than it actually is in the living specimens. The living individuals showed great powers of expansion and contraction; in spirit the larger of the two specimens is 8.2 cm. long, while its maximum breadth is 2.1 cm. The proboscis is very short compared to the length of the body, and measures 1.1 cm. in length. The ventral margins of the proboscis are not united with one another even at its base. The whole of the surface of the body is covered over by minute irregularly arranged papillae; the papillae near the two ends of the body are larger than those in the middle, while the proboscis papillae are very minute.

Two rather small hooks of a pale yellow colour are present in the normal situation on the ventral surface. The musculature of the body is broken up into nineteen bundles in the middle of the body, but higher up and lower down the muscle-bands become more or less contiguous, and it is not possible to count the bundles. There are five pairs of segmental organs with large funnels; the lateral margins of the funnels are produced into very long spirally coiled lobes. Of the five pairs of segmental organs the three anterior pairs are rather poorly developed structures, and are situated in front of the insertion of the ventral hooks, while the two posterior pairs are very well-developed with elongated, ovoid vesicles and very long spiral lobes for the funnels. The anal vesicles are well-developed tubular structures reaching to a little more than half the length of the body; each of the vesicles has three rows of rather large funnels extending over a little more than half the length of the vesicles. The body-wall is very thick at the two ends of the body but much thinner in the middle.

The living specimens were of a pale pinkish colour due largely to the pinkish coelomic fluid which could be seen shining through. The proboscis and the two ends of the body were light yellow with a tinge of green here and there. Specimens preserved in spirit after fixation in 10% Formalin are of a deep yellowish colour.

The two type-specimens, since the description was written, have unfortunately been lost and are not available for future reference. I have, however, requested Mr. R. H. Whitehouse, Marine Biologist of the Madras Fisheries, to kindly procure some more specimens from the original locality.

*Relationships*:—The species described in the previous pages differs from the other known species of the genus in having five pairs of segmental organs and the musculature divided into nineteen bundles. It shows a distinct advance on the condition described by me in *T. kempi*<sup>1</sup> in having five pairs of segmental organs, even though the number of muscle-bands has become reduced to nineteen.

*Remarks*:—As has been noted above, the animals showed great powers of extension and contraction of the body. One of the specimens also showed the phenomenon of the autotomy of the proboscis, as it threw off the proboscis on being taken out of sea water. This latter peculiarity has been observed in the case of other marine species, but the group of the essentially brackish water Asiatic species (*loc. cit.*) of the genus differs very markedly in this respect from the marine species.

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<sup>1</sup> *Mem. As. Soc. Bengal*, VI, pp. 321-338, pl. xi (1919).

## IX. ON THE OCCURRENCE OF *PLACOCEPHALUS JAVANUS* (LOMAN) IN SIAM.

By TOKIO KABURAKI, *Zoological Laboratory, the  
Museums, Cambridge.*

Owing to Loman<sup>1</sup> and v. Graff's<sup>2</sup> works, it was made out clearly that *Placocephalus javanus* (Loman) is fairly common in the Malay Archipelago. It has hitherto been recorded from Java, Sumatra and Singapore. This fact is of some interest from the point of view of geographical distribution, though its distribution might have been brought about through the agency of man.

The purpose of the present report is to record the occurrence of the species, which I identify with *Plac. javanus*, in Siam. Owing to the kindness of Dr. N. Annandale of the Indian Museum, I was able to observe one individual only of this species, which was obtained by Mr. W. N. Dunn in a certain garden in the town of Singgora, Siam. To the gentlemen named I beg to express my thanks for the opportunity of observing the planarian.

The specimen was preserved in planarian fixative<sup>3</sup> and was in fairly good condition, except that it was torn near the middle of the body. In shape the animal conforms to the typical *Placocephalus* outline, with the head, which is of a semi-lunar shape, not a great deal wider than the trunk, and only marked off from the trunk by a constriction. The greater part of the trunk, rather stoutly built, is of almost similar breadth, though the body tapers extremely gradually to a rather pointed posterior end. The dorsal surface is slightly convex and the ventral nearly flat; the ambulacral surface forms a scarcely raised ridge, rather less than one-eighth the width of the body, and extending the whole length.

<sup>1</sup> Loman, J. C. C., Zwei neue Arten von Bipalium. *Zool. Anz.*, VI Jahrg. 1883, p. 168. Über den Bau von Bipalium Stimpson, nebst Beschreibung neuer Arten aus dem indischen Archipel. *Bijdragen tot de Dierkunde*, 14 Afl., 1888, pp. 64-85. Über neue Landplanarien von den Sunda-Inseln. *Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien* herausgeg. von M. Weber, I Heft, 1890, pp. 138, 145, 151. On some Landplanarians of the genus Bipalium from the Leyden Museum of Natural History. *Notes from the Leyden Museum*, Vol. XVII, 1895, p. 30. Hallez, P., Catalogue des Turbellariés du Nord de la France et de la côte Boulonnaise. *Revue biol du Nord de la France*, T. II, 1889-90 (1893), p. 110. Bleeker, P., Bijdrage tot de geneeskundige topographie van Batavia. *Natuur- en Geneeskundig Archief voor Nederlandsch Indië*, I, 1844, p. 523.

<sup>2</sup> Graff, L. v., Bestimmungsschlüssel für die Indo-Malayischen Landplanarien. *Annales du Jardin Botanique de Buitenzorg*, Suppl. II, 1898, p. 124. Monographie der Turbellarien. II. Tricladida terricola (Landplanarien), 1899, pp. 465-467.

<sup>3</sup> 30 c.c. Nitric acid, 30 c.c. Corrosive sublimate and 40 c.c. Distilled water.

This specimen attains in the preserved state a length of 87.5 mm. and the greatest breadth, a little behind the neck, of 4 mm.

According to Dr. Annandale's note, taken while the worm was living, the dorsal surface of the body is of a blackish colour with a broad brown median dorsal band, which is divided longitudinally by a fine black line, and is bounded on either side by a black line of about twice the width of the fine one. These three lines extend from the head to the caudal extremity, much as in the form reported from Singapore. The mid-dorsal line widens quite extraordinarily above the pharyngeal region, revealing a spindle-like marking, and as it approaches the hind end becomes gradually indistinct. The present specimen varies in the colouration of the broad dorsal band from the examples previously recorded. According to v. Graff, however, this, not being constant, must be regarded as a variation. Further, in the present worm there exists just a suspicion of a lateral dark line at the edge of the body, as has been described by v. Graff in some forms from Java as well as from Singapore. The head is almost uniformly blackish, without any sign of marking, but gets slightly lighter towards the frontal margin. Ventrally, the ambulacral surface is as usual of a much paler colour than the rest of the surface. On either side the colour may be described as a dark grey shade, getting much lighter laterally.

It is not easy to assign the distribution of the eyes in the head, but they surround as usual its entire fringe and are continued round to the sides of the neck.

The mouth is placed slightly in front of the commencement of the middle third of the body. I could make out its position by a slight protrusion of the pharynx.

According to Loman,<sup>1</sup> *Plac. javanus* is protandrous, the male genital organs being mature in July and August, and the egg-cocoons not being deposited till October or November. In the present specimen, secured on the 24th of January, 1916, the genital organs were not developed. Like other forms, this species may to some extent reproduce asexually by transverse fission, as mentioned by v. Graff.

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<sup>1</sup> Loman, J. C. C., Over den bouw van de Land-Planariën. *Tijdschr. Nederl. Dierk. Ver.*, Deel I, p. 130. Shipley, A. E., On the Occurrence of *Bipalium kewense*, Moseley, in a new Locality; with a Note upon the Urticating Organs. *Proc. of the Camb. Philos. Soc.*, Vol. VII, Pt. IV, 1891, p. 144.

X. INDIAN FRESHWATER MOLLUSCS  
ASSIGNED TO THE GENUS *BITHYNIA*.

By N. ANNANDALE, D.Sc., F.A.S.B., Director, Zoological  
Survey of India.

IN Mr. H. B. Preston's volume on the Freshwater Molluscs in the *Fauna of British India* series, eighteen species are assigned to the genus *Bithynia*, Leach (with the two subgenera *Hydrobioides*, Nevill and (?) *Fossarulus*, Neumayr) and several allied forms have since been described from Burma and Assam. All of these (22 species) I have examined, so far at any rate as the shell and operculum are concerned. I find no less than five distinct genera included among Mr. Preston's eighteen species. It is unfortunate that in the official account of an important section of the fauna of India no attempt seems to have been made to examine these species critically. Some of them, probably the majority, must be represented in English collections.

I shall not attempt at present to revise these species, but merely to assign them to their proper genera and sub-genera, to point out the characteristic features of these, and to describe a new genus and a new subgenus that seem to be necessary.

Of the five genera here discussed, four are closely related and must be included in the subfamily Bithyniinae. The fifth, however, which has recently been described by Col. Godwin-Austen, is so distinct that it may be accepted as the type of a new subfamily, the Mysorellinae. The external anatomy of the two subfamilies is identical, but there are important differences in the radula as well as the shell. The subfamilies may be briefly described as follows:—

**BITHYNIINAE.** Shell never very thick, smooth to the naked eye or with spiral ridges, ovate or globose, with the peristome continuous and the columellar fold ridge-like. Operculum calcareous, concentric or spiral. The central tooth of the radula usually bearing a series of latero-basal denticulations on each side. The external male organ with a well-developed lateral process.

**MYSORELLINAE.** Shell rather thick, with strong spiral ridges, turbate, with the peristome continuous and prominent. Operculum thick, calcareous, concentric. The central tooth of the radula without latero-basal denticulations but bearing a single downwardly-directed blunt process on either side. The external male organ as in the Bithyniinae.

Key to the Indian Genera, species of which have been assigned to  
*Bithynia*, Leach.

1. Operculum spiral on *both surfaces*, with the nucleus eccentric. Whorls of shell more or less tumid and body-whorl very large; umbilicus closed or rimate; columellar fold ridge-like but by no means prominent; central tooth of radula with latero-basal denticulations in a series on either side ... .. *Amnicola*  
(*Alocinma*).
2. Operculum concentric, or mainly so externally, with the nucleus central or sub-central, almost smooth internally.
  - A. Shell conspicuously perforate, turbinate, ornamented with strong spiral ridges; peristome continuous, prominent, uniform; central tooth of radula with a single blunt, downwardly-directed lateral process at each side ... .. *Mysorella*.<sup>1</sup>
  - B. Shell broadly but shallowly umbilicate, with a broad oblique groove proceeding downwards from the umbilicus to the lower margin of the mouth; sculpture consisting of fine spiral grooves; central tooth of radula as in *Amnicola* ... .. *Sataria*, nov.
  - C. Shell narrowly umbilicate or subumbilicate, with a narrow groove descending obliquely from umbilicus but not reaching margin of mouth; columellar fold forming a sharp, prominent ridge continuous with outer lip; outer lip hardly thickened; central tooth of radula as in *Amnicola* ... .. *Bithynia*.
  - D. Shell resembling that of *Bithynia*, but with the columellar fold greatly thickened and the whole outer lip more or less incrassate; a varix often present on the body-whorl; central tooth of radula as in *Amnicola* ... .. *Hydrobioides*.

Two genera in this key (*Mysorella* and *Sataria*) are, so far as we know, monotypic. *Mysorella* has recently been described by Col. Godwin-Austen,<sup>2</sup> while *Sataria* is here described as new; but the type-species of both have long been known. *Hydrobioides* was first erected as a subgenus of *Bithynia* by the late Mr. G. Nevill.<sup>3</sup> I have recently discussed it at some length.<sup>4</sup> Dr. Bains Prashad<sup>5</sup> and I have also, still more recently, proposed a new subgenus (*Alocinma*) of *Amnicola*, Gould and Haldeman, to contain certain Indian and Persian species. A large proportion of the Indian species hitherto assigned to *Bithynia* belong to this subgenus, more in fact than can be retained in the former genus. The species described by Mr. Preston, with those recently described by myself, may now be identified generically as follows:—

To the genus *Amnicola* and the subgenus *Alocinma* I attribute the following:—

*Bithynia travancorica*, Benson; *B. subpulchella*, Nevill; *B. inconspicua*, Dohrn; *B. orcula*, Frauenfeld; *B. laevis*,

<sup>1</sup> Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 431 (1919).

<sup>2</sup> Godwin-Austen, *Rec. Ind. Mus.* XVI, pp. 211, 431 (1919).

<sup>3</sup> Nevill, *Hand List Moll. Ind. Mus.* II, p. 42 (1884).

<sup>4</sup> Annandale, *Rec. Ind. Mus.* XIV, p. 117 (1918).

<sup>5</sup> Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 23 (1919).

Morelet; *B. stenothyroides*, Dohrn; *B. dibrugarhensis*, Preston; *Amnicola alticola*, Annandale.

To *Bithynia*, Leach, the following:—

*B. tentaculata* (Linné), the type-species; *B. cerameopoma* (Benson); *B. pulchella* (Benson); *B. lutea*, Gray; *B. pygmaea*, Preston; *B. troscheli* (Paasch).

To *Hydrobioides*, Nevill:—

*B. turrita*, Blanford, the type-species; *B. nassa*, Theobald; *B. moreletiana*, Nevill; *Hydrobioides nana*, Annandale; *H. avarix*, Annandale.

To *Salaria*, gen. nov.:—

*Bithynia evezardi*, Blanford, the only known species.

To *Mysorella*, Godwin-Austen:—

*Bithynia costigera* (Küster) with its race *curta*, Nevill, which is the type of the genus.

All these species occur within the limits of the Indian Empire, but *B. tentaculata* and *B. troscheli* are Palaearctic and are only found, so far as India is concerned, in Kashmir and the neighbouring country, while *Hydrobioides* seems to be exclusively Burmese; *Mysorella* is confined to the southern part of Peninsular India (plains and Mysore Plateau) and Ceylon, and *Salaria* to the Bombay section of the Western Ghats. The range of *Alocinma* extends from Mesopotamia to Upper Burma, and the south of the Indian Peninsula, but the subgenus is closely allied to the Palaearctic *Pseudamnicola*, which may also be regarded as a subgenus of *Amnicola*. *Amnicola* (s.s.) is American. *Bithynia* is found all over Europe and Asia, but is perhaps mainly Palaearctic.

#### Subfamily BITHYNIINAE.

Genus *Amnicola*, Gould and Haldeman (1841).

1865. *Amnicola*, Simpson, *Smiths. Misc. Coll.* 201, p. 12.

This genus, as has been pointed out recently, can be divided into three subgenera, *Amnicola*, s.s. (American), *Pseudamnicola* (Palaearctic) and *Alocinma* (Indian, Persian and Mesopotamian). All the Indian species of the genus I have examined belong to it.

Subgenus *Alocinma*, Annand. and Prashad (1919).

1919. *Alocinma*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 23.

The shells of this subgenus are more or less globose, with the whorls somewhat tumid, the body-whorl very large and the suture rather wide. The umbilicus is almost or entirely closed and the columellar fold is never prominent though always ridge-like. There is no well-defined groove proceeding downwards from the umbilicus outside the fold. The shell-sculpture is microscopic. The

structure of the operculum is distinctive when it can be seen, but is often obscured by deposits of algae or mineral substances on the surface. These should always be cleared away before the operculum is examined. It fits precisely into the mouth of the shell. The radula differs from that of *Bithynia* in the following points:— (1) the central tooth has a distinct quadrate projection on its disc and is produced in the middle on the basal margin; (2) the latero-basal denticulations on this tooth are very few and are situated at some distance from the lateral margins; (3) none of the denticulations of the lateral teeth are greatly enlarged; (4) those of both marginals are minute and sharp. The soft parts seem to be very similar in the two genera.

TYPE-SPECIES, *Amnicola sistanica*, Annandale and Prashad.

Mousson's<sup>1</sup> *Bithynia ejecta* from Mesopotamia belongs to this subgenus, as well as the type-species and the Indian and Burmese forms listed above.

#### Genus *Bithynia*, Leach (1818).

1919. *Bithynia*, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 213.

The shell of this genus is as a rule more elongate, more acuminate and more conical than that of *Amnicola*. The umbilicus is usually perforate but constricted and even when it is completely closed a well-defined groove can be distinguished proceeding obliquely downwards from it but not meeting the margin of the lip. The columellar fold is a sharp and prominent ridge, forming a wall along the inner margin of the groove. The shell-sculpture in the Indian forms is microscopic. The operculum is never very thick. It is marked externally with coarse concentric ridges, encircling a central or subcentral nucleus. The internal surface is nearly smooth. In young specimens traces of a spiral structure can sometimes be detected on the external surface. The radula differs from that of *Alocinma* in the points noted in discussing the latter genus.

TYPE-SPECIES, *Helix tentaculata*, Linné.

#### *Hydrobioides*, Blanford (1869).

1918. *Hydrobioides*, Annandale, *Rec. Ind. Mus.* XIV, p. 117.

This genus is closely related to *Bithynia* but may be distinguished by the structure of the lower part of the shell and of the radula. Although the spire and the upper part of the body-whorl are thin the lower part of the latter, or rather the lower and outer part, is considerably thickened and has a more or less porcellaneous appearance. The columellar callus is also much broader and flatter. In several species a prominent varix on the body-whorl is a conspicuous feature. The shell varies in shape so greatly that two subgenera may be distinguished. The operculum is like that of *Bithynia*, but is relatively smaller<sup>2</sup> and the concentric lines

<sup>1</sup> Mousson, *Fourn. Conchyl.* XXII, p. 46 (1874).

<sup>2</sup> It is sometimes withdrawn into the shell in highly contracted specimens.

penetrate to the internal surface. The radula closely resembles that of *Alocinma*; but the laterals have the central denticulation much enlarged and bear a distinct prominence on their disc.

The two subgenera may be distinguished as follows:—

1. Shell more or less elongate, acuminate, with the main axis of the spire and that of the body-whorl in the same straight line and the mouth vertical ... *Hydrobioides* (s.s.)
2. Shell globose, with the spire short and oblique, almost neritiform, with the mouth very oblique ... *Paranerita*, nov.

The type-species of *Hydrobioides* (s.s.) is *Bithynia turrata*, Blanford; that of *Paranerita*, *Hydrobioides physcus*, Annandale, the only known species. I can find no structural difference between the animals of the two subgenera.

The peculiarities of the lower part of the shell in both subgenera seem to be correlated with a very definite, probably seasonal and recurring period of arrested growth. The varix in those species in which it persists represents the last period of rest, after which there is apparently only one more growth-period. In several shells in Nevill's series of his *Bithynia moreletiana*, which must be referred to this genus, a well-defined varix is present at some distance from the mouth, but beyond this point the shell is very thin and the outer lip is sharp, proving that the animals were killed during a period of active growth.

The porcellaneous appearance of the mouth and the outlines of the shell give the species of *Hydrobioides* (s.s.) a superficial resemblance to those of *Pachydrobia*, Crosse and Fischer, an Indo-Chinese genus; but the structure of the operculum is very different and the male organ of *Pachydrobia* differs in being simple and without a lateral process. The shell of *H. (Paranerita) physcus*, on the other hand, resembles that of *Julliena* of the same authors and from the same region, but here again there are the same structural differences in the animal.

#### Genus *Sataria*, nov.

The shell is moderately small and thick, almost trochiform, with swollen whorls. The umbilicus is patent but not deep and is approached from the anterior border of the mouth by a broad, deep, oblique groove. The peristome is continuous, uniformly thickened internally, prominent and produced to a point both above and below. The sculpture of the shell consists of fine but distinct spiral grooves. The operculum is calcareous, of oval outline and rather smaller than the mouth of the shell. The operculum is stout and marked with strong concentric ridges externally, the nucleus being central; internally it is convex and without sculpture. The radula resembles that of *Bithynia* but the denticulations of the teeth are blunter and there is a quadrate process on the disc of the central tooth. Nothing is known of the soft parts.

The only known species is Blanford's *Bithynia evezardi*<sup>1</sup> from Mahableshwar in the Satara district and Khandalla in the Poona district of the Bombay Presidency. Both places are situated at moderate altitudes in the Western Ghats and the range of the genus seems to be coterminous with that of the remarkable Littorinid genus *Cremnoconchus*, Blanford, which lives in the spray of waterfalls. Nothing is known of the habits of *Sataria* and very few specimens have been collected.

Subfamily *MYSORELLINAE*, nov.

Genus *Mysorella*, Godwin-Austen (1919).

1919. *Mysoria*, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 211.

1919. *Mysorella*, *id. ibid.*, p. 431.

1919. *Mysoria*, Annandale, *Rec. Geol. Surv. Ind.* I, p. 211.

In describing this genus (under the name *Mysoria*) Col. Godwin-Austen drew attention to the remarkable difference between its radula and that of *Bithynia* and suggested that they might be placed in different families. The external anatomy, however, is so similar in the two genera that this course seems unnecessary, and the recognition of a special subfamily will meet the case, unless some conspicuous difference can be found in the internal anatomy. The original name, which was preoccupied in Insecta, was subsequently changed to *Mysorella*.

TYPE-SPECIES, *Paludina costigera*, Küster.

Two local races are distinguished, the typical form from the southern part of the Madras Presidency and Ceylon and the var. *curta*, Nevill<sup>2</sup> from the Mysore plateau. The former is a mollusc of the plains and is common in the neighbourhood of the town of Madras, while the latter has been found only at an elevation of about 3,000 feet above sea-level.

It is noteworthy that while the shell has a very close external resemblance to that of the Littorinid *Cremnoconchus syhadrensis* (Bfd.) and both genera are highly modified, their habits are quite unlike. *Cremnoconchus* lives on vertical rocks kept wet by the spray of waterfalls, while *Mysorella* frequents the edge of ponds and flooded rice-fields. In the latter it burrows into the mud when desiccation takes place, and it is completely aquatic. The shorter-shelled form (*curta*) is found among stones, while the *forma typica* usually frequents a muddy bottom.

<sup>1</sup> See Blanford, *Fourn. As. Soc. Bengal* XLIX (2), p. 220; Nevill, *ibid.*, XLX (2), p. 157, pl. vi, fig. 13.

<sup>2</sup> Nevill, *Hand List Moll. Ind. Mus.* II, p. 42 (1884).

## XI. TAXONOMIC STUDIES ON THE SOFT PARTS OF THE SOLENIDAE.

By EKENDRANATH GHOSH, M.Sc., M.D., *Offg. Professor of Biology, Medical College, Calcutta.*

(Plates II, III.)

### INTRODUCTION.

The anatomy of nearly all the known genera of Solenidae has been described by Bloomer (5-17) in a series of papers published in the *Journal of Malacology*, and in the *Proceedings of the Malacological Society*. The animal of *Solen sloanii*, Gray, has been briefly described by Hedley (31) in 1899. Drew (25), in the year 1907, noted the anatomy of *Ensis directus*, Conrad, along with its habits and especially its movements. In the year 1916, Annandale and Kemp (*Mem. Ind. Mus.* V, p. 354) added a short note on what was then doubtfully considered to be a dwarfed form of *Solen fonesi*, Dunker, and I described the anatomy (28) in an appendix to the same paper. No stress has been put upon the taxonomic importance of the soft parts, however, in any of these publications with the exception of a single one of them titled "Classification of the British species of the genus *Solen*, Linné" by Bloomer (5) and scattered notes in his other papers. The present paper aims at treating the subject with a view to define the subfamilies and genera from the soft parts, including their gross internal anatomy. It is also intended to append an account of the gross anatomy of species, the soft parts of which are still unknown.

I should specially mention that I have received all the specimens from the Zoological Survey of India through the kindness of Dr. N. Annandale. Lastly, I heartily thank Prof. H. H. Bloomer for his kindness in sending his papers to me at my request.

### GENERAL NOTES ON THE SOFT PARTS.

The animals are either narrow and elongated with more or less straight and parallel margins or short and broad (deep) with rounded margins.

**MANTLE LOBES.** The mantle lobes are fused with each other in various degrees in the different genera. The fusion, being incomplete, has left a number of gaps bounded laterally by free mantle margins and described as *apertures*. An anterior aperture for the protrusion of the foot is formed by the separation of the anterior margins of the mantle lobes. This is known as the *pedal*

*aperture.* It may extend posteriorly both along the dorsal and ventral margins but specially along the latter. In two species, so far studied, the free anterior margins of the mantle lobes have given rise to two muscular flaps from their inner surfaces which serve to close the pedal aperture when the foot is withdrawn into the mantle chamber. The flaps may be named the *pedal valves*. The outer surface of the thick muscular anterior margin of each mantle lobe sometimes presents a groove parallel to and slightly behind the free margin which receives a ridge from the valve. Posteriorly, the mantle lobes leave two apertures one above the other and placed at the end of two tubes formed from the mantle lobes. They are known as the anal and branchial siphon. The two siphonal tubes are either constricted completely in a single piece as in the typical genera, or completely or partially separate from each other in others. A fourth aperture has been described in the ventral margin of the fused mantle lobes. Bloomer (8, pp. 43-45) has conclusively shown that this aperture in the Solenidae is not homologous with a similar one in other Pelecypoda and is derived secondarily from the posterior end of the pedal aperture. The degree of fusion of the mantle lobes appears to have some distinct bearing on the assortment of the genera. Lastly, from the union of the mantle lobes with each other or with the walls of the siphons, spaces may be formed either demarcated or completely separated from the general mantle chamber. Thus a space has been described by Bloomer (7) in *Cultellus pellucidus* formed in the dorsal aspect anteriorly by the mantle lobes being joined together a little below their margins. This chamber does not communicate with the mantle cavity and is known as the *suprapedal chamber* [Bloomer (8), p. 41]. Another chamber may be formed by the union of the dorsal margins of the mantle lobes in front of the anterior adductor muscle and lying above the foot. In some genera a space is enclosed posteriorly by the mantle lobes (which are free at their posterior margins), and limited in front by the union of the siphonal tubes at their anterior margins with the mantle lobes, either directly along their inner side in front of their free posterior margins (*Solecurtus*, *Azor*), or through the intervention of narrow (*Novaculina*) or wide lateral processes (*Tagelus*), extending from the free posterior margins of the mantle lobes to the base of the siphonal tubes. Further, in *Tagelus* and *Azor*, the dorsal wall of the upper siphonal tube is connected with the ventral aspect of the posterior adductor muscle. This space contains the siphonal tubes (which may be completely retractile within the chamber) and may be designated as the *siphonal space*.

**PALLIAL MUSCULATURE.** A *cruciform muscle* is found in some genera, showing their relation to the fam. Psammobiidae.

**FOOT.** The foot is an elongated organ more or less cylindrical in typical forms but somewhat flattened in others. It arises from the anterior or antero-ventral aspect of the visceral mass. The shape of the foot, specially its anterior portion, is so variable in different degrees of retraction that it is difficult to form an idea

of its exact shape in preserved specimens in which the organ may be fixed in any degree of contraction. The foot of *Cuttellus javanicus* has been figured by Weber (50), who showed the different shapes it can assume in different degrees of extension.

The intrinsic pedal musculature as described by Bloomer (5), and followed by me in my specimens, requires a brief notice in order to understand the differences in the arrangement of the muscles in the different genera. The pedal musculature consists of (1) two layers of longitudinal muscles on each side (an outer, and an inner abutting on the pedal cavity) separated by (2) a dorso-ventral semi-circular band; (3) two rows of transverse muscle bands extending across the pedal cavity along its dorsal and ventral surfaces, and passing to the inner side of the semi-circular layers; (4) a thin layer of circular muscles just beneath the epithelial covering of the foot (the *pedal integument* of Bloomer); (5) lastly, a set of oblique muscles extending from the pedal integument between the outer longitudinal muscles to the outer side of the semi-circular bands.

The *protractor pedis* muscle is well developed in some genera (*Solecurtus*, etc.) but rudimentary or absent in others (*Solen*, etc.).

The *retractor pedis anterior* muscle, one on each side, consists of one or two bands which pass upwards to be attached to the valve. The pedal portion of the muscle consists of radiating fibres which spread out in the foot either on the inner side of or superficially to the longitudinal muscles of the foot. They are of some taxonomic importance in the differentiation of some genera.

The *retractor pedis posterior* muscle bifurcates into right and left portions which are attached to the corresponding valves. It does not bifurcate in *Cuttellus cuttellus*, Dunker. The muscle at its insertion may either remain separate from or merge into the fibres of the posterior adductor muscle. The impression of the muscle on the valve may be of different sizes in comparison with that of the posterior adductor muscle.

**LABIAL PALPS.** The palps are wide and short, or narrow and elongated. The anterior lips formed by the union of the outer labial palps are either placed immediately behind the anterior adductor muscle, or are removed posteriorly from the muscle. A *labial groove* has been described by Bloomer (3) on the inside of each mantle lobe passing dorsally from the fourth aperture towards the foot. The distal portions of the labial palps are placed in the groove.

**GILLS.** The gills are generally narrow (in depth), elongated, and are often prolonged into the siphon. The outer lamella of the outer gill (demibranch) is generally attached to the mantle lobe along its dorsal margin. The inner lamella of the inner gill is divisible into visceral and cloacal portions in consideration of its attachment along its dorsal margin. The visceral portion is generally free (except in *Ensis*), whereas the cloacal portion is either free or joined to its fellow of the opposite side. *Branchial*

*retractor* muscles are developed in some genera along the axis of the gills. They serve to throw the gills into folds when the siphons are retracted and withdrawn between the valves.

The gills are of synoptorhabdic type, *i.e.* the filaments are connected by interfilamentar tissues. They are either simple and homorhabdic, or plicate (*i.e.* thrown into vertical folds) and heterorhabdic (sometimes very indistinctly).

**ALIMENTARY CANAL.** The *oesophagus* may vary in its course. The *stomach* has been divided by Bloomer (5) into four portions. The antero-ventral (*oesophageal*) is continuous with the oesophagus in front and separated from the antero-dorsal portion (*cardiac*) by a muscular ridge. The middle portion (*central*) is ventro-lateral in position adjoining the oesophageal portion. The posterior portion (*pyloric*) is separated from the central portion by a ridge passing ventrally, and from the cardiac portion by another passing to the dorsal aspect.

The pyloric stomach gives off the *coecum* of the crystalline style either from its ventral aspect or from its posterior end. The course of the coecum is somewhat different in the different genera.

The origin and course of the *intestine* may be thus considered in a tabular form:—

I. *Solen* type. The intestine arises directly from the ventral aspect of the pyloric chamber independently of the coecum. It consists of two limbs which pass along the dorsal and ventral aspects of the coecum respectively. The type may show the following variations:—

- (a) The two limbs of the intestine simple (not folded) (*Ceratisolen*, *Subcullellus*).
- (b) The anterior limb forming a number of large folds (*Pharella*).
- (c) The anterior limb with closely placed coils and posterior limb simple (*Siliqua*).
- (d) The anterior limb with closely placed coils and posterior limb with one or more folds (*Solen*).
- (e) The anterior limb with closely lying coils and posterior limb with a number of large loops (*Ensis*).

II. *Novaculina* type. The intestine arises directly from the pyloric stomach and forms several long loops traversing the entire length of the visceral mass.

III. *Solecurtus* type. The intestine arises in connection with the coecum as a common tube and is only separated from it outwardly by two lateral grooves. It forms a separate tube near the distal end of the coecum and then passes along the ventral aspect of the coecum (corresponding to the second limb of the first type). The course is either simple or is attended with loose or close coils. This type of intestine is also found in members of the fam. Psammobiidae to which some of the genera of the Solenidae are undoubtedly closely related. This point has already been emphasized by Dall (23) and Bloomer (16).

**VASCULAR SYSTEM.** The position of the heart varies somewhat in different genera. It may occupy the anterior, middle or posterior portion of the pericardial chamber.

**NERVOUS SYSTEM.** Some difference has been noted in the position of the *viscero-parietal ganglia* varying from beneath the bifurcation of the retractor pedis posterior muscle to the antero-ventral aspect of the posterior adductor muscle. There are also some minor differences in the origin, number and distribution of the nerves from the various ganglia.

#### CLASSIFICATION.

The family Solenidae may be divided into three subfamilies, two of which form natural assemblages of genera having a number of important characters in common. The genus *Novaculina*, Benson, differs so much from either of the two other subfamilies that it is best placed in a subfamily of its own.

#### Subfam. SOLENINAE.

1858. Subfam. Soleninae, subfam. Pharinae (pars), Adams and Adams, *Gen. Recent Mollusca*, pp. 340, 342.  
 1862. Solenaria, Siliquaria (pars) Bronn, *Thier-Reichs. Malacozoa Acephala*, III (2), p. 476.

The present subfamily includes the typical genera of the family, presenting a narrow, elongated body, compressed from side to side, and a *Solen* type of intestine. It may be diagnosed as follows:—

*Animal.* Body elongated, narrow in depth and compressed laterally. Pedal aperture variable in extent. United ventral margins of the mantle lobes forming a very narrow elongated surface. No cruciform muscle. Siphons either fused in a single piece with two siphonal canals, or completely free from each other. No siphonal space (p. 48) posteriorly. A narrow, elongated cylindrical foot extending horizontally forward through the pedal aperture. Retractor pedis anterior muscle bifurcated or not (*Solena*, *Pharella*, *Cultellus*) and generally directed upwards and forwards. Protractor pedis muscle rudimentary or absent. Gills simple or plicate. Intestine arising directly from the pyloric stomach and consisting of two limbs. Viscero-parietal ganglia beneath the bifurcation of the retractor pedis posterior muscle or under the posterior adductor muscle (*Pharella*).

The subfamily forms a natural group by itself. Further study of the soft parts of the animals of the present subfamily will perhaps raise it to the rank of a distinct family.

#### Gen. *Solen*, Linné.

- 1782-93. *Solen* (pars), Linné, *Syst. Nat.*, ed. XIII (edited by Gmelin), p. 3223 (pars VI).  
 1858. *Solen*, Adams and Adams, *Gen. Recent Mollusca*, II, p. 340; III, pl. xcii, fig. 1.  
 1874. *Solen* (pars), Reeve, *Conch. Icon.*, XIX.

1887. *Solen*, Fischer, *Man. de Conch.*, p. 1110.

1889. *Solen* (pars), Clessin in Martini-Chemnitz, *Syst. Conch.-Câb.*, XI (*Solanacea*), p. 2.

The original genus *Solen*, Linné, has been split up by Schumacher (45) into three, viz., *Solen*, *Ensis* and *Cultellus*, the distinction of which has been confirmed by the anatomical researches of Bloomer (8, pp. 43-45). He described and compared a large number of species of *Solen* in a series of papers. I have three species of *Solen* at my disposal, viz., *S. kempi*, Preston, *S. sp.* from Japan and another species which appears to be new (*S. gravelyi*, sp. n.), the anatomy of which I have been able to study.

The following diagnosis has been drawn up from the work of Bloomer as well as from my study of the above species:—

*Animal.* Body elongated, and narrow; dorsal and ventral margins very nearly parallel to each other; anterior and posterior margins straight and sloping. Pedal aperture generally confined to the anterior margin, sometimes extending posteriorly. No fourth aperture. Siphon a single piece with the distal end fringed with tentacles. Anterior adductor muscle narrow and elongated. Posterior adductor muscle oval. Foot cylindrical, somewhat flattened laterally with the anterior end more or less dilated. Radiating fibres of the retractor pedis anterior muscle passing outside the longitudinal muscle of foot. Labial palps elongated and narrow ending in a point generally. Anterior lip of the mouth separated from the posterior end of the anterior adductor muscle by a distinct interval. Gills narrow and elongated, prolonged into the proximal end of the branchial siphonal canal; plicate and heterorhabdic, the plicae being free from one another. Visceral portion of the gills forming less than half their entire lengths. Inner lamella of the inner gill free in the visceral portion, but united with its fellow of the opposite side behind (except in *S. gravelyi*, sp. n.). Coecum arising from the ventral aspect of pylorus and passing forward. Intestine generally of *Solen* subtype (p. 50). Heart generally placed in the middle of the pericardial chamber. Liver not extending anteriorly over the anterior adductor muscle. A single anterior pallial nerve from each cerebro-pleural ganglion. Viscero-parietal ganglia placed beneath the bifurcation of the retractor pedis posterior muscle. A single circumpallial nerve.

#### *Solen kempi*, Preston.

1915. *Solen kempi*, Preston, *Rec. Ind. Mus.*, XI, p. 305, figs. 18, 18a.

1916. *Solen kempi*, Annandale and Kemp, *Mem. Ind. Mus.*, V, p. 355.

1916. *Solen annandalei*, *id.*, *ibid.*, pl. xvi, fig. 8.<sup>1</sup>

*Animal* (pl. II, figs. 1-5). The body is five times longer than broad, being deepest somewhat behind the anterior end. The anterior margin is curved above and straight below. The posterior

<sup>1</sup> Dr. Annandale informs me that the figures on the plate have been accidentally transposed owing to incorrect labels received from the author of the species.

margin is straight. The dorsal margin is slightly concave in front and slightly convex behind. The siphon is long and segmented, but missing in the specimen as "it threw it off when captured" (Dr. N. Annandale's note). The surface of the distal end of the branchial siphon presents six small prominences. The pedal aperture is confined to the anterior margin and the antero-ventral notch. It is bounded by the pedal valves, with a small tentacle-like process from the dorsal aspect where the pedal valves meet.

The foot is long, somewhat flattened, and is shaped like the blade of a scalpel from the side; it is about half the body in length, and is more thickened in the middle than at either end.

The anterior adductor muscle is very long, five times as long as deep. The posterior adductor muscle is wide and slightly elongated.

The labial palps are narrow and greatly elongated, being somewhat wide posteriorly and tapering to a curved point behind.

The gills are elongated, about five times as long as broad, and more than one-third the body in length. The visceral portion of the gills is very small.

The oesophagus is fairly long and curved. The stomach has a well developed cardiac and pyloric portion, the latter forming a distinct cul-de-sac beyond the crystalline style. The intestine arising from the anterior end of the pyloric chamber soon forms a number of close coils and then passes round the long coecum forming loose folds in its posterior limb. It forms a round loop before ending in the rectum. The digestive gland surrounds the stomach and the beginning of the intestine.

The heart is placed in the middle of the pericardial chamber.

Considering the general structure of the body, the animal is evidently more elongated in its anterior than in its posterior portion, the effect being impressed upon all the organs in that part of the body.

#### *Solen* sp.

A single specimen was received from the Zoological Survey of India. It was brought by Dr. N. Annandale from Moji, Japan.

*Animal.* The body is about five times as long as broad (6.4 cm. long), with the posterior end slightly deeper than the anterior. Both the anterior and posterior margins are straight, the anterior sloping forwards. The pedal aperture is confined to the anterior margin. The siphon is very short and completely retractile inside the shell. The branchial aperture is much wider than the anal, and presents a pair of small valves at its proximal end. A longitudinal ridge extends from the ventral aspect of the proximal portion of the branchial siphon to the fused ventral margin of the mantle, with a second smaller one beneath and parallel to it.

The anterior adductor muscle is elongated, but not so narrow. The posterior adductor muscle is small and oval. The retractor pedis posterior muscle is elongated and larger than the posterior adductor muscle at its insertion.

The foot is comparatively short but wide with a free anterior oblique surface presenting a vertical ridge; it is flattened from side to side and is widest at the junction of the anterior and middle thirds of its length; lastly, it presents an oval patch of transverse folds on its ventral surface posteriorly.

The labial palps are triangular, being about one-fourth the body in length. The gap between the anterior lip and the anterior adductor muscle is comparatively short.

The gills are about half the body in length, and are about five times as long as broad; they are prolonged to the base of the labial palps; the visceral portions of the gills are about as long as the cloacal portion. The lamellae are separated by long interlamellar septa extending alternately between the principal filaments, and the plicae of both the lamellae are free from one another.

The oesophagus is short and nearly horizontal. The oesophageal stomach is narrow and elongated, and separated from the flattened cardiac chamber by a prominent muscular ridge. The pyloric chamber is wide and extends posteriorly beyond the coecum as a rounded sac. The coecum of the crystalline style is long and extends forwards along the ventral aspect of the visceral mass. The intestine begins close to the pyloric coecum and passes along the anterior aspect of the coecum forming loosely coiled folds. Without reaching the anterior end of the coecum, the intestine turns back and passes along the right side of the coecum to end in the rectum with a sharp bend.

*Shell.* Thick, strong, epidermis yellowish, with wide vertical flesh-coloured stripes above and long indistinct horizontal stripes of the same colour below the diagonal line from the antero-superior to the posterior inferior corner. Epidermis slightly corroded in its posterior upper quadrant. Length 4 to  $4\frac{1}{2}$  times as long as broad. Greatest width near the posterior end. Anterior margin straight, sloping forwards from above, with the antero-superior angle obliquely truncate, and the antero-inferior angle slightly rounded. Posterior margin nearly straight, sloping backwards from above, and strongly rounded above and below. Umbonal teeth anterior, one in each valve, left tooth slightly stouter than the right.

Anterior adductor impression wide, elongated. Anterior retractor at a short distance behind and above the level of the anterior adductor. Posterior adductor impression small and oval. Posterior retractor triangular, smaller than posterior adductor. Retractor siphonis impression elongately oval.

Length 64 mm. Breadth 15 mm.

*Solen gravelyi*, sp. nov.

(Pl. II, figs. 6-9).

Three specimens of this species were collected by Dr. F. H. Gravely at Chandipore, Balasore (Orissa).<sup>1</sup> They seem to form a

<sup>1</sup> See Gravely, *Rec. Ind. Mus.*, XVI, p. 395 (1919).

new species which is named in honour of the collector. The description of the shell will follow the notes on the animal.

*Animal.* The body is 5 to 6 times as long as broad, nearly straight both anteriorly and posteriorly, being somewhat sloping in front. The anterior free margins of the mantle lobes bounding the pedal aperture are thick and muscular, and present a groove on their outer surface which receives a constriction of the valve just behind the anterior margin. The pedal aperture extends to the antero-ventral corner, and is slightly dorsal to the anterior end of the anterior adductor muscle. The ventral surface of the mantle is elongated and very narrow; it presents a median band along the middle line. The siphon is short and presents a longitudinal ribbing on the surface.

The anterior adductor muscle is long and narrow, and is slightly curved. The posterior adductor muscle is small and oval. The retractor pedis posterior muscle is smaller than the posterior adductor muscle at its insertion. There is a well-developed retractor siphonis muscle. The foot is a comparatively short cylindrical organ slightly flattened laterally and presents a knob-like swelling which ends in a blunt point at the free extremity.

The labial palps are narrow and elongated, less than one-fourth the body length.

The gills are very long and narrow, 9 to 10 times as long as broad. They are half as long as the body, and are prolonged over the dorsal aspect of the labial palps; the visceral portion of the gills is less than half their entire lengths. The inner lamella of the inner gill is free in the visceral portion. In the cloacal portion the inner lamella of the inner gills are free from each other—differing in this respect from the other species of *Solen* and resembling those of *Ensis*.

The oesophagus is long. The anterior limb of the intestine is simple, but the posterior limb presents loose folds posteriorly before it forms a loop for ending in the rectum.

*Shell.* The shell is very thin, translucent, very brittle, with a whitish epidermis somewhat corroded in its upper anterior quadrant; length about 4 to 5 times the breadth; anterior margin nearly straight and directed from above a little forward with a rounded antero-superior and antero-inferior corner; a strongly marked constriction just behind and parallel to the anterior margin; posterior margin straight or slightly convex, nearly vertical. Umbonal teeth anterior, one in each valve.

Anterior adductor impression narrow and elongated, with tapering ends. Anterior retractor impression very small, behind the anterior adductor. Posterior adductor impression small and oval, at a distance from the postero-superior angle. Posterior retractor impression rounded in front of the posterior adductor and smaller than the latter.

Length 16 mm. Breadth about 4 mm.

*Type-specimen*: M. 11925 Z.S.I. (*Ind. Mus.*).

Comparing the general conformation of the body of the three species under consideration we find that in *S. kempi*, Preston, the elongation has far more affected the anterior than the posterior portion of the body, and that in *S. gravelyi* the anterior and the posterior portions are perhaps equally affected in the process. In *S. sp.* from Japan the posterior portion of the body is comparatively more elongated than the anterior.

Although a large number of species of *Solen* have been described from their shells, only a few are known by their animals.

Considering the few species described by Bloomer and three species of mine, it is premature, at the present moment, to attempt to group the various species of *Solen* into sections according to the conformation of their soft parts. And the anatomical conditions may, if possible, be further co-related with the peculiarities of the shells. For the present, a division of the above species into sections may be provisionally suggested as follows:—

Section I. Body elongated equally both anteriorly and posteriorly.

Types: *S. vagina*, *S. gravelyi*.

Section II. Body elongated more anteriorly than posteriorly.

Type: *S. kempi*.

Section III. Body elongated more posteriorly than anteriorly.

Types: *S. sp.* from Japan, *S. dolerscoti*.

#### Subgen. *Solena*, Browne (1756).

1854. *Hypogella*, Gray, *Ann. Mag. Nat. Hist.* (2) XIV, p. 23.

1858. Subgen. *Solena*, Browne, Adams, *Gen. Recent Mollusca*, II, p. 342.

1887. Sect. *Hypogella*, Gray in Fischer, *Man. de Conch.* p. 1110.

The anatomy of *Solena rudis*, Adams, has been studied by Bloomer (11). The anatomical peculiarities in which it differs from the species of *Solen* have sufficient grounds for ranking the present animal as the type of a subgenus already erected for it. The following diagnosis has been drawn from Bloomer's anatomical work on *S. rudis*:—

*Animal.* Body elongated with rounded anterior and posterior margins. Pedal aperture confined to the anterior margin and guarded by pedal valves. Siphon a single piece. A pair of valves in the proximal portion of the siphon in both the apertures. Anterior adductor muscle broad and deep (more or less oval in shape). Posterior adductor muscle of the same size, being much larger than the retractor pedis posterior muscle at its insertion. Foot more or less flattened, but somewhat swollen towards the distal end. Fibres of the retractor pedis anterior muscle passing between the longitudinal muscles and the pedal integument. Labial palps relatively short and wide, the anterior lip being separated from the posterior end of the anterior adductor muscle by a short interval. Gills heterorhabdic and plicate, alternate inter-

lamellar septa extending half way up the gill. Coecum of the crystalline style arising as a posterior continuation of the pylorus, large in size, very curved and comparatively short in its course. Intestine like that of *Solen* with an additional large loop before it ends in the rectum. Heart posterior. The general conformation of the body distinctly shows that the body has been elongated in its posterior portion, perhaps beyond the posterior end of the visceral mass, the remaining anterior portion being affected to a minimum. The maximum of elongation has taken place in that portion of the body which lies behind the posterior adductor muscle.

#### Gen. *Neosolen*, gen. nov.

1916. *Solen? fonesi*, Annandale and Kemp, *Mem. Ind. Mus.* V, p. 354, fig. 5, pl. xvi, fig. 7.

1916. *Solen? fonesi*, Ghosh, *ibid.* p. 368, figs. 1-3.

The present genus is erected for the reception of a species which was doubtfully thought to be a dwarfed form of *Solen fonesi*, Dunker. The fairly complete literature at my disposal shows that it ought to be referred to a genus of its own. I propose for the species the name *Neosolen aquae-dulcioris*. The following diagnosis is drawn from my anatomical notes (28) and from a further examination of spirit specimens:—

*Animal.* Body 3 to  $3\frac{1}{2}$  times as long as broad, sloping anteriorly at both the anterior and posterior margins; anterior margin slightly curved. Pedal aperture confined to the anterior margin and antero-ventral corner. Thick anterior margins of the mantle lobes extending beyond the anterior margin of the valves. Concresced ventral margins of the mantle lobes forming a narrow surface. Siphon a long segmented piece, each segment with a tentacular fringe round its distal margin. Anterior adductor muscle elongated and narrow, with a short space between it and the upper end of the pedal aperture. Posterior adductor muscle oval, of smaller size than the retractor pedis posterior muscle at its insertion. Foot elongated, cylindrical, slightly flattened laterally; it is stouter towards the apex, where it forms a distinct rounded annular swelling and still further a conical process at the tip. Fibres of the retractor pedis anterior muscle passing between the longitudinal muscles and the pedal cavity. Labial palps short and broad, subtrigonal, and about one fourth the body length. Anterior lip immediately behind the anterior adductor muscle, with no interval between the two. Gills short and deep,  $3\frac{1}{2}$  to 4 times as long as broad and more than half the body in length, just continued into the proximal portion of the branchial canal; visceral portion nearly as long as the cloacal; gills broadly plicate and sub-heterorhabdic, with interplical junctions. Attachment of gills similar to those in *Solen*. Coecum from the postero-ventral aspect of pylorus and passing forward in its long course. Heart pushed forward into the anterior portion of the pericardial chamber by the outgrowths of the kidneys which constrict the middle portion of the pericardium.

Viscero-parietal ganglia placed beneath the bifurcation of the retractor pedis posterior muscle.

The general conformation of the body shows that the present animal is considerably abbreviated antero-posteriorly in comparison with that of the species of *Solen*. The process of elongation has mainly affected the posterior region of the body behind the posterior adductor muscle and a small anterior region including the anterior adductor muscle. The animal is evidently more primitive than the species of *Solen*. It is quite suggestive that the type of body in *Solen* might have passed in evolution through a stage more or less resembling the present genus in descending from a still more abbreviated type of ancestor.

*Type-specimen*: No. M. 2281 z.s.i. (*Ind. Mus.*):

FURTHER NOTES ON THE ANATOMY OF *N. AQUAE-DULCIORIS*, sp. nov.

*Gills*. The gills are plicate and heterorhabdic. The principal filament is somewhat flattened laterally and is slightly different from the ordinary filaments. The interlamellar septa extending between the principal filaments are very short bringing the lamellar closer to each other. The plicae themselves are also connected with one another antero-posteriorly by interplicar tissues.

The oesophagus is nearly horizontal with a slight curve having its convexity directed upwards. The wide oesophageal stomach is separated from the cardiac stomach, extending beyond the former in front by a thick prominent horizontal fold. The pyloric stomach does not extend beyond the coecum of the crystalline style posteriorly. The central stomach is triangular in shape and is separated from the cardiac and pyloric chambers by a ridge continuous with that in front.

The shell was described and figured in the paper cited above.

#### Gen. *Ensis*, Schumacher.

- 1782-93. *Solen* (pars), Linné, *Syst. Nat.* ed XIII, edited by Gmelin.  
 1817. *Ensis*, Schumacher, *Essai d'un. Nov. Syst. des Habit. des vers Testacé*, pp. 47, 143, pl. xiv, fig. 1.  
 1840. *Ensatella*, Swainson, *Tr. Malac.* p. 365.  
 1858. *Ensis*, Schumacher in Adams, *Gen. Recent Mollusca*, II, p. 342; III, pl. xcii, figs. 2, 2a, 2b.  
 1887. *Ensis*, Schumacher in Fischer, *Man. Conch.*, p. 1110.  
 1889. *Solen* (pars), Clessin in Martini and Chemnitz, *Conch-Cab.*, pp. 10, 14, pl.

The genus has been studied by Bloomer (5) who described the anatomy of *Ensis ensis* with full details and later on compared it with several other species (11, 12, 13). Drew (25) briefly noticed the animal of *E. directus*. He figured the siphon and the ventral aspect of the animal and gave a schematic transverse section of the body showing the attachments of the gills not fully dealt with by Bloomer. The following diagnosis is drawn from the researches of Bloomer and Drew:—

*Animal*. Body narrow and greatly elongated. Pedal aperture either confined to the anterior margin, or extending posteriorly

along the ventral margin for a short distance. A fourth aperture and labial grooves present. Siphon of a single piece, comparatively short, and with a tentacular fringe. Anterior adductor muscle elongated, but not very narrow. Posterior adductor muscle less elongated. Retractor pedis posterior muscle much smaller than the posterior adductor muscle at its insertion. Foot narrow and elongated, somewhat flattened laterally and swollen and keeled at the anterior extremity. Fibres of the retractor pedis anterior muscle spread on the inner side of the longitudinal muscle. Anterior lip separated from the anterior adductor muscle by a long interval. Gills elongated, heterorhabdic and plicate, the plicae being free from one another; gills extending into the siphon. Outer lamella of the outer gill attached to the mantle lobe along their dorsal margin. Inner lamella of the inner gill attached to the side of the foot along its dorsal margin, but free behind in the cloacal region. Coecum of the crystalline style short and extending postero-ventrally from the posterior end of the pyloric chamber. Intestine of *Ensis* sub-type. Digestive gland extending over the anterior adductor muscle. Heart in the middle of the pericardial chamber. Viscero-parietal ganglia beneath the bifurcation of the retractor pedis posterior muscle. Two nerves from each cerebro-pleural ganglion. Two circumpallial nerves.

The structure and general conformation of the animal distinctly show that the members of the present genus have attained the greatest degree of elongation and are greatly removed from the ancestral stock.

#### Gen. *Ceratisolen*, Forbes.

1847. *Pharus*, Leach, *Ann. Mag. Nat. Hist.* XX, p. 272.  
 1848. *Ceratisolen*, Forbes and Hanley, *A History of British Mollusca and their shells*, p. 259.  
 1858. *Pharus*, Leach in Adams, *Gen. Recent Mollusca*, II, p. 343; III, pl. 92, fig. 3, 3a, 3b.  
 1874. *Pharus*, Leach in Reeve, *Conch. Icon.*, XIX, fig. 1.  
 1887. *Pharus*, Leach in Fischer, *Man. Conch.*, p. 1108.

The anatomy of *C. legumen* L. has been studied by Bloomer (8, pp. 31-40). The following diagnosis has been drawn up from his work:—

*Animal.* Body moderately elongated (comparatively shorter than that of *Solen* or *Ensis*), nearly straight along the anterior and posterior margins. Pedal aperture extending a short distance along both the ventral and dorsal aspects. A chamber above the anterior adductor muscle opening in front and continuous with the pedal aperture. A fourth aperture at the postero-ventral end of the pedal aperture continuous with it and fringed with tentacles. Siphon of two long and narrow separate tubes. Anterior adductor muscle elongated. Posterior adductor muscle placed rather posteriorly and comparatively small. Retractor pedis posterior muscle much smaller than the posterior adductor muscle at its insertion; bifurcated portions long. Foot large, conical or club-shaped, truncate. Fibres of the retractor pedis anterior muscle passing outside the longitudinal muscle. Labial palps short and wide.

Anterior lip close behind the anterior adductor muscle. Gills small and narrow, non-plicate and homorhabdic. Attachments of gills similar to those in *Solen*. No division into oesophageal and cardiac chambers. Coecum of the crystalline style from the anterior portion of the ventral aspect of the pyloric chamber. Intestine of two simple limbs. Digestive gland passing over the anterior adductor muscle. Heart placed in the middle of the pericardial chamber; blood red. A single circumpallial nerve.

The anatomical researches of Bloomer on *Ceratisolen* has disclosed some facts which help to determine the relation of *Ceratisolen* with other genera of the family. The general conformation of the body shows that the animal is less elongated than *Ensis* and *Solen* but more so than *Neosolen*, *Subcultellus* and *Cultellus*; the position of the posterior adductor muscle near the hinder end of the body is certainly compatible with the view that the posterior end has not elongated behind the attachment of the muscle. The genus, however, resembles the genus *Subcultellus* (*Cultellus pellucidus*) most closely in having a fourth aperture in continuation of the pedal aperture (a condition of great morphological importance), and in several other points, viz. in the separation of siphonal tubes, attachments of gills, relation of the pedal fibres of retractor pedis anterior muscle with the longitudinal layer of muscles, and in the direction of the coecum of the crystalline style, but differs from the latter in having simple, non-plicate gills, in the position of the heart and digestive gland. Differing from *Ensis* in the attachments of the gills, arrangement of the pedal fibres of the retractor pedis anterior muscle, direction of the coecum and its mode of origin, and in the presence of a single circumpallial nerve, the genus cannot be assigned an intermediate stage between *Ensis* and *Subcultellus*, giving origin to the former genus by the fusion of the siphonal tubes and separation of the fourth aperture. It, however, resembles the genus *Ensis* in the extension of the digestive gland over the anterior adductor muscle, a character absent in *Subcultellus* but present in *Cultellus*. Thus it obviously follows that although the genera *Ceratisolen* and *Subcultellus* are more or less related to each other and to *Ensis* on the one hand and *Cultellus* on the other, they cannot be considered to form a connecting link between the above genera in the direct line of ancestry but to represent diverging offshoots from the same stock.

#### Gen. *Subcultellus*, gen. nov.

1810. *Cultellus* (pars), Schumacher, *Essai Nouv. Syst. Habit. des Vers. Testacé*, pp. 43, 130, pl. vii, fig. 4.  
 1835. *Solen pellucidus*, Pennant, *Lamarek. Hist. Nat. Anim. Sans. Vert.*, VI, p. 56.  
 1851. *Ensis pellucidus*, Pennant in Gray, *Cat. Brit. Mus.*, VII, p. 60.  
 1858. *Ensis* (pars), Adams, *Gen. Recent Moll.*, II, p. 342.  
 1874. *C. pellucidus*, Pennant in Reeve, *Conch. Icon.*, fig. 4.  
 1887. *Cultellus*, Schum. (pars), Fischer, *Man. Conch.*, p. 1, 109.  
 1889. *Cultellus*, Schum. (pars), Clessin in Martini-Chamnitz, *Conch. Cab. (Solanacea)*, XI, p. 38.

The present genus is erected for the reception of *Solen pellucidus*, Pennant (*Zool. Brit.* IV, pl. 46, fig. 23). The anatomy of *Solen* (*Cultellus*) *pellucidus* (7) and of two species of *Cultellus* [*C. javanicus* (11), *C. cultellus* (16)] has been described by Bloomer (7, 11, 16). I have been able to study the animal of *C. subellipticus*, Dunker. The animal of *C. pellucidus* differs from those of the other three species in having a fourth aperture, a suprapedal chamber, an elongated anterior adductor muscle, very small posterior adductor muscle, a wedge-shaped foot, a large coecum with a long course, and lastly in having no fringe of long tentacles round the distal margin of the siphonal tubes. These features, along with an elongated body, are sufficient to split the genus *Cultellus* into two, and I suggest to form a new genus *Subcultellus* for *Cultellus pellucidus*. The relation of *Subcultellus* with *Ceratisolen* has already been dealt with. The present diagnosis is drawn from Bloomer's work.

*Animal.* Body somewhat elongated (more than *Cultellus*). Pedal aperture large, extending both dorsally and ventrally to some distance posteriorly. Margins of pedal aperture crenulate. A chamber formed dorsally by the union of the mantle lobes a little below their margins. A fourth aperture at the postero-ventral end of the pedal aperture. Siphons separate, with very short anal and branchial tubes. Anterior adductor muscle elongated, wider posteriorly than anteriorly. Posterior adductor muscle very smooth, but larger than retractor pedis posterior muscle at its insertion. Foot large, wide anteriorly and terminating in a deep obliquely truncate extremity. Fibres of the retractor pedis anterior muscle passing outside the longitudinal layers of muscles. Gills similar to those in *Solen*. Anterior lip of mouth immediately behind the anterior adductor muscle. Pyloric chamber very large, coecum of the crystalline style very wide proximally and arising from the ventral aspect of the pylorus; it is of considerable length extending along the greater portion of the visceral mass. Intestine of two simple limbs. Digestive gland not extending over the anterior adductor muscle. Heart at the anterior end of the pericardial chamber.

#### Gen. *Cultellus*, Schumacher.

- 1782-93. *Solen* (pars), C. A. Linné, *Syst. Nat.*, ed. XIII, pp. 3223, 3224.  
 1817. *Cultellus*, Schumacher, *Essai Nouv. Syst. Habit. des Vers Testacé*, pp. 43, 130, pl. vii, fig. 4.  
 1835. *Solen Cultellus*, Lin. and *S. javanicus*, Lamk., Lamarck, *Hist. Nat. Anim. Sans. Vert.*, VI, pp. 56, 58.  
 1858. *Cultellus*, Schum., Adams, *Gen. Recent Moll.*, II, p. 344: III, pl. xciii, figs. 2, 2a.  
 1858. *Pharella*, Gray (pars), (*Solen javanicus*, Lamarck) *id.*, *ibid.*, II, p. 344, pl. xciii, figs. 1, 1a, 1b.  
 1887. *Cultellus*, Schum., Fischer, *Man. Conch.*, p. 1100.  
 1889. *Cultellus*, Schum., Clessin, Martini-Chemnitz, *Conch. Cab.*, XI (*Solenacea*), p. 36.

*Animal.* Body comparatively short. Anterior and posterior ends tapering and rounded. Pedal aperture extending beyond the anterior margin both dorsally and ventrally (nearly to half the ventral margin). No fourth aperture. Siphons separate, very short, fringed with long tentacles which extend to the adjacent fused mantle margins. Anterior adductor muscle slightly elongated. Posterior adductor muscle rounded or oval, placed backward due to the elongation of the retractor pedis posterior muscle. Retractor pedis posterior muscle very small at its insertion. Foot elongated, compressed laterally and of uniform depth; free anterior end truncate obliquely. Retractor pedis anterior muscle not bifurcated. Fibres of retractor pedis anterior muscle spreading irregularly both inside and outside the longitudinal muscles. Labial palps short, wide and triangular. Anterior lip immediately behind the anterior adductor muscle. Gills heterorhabdic and broadly plicate, plicae connected by interplicar tissues; gills short and wide, visceral portions much shorter than the cloacal. Outer lamella of the outer gills free dorsally. Inner lamella of the inner gill free dorsally in the visceral portion, but united with its fellow of the opposite side below the cloacal chamber. Pyloric stomach very large. Coecum arising from the postero-ventral aspect of the pylorus, very short and passing ventrally and slightly anteriorly with a curve. Limbs of the intestine with closely formed folds at their junction. Digestive gland passing to the anterior adductor muscle. Heart occupying nearly the entire length of the short pericardial chamber.

#### *Cultellus subellipticus*, Dunker.

1861. *C. subellipticus*, Dunker, *Proc. Zool. Soc.*, p. 421.

1874. *C. subellipticus*, Dunker, Reeve, *Conch. Icon.*, XIX, fig. 9.

1889. *C. subellipticus*, Dunker, Clessin, Martini-Chernitz, *Conch. Cab.*, XI (*Solenacea*), p. 43.

*Animal.* The body is comparatively short, about twice as long as broad, rounded at both ends, and somewhat tapering anteriorly. The pedal aperture extends anteriorly to the antero-dorsal aspect of the anterior adductor muscle and ventrally beyond the antero-ventral corner to the level of the posterior end of the anterior adductor muscle. The siphons are very short and separate; there is a row of small tentacles round the anal and branchial apertures and a row of large tentacles round them. The anterior adductor muscle is broadly oval and comparatively small. The posterior adductor muscle is slightly elongated. The labial palps are short, triangular and tapering to a point postero-ventrally. They are about one-fourth the body in length. The foot is slightly longer than half the body and about twice as long as broad. The retractor pedis anterior muscle is short and is directed upwards and slightly forwards.

The gills are broad, about half the body in length and  $2\frac{1}{2}$  to  $2\frac{1}{4}$  times as long as broad. They are broadly plicate. The lamellae are closely applied to each other and are connected by extensive

interlamellar tissue only leaving spaces inside the plications. The plicae are connected with one another by interplacar tissues and the surface of the gills is covered over by a thin membrane.

The oesophagus is horizontal and short. Cardiac stomach extending slightly in front beyond the oesophageal portion. Pyloric stomach not protruding posteriorly beyond the origin of the coecum. Coecum of the crystalline style short and tapering at the distal extremity. The anterior limb of the intestine forming a few closely placed coils near the junction with the posterior limb which is simple and presents a wide loop above before it ends in the rectum.

#### Genus *Pharella*, Gray.

1854. *Pharella*, Gray, *Ann. Mag. Nat. Hist.* (2) XIV, p. 24.  
 1858. *Pharella*, Gray, Adams, *Gen. Recent Moll.*, II, p. 343.  
 1887. *Pharella*, Gray, Fischer, *Man. Conch.*, p. 1108.

The animal of a single species of *Pharella* (*P. orientalis*, Dunker)<sup>1</sup> is known through the researches of Bloomer (10). The following diagnosis is drawn from his paper:—

*Animal.* Body somewhat elongated. Pedal aperture extending over the anterior adductor muscle dorsally and along the ventral margin still further posteriorly. No fourth aperture. Siphons separate, consisting of short anal and branchial tubes, fringed with tentacles. Anterior adductor muscle large and nearly rounded. Posterior adductor muscle large and rounded. Foot large, compressed and abruptly truncate in front. Retractor pedis anterior muscle not bifurcated; its fibres passing inside the longitudinal muscles of the foot. Retractor pedis posterior muscle connected with the posterior adductor muscle. Labial palps short, wide and angular. Anterior lip separated from the anterior adductor muscle by a short interval. Gills elongated, narrow, heterorhabdic and plicate. Coecum of the crystalline style directed forward from the ventral aspect of the pylorus. Intestine of two simple limbs. A single nerve from each cerebro-pleural ganglion. Viscero-parietal ganglia under the posterior adductor muscle, each giving off a branchial and a pallial nerve. Heart towards the anterior end of the pericardial chamber.

The anatomical features of the present animal distinctly show that it is elongated in the middle region of the body between the two adductor muscles. Allowing for the necessary changes consequent upon this elongation, this genus is related to *Cultellus* which seems to be more primitive than the present one in many respects.

#### Genus *Siliqua*, Mühlfeldt.

1811. *Siliqua*, Mühlfeldt, *Magazin d. Ges. naturf. Fr. Berlin*, V (1), p. 38.  
 1817. *Leguminaria*, Schumacher, *Essai Nouv. Syst. Habit. des Vers Testacé*, pp. 42, 126, pl. vii, fig. 1.

<sup>1</sup> *Solen orientalis*, Dunker, *Proc. Zool. Soc. Lond.*, p. 423 (1861). *Cultellus orientalis*, Clessin in Martini-Chemnitz, *Conch. Cab.*, XI, p. 46.

1858. *Siliqua*, Mühlf., Adams, *Gen. Recent Moll.*, II, p. 345.  
 1870. *Manchaera*, Gould, *Report on the Invertebrata of Mass.* (2nd Edition), p. 46, fig. 369.  
 1887. *Siliqua*, Mühlf., Fischer, *Man. Conch.*, p. 1109.  
 1889. *Manchaera*, Gould, Clessin in Martini-Chemnitz, *Conch. Cab.*, XI (*Soleiacea*), p. 57.

The anatomy of two species of *Siliqua* has been studied by Bloomer (13). The following diagnosis is drawn from his researches:—

*Animal.* Body elongated (but shorter than *Solen* and *Ensis*), 2 to 3 times as long as broad. Anterior and posterior margins more or less rounded. Entire margin of each mantle lobe fringed with a thin narrow membrane. Pedal aperture extending above to the anterior end of the adductor muscle, and below about half-way along the ventral margin. Siphon a single piece, wide and comparatively short. A muscular ridge inside each mantle lobe a short distance dorsal to the fused ventral margins. A strong siphonal retractor muscle. No fourth aperture. Anterior adductor muscle short and deep. Posterior adductor muscle slightly elongated and deep. Retractor pedis posterior muscle very small in comparison with the posterior adductor muscle at its insertion. Foot elongated and cylindrical, dilate and truncate obliquely at the extremity. Fibres of the retractor pedis anterior muscle passing partly into the pedal integument and partly inside the longitudinal muscle. Labial palps elongated and tapering. Anterior lip placed immediately behind the anterior adductor muscle. Gills broad and comparatively short, homorhabdic and non-plicate, reaching the wall dividing the siphonal chambers. Attachments of gills like *Solen*. Pyloric stomach very large. Coecum of the crystalline style arising from the ventral side of the pyloric chamber at its posterior end, large and directed towards the front. Intestine like *Solen*. Digestive gland not reaching the anterior adductor muscle. Heart in the middle of the pericardial chamber. A single nerve from each cerebro-pleural ganglion. Viscero-parietal ganglia situated between the bifurcation of the retractor pedis posterior muscle, with a branchial and a posterior pallial nerve from each ganglion.

The anatomical peculiarities of the present genus tend to show that the animals are in many respects more primitive than the other members of the subfamily.

#### Subfam. *NOVACULININAE*, nov.

The present subfamily is made to include the single genus *Novaculina*, Benson. It seems to be greatly removed from and more primitive than the other two subfamilies.

*Animal.* Body comparatively short and deep, widened out laterally, about twice as long as broad, straight anteriorly, and concave posteriorly. Pedal aperture extending ventrally as a deep wide notch at the antero-ventral corner, not extending dorsally. Fused ventral margins of the mantle lobes forming a very wide

surface and traversed by numerous transverse bands of muscle. No cruciform muscle. Siphonal tubes completely separate from each other. A wide siphonal space posteriorly. A very short stout foot with a disc-like anterior end projecting forwards and downwards. Retractor pedis anterior muscle bifurcated with the bands passing upward and backward. Gills simple, homorhabdic and non-plicate. Outer lamella of the outer gill attached dorsally to the mantle lobe. Intestine of several long loops. Heart in the middle of the pericardial chamber. Viscero-parietal ganglia beneath the bifurcation of the retractor pedis posterior muscle.

### *Novaculina gangetica*, Benson.

(Pl. III, fig. 20-23).

1830. *Novaculina*, Benson, *Glean. Science, Calcutta*, II.  
 1858. Subgen. *Novaculina*, Benson (Gen. *Siliquaria*, Schumacher), Adams, *Gen. Recent. Moll.*, II, p. 347.  
 1874. *Solecurtus novaculina*, Benson sp., Reeve, *Conch. Icon.*, XIX, fig. 31 a, b.  
 1887. Subgen. *Novaculina* (Gen. *Solecurtus*), Fischer, *Man. Conch.*, p. 1, 107.  
 1889. *Tagelus gangeticus* (pars), Benson sp., Clessin, Martini-Chemnitz, *Conch. Cab.*, XI (*Solenacea*), p. 81.

*Animal.* The body is about three times as long as broad, widest in the vertical line of the antero-ventral notch. The anterior margin is nearly vertical with a deep notch at the antero-ventral corner; it does not project beyond the anterior margin of the shell. The pedal aperture is somewhat oblique and extends to the antero-ventral corner. The dorsal margin is convex in front and concave behind. The fused ventral margins form a wide surface, in breadth about one-third the body length; the surface is slightly convex in front and concave behind. The siphons consist of two separate anal and branchial tubes connected proximally with the posterior margins of the mantle lobes through the intervention of lateral flaps. The branchial siphon is longer and stouter than the anal, being one-half to one-third the body length; the surface of both the siphons is finely ribbed, but not segmented. The apertures are constricted and without tentacular fringe. A circular space is formed round the base of the siphonal tubes and enclosed by the mantle lobes and the lateral flaps from them. This space, named the *siphonal space*, is mentioned by Weber (50, p. 280) to extend halfway between the base of the upper siphonal tube and the posterior adductor muscle. The siphons do not seem to be completely retractile inside the shell.

The anterior adductor muscle is elongated and obliquely pyriform. The anterior limb of the retractor pedis anterior muscle is placed behind the anterior adductor muscle. The posterior adductor muscle is elongated with a notch on the postero-dorsal aspect in which is lodged the retractor pedis posterior muscle. The siphonal muscle is a thick sheet, elongated and trapezoidal in shape.

The labial palps are shaped like an equilateral triangle, the outer one extending slightly more ventralwise than the inner. A

side of the palp is five times smaller than the body length. The anterior and posterior lips are comparatively wide (deep).

The gills are elongated, about half the body in length and thrice as long as broad. The inner gill extends a little further forward beneath the labial palps and slightly below the outer one along the antero-ventral margin. The gills do not extend into the branchial siphon. The visceral portion of the gills is of the same length as the portion behind. Owing to the widening out of the body from side to side, and along with it the visceral mass, the gills are directed more or less outward from their dorsal attachments. The visceral portion of the inner gill is free along its dorsal margin. The gills are simple and non-plicate, but they are capable of much folding posteriorly owing to the presence of well-developed branchial retractor muscles.

The foot is short and stout, slightly flattened from side to side and is about one-fifth the body in length. The free end is somewhat dilated to form a disc-like expansion more or less concave on the surface which presents a vertical ridge. The plane of the surface is oblique to the long axis of the foot [at right angles according to Preston (40)], which is directed forward and slightly downward from the visceral mass. The retractor pedis anterior muscle has a short and slender anterior and a stout long posterior limb, both passing upward and backward. The fibres form a thick strand in the dorso-lateral aspect of the foot posteriorly, but spread out anteriorly on the inner side of the inner longitudinal muscle-layer. The bifurcations of the retractor pedis posterior muscle are rather short. The protractor pedis muscle is wanting. The inner longitudinal layer is much thicker than the outer. The semi-circular layers are not so thick. The muscles of the pedal integument are well-developed with numerous strands of oblique muscles passing inward from the layer. Transverse muscle strands extend through the entire depth of the foot, passing to the semi-circular layers. At the distal end of the foot the longitudinal muscles are separated into distinct bundles by the branching of the semi-circular muscles and by the transverse muscles thus forming a close network.

The oesophagus is short, flattened dorso-ventrally, and is horizontal in its course. The stomach is a wide irregular cavity and differs greatly from that of the other members of the family. The oesophageal stomach is a wide cavity receiving the oesophagus on its dorsal aspect and extending in front beyond the opening of the oesophagus. It is placed towards the right side of the body. The cardiac stomach is smaller than the oesophageal chamber lying towards the left side of the visceral mass and pushing the oesophageal stomach to the right. The central cavity is a small chamber on the left side, separated by a vertical ridge from the cardiac stomach in front and by a curved ridge from the pyloric chamber behind. The pyloric stomach is a large rounded sac extending posteriorly behind the origin of the coecum. The coecum of the crystalline style arises from the antero-ventral aspect of the pyloric

chamber on the left side and passes forward and downward to reach the base of the foot, gradually shifting to the middle line in its course. The intestine begins from the right side of the pylorus close to the origin of the coecum of the crystalline style. The intestine immediately after its origin forms a number of closely placed coils and then passes forward along the dorsal aspect of the coecum to the base of the foot. It then turns backwards and passes in the same direction along the left side of the dorsal aspect of the coecum to the dorsal aspect of the visceral mass between its left wall and the stomach, where it sharply bends downward and forward to pass along the left side of the coecum to reach the base of the foot again. Lastly, it curves backward and passes along the right side to reach the posterior and dorsal aspect of the visceral mass, where it forms a broad loop to end in the rectum. The rectum has its usual course. The digestive gland surrounds the stomach but does not reach the anterior adductor muscle.

The glandular sac of the kidney is placed on the ventral aspect and then on the outer side of the non-glandular sac, extending backward to the posterior adductor muscle and lying beneath the retractor pedis posterior muscle and its bifurcation. Posteriorly from the glandular sac a big diverticulum is given off, which in its forward course gives origin to another small sac interpolated between itself and the glandular sac. The non-glandular sac in its backward course lies at first between the venacava and the pericardium in contact with its fellow of the opposite side, but separated from it in its further course by the venacava coming in contact with the pericardium. There is an interrenal aperture between the two non-glandular sacs.

The visceroparietal ganglia are placed beneath the bifurcation of the retractor pedis posterior muscle. The pedal ganglia are placed in the visceral mass just above the junction of the dorsal and ventral halves and at a distance from the base of the foot nearly equalling its long axis.

The gonads extend along the side of the stomach to the dorsal aspect of the oesophagus.

The anatomical study of the animal distinctly shows that the genus is more primitive than the members of the other two subfamilies. Further, the animal seems to be secondarily modified as shown from its flattening in the dorso-ventral direction. The short stumpy foot with a disc-like flattened surface is certainly an indication of its primitive nature.

#### Subfam. SOLECURTINAE.

1858. Subfam. Pharinae (pars), Adams, *Gen. Recent Moll.*, II, p. 342.  
1862. Siliquaria (pars), Bronn, *Thier-Reichs, Malacozoa Acephala*, III (2), p. 476.

The present subfamily include the rest of the genera. Forming a natural group, they are more primitive than the members of the Soleninae, but are greatly specialised and less primitive than *Novaculina*. In the presence of a cruciform muscle and in the con-

nection between the coecum and intestine, they closely resemble the members of the fam. Psammobiidae to which the genera have been referred by Dall (23) and Bloomer (16). For the present they are considered to form the present subfamily, which will have to be raised to a family when the animals will be further known to us. They are undoubtedly more related to Psammobiidae than to the other two subfamilies.

The subfamily may be diagnosed as follows:—

*Animal.* Body comparatively short, but deep and widened out laterally. Pedal aperture extending along the entire ventral margin or a portion of it, sometimes along a small portion of the dorsal margin. United ventral margins of the mantle lobes short and comparatively wide (from side to side). A cruciform muscle in the ventral surface. Siphonaltubes either completely separate from each other or with a fused proximal portion. A large deep, linguiform foot generally protruding obliquely forward and downward from the pedal aperture. A siphonal space present or absent. Retractor pedis anterior muscle not bifurcated, and directed vertically upward. Labial palps comparatively short, generally triangular. Anterior lip close behind the anterior adductor muscle. Gills heterorhabdic, plicate, with the plicae free and flattened out antero-posteriorly. Intestine fused with the coecum and consisting of a single limb (corresponding to the second limb of Soleninae). Viscero-parietal ganglia variously placed.

#### Gen. *Solecurtus*, Blainville.

- 1782-93. *Solen* (pars), Linné, *Syst. Nat.*, ed. XII, p. 3225.  
 1825. *Solecurtus*, Blainville, *Man. Malac. Conch.*, p. 568.  
 1826. *Psammobia*, Risso, *Hist. Nat. princip, prod. etc.*, IV, p. 375; *Psammosolen*, *Ibid.*, V (Index).  
 1839. *Solenocurtus*, Sowerby, *Man. Conch.*, p. 99.  
 1842. *Solenocurtus*, *id.*; 2nd edition, p. 262.  
 1840. *Solenocurtus*, Swainson, *Tr. Malac.*, p. 366.  
 1847. *Cyrtosolen*, Herrmannsen, *Indicis Gen. Malac. prim.*, p. 468.  
 1858. *Macha*, Oken, Adams, *Gen. Recent Moll.*, II, p. 346; III, pl. xciii, figs. 4, 4a, 4b.  
 1874. *Solecurtus*, Reeve, *Conch. Icon.*, XIX.  
 1887. *Solecurtus*, Blainville, Fischer, *Man. Conch.*, p. 1,107.  
 1889. *Solecurtus*, Blainville, Clessin, Martini-Chemnitz, *Conch. Cab.*, XI (*Solenacea*), p. 84.

The anatomy of three species of *Solecurtus* has been studied by Bloomer (8, II), viz. *S. strigillatus*, L., *S. candidus*, and *S. dombeyi*, Lam. The anatomy of the latter differs in so many points from that of the other two, that it is necessary to separate it and place in a distinct subgenus if not in a genus of its own.

The following diagnosis is drawn from Bloomer's description:—

*Animal.* Body short and wide with the anterior margin rounded. Pedal aperture extending above to the anterior end of the anterior adductor muscle and below nearly to the middle of the ventral margin. A wide ventral surface. Cruciform muscle typical, shaped like a cross. Siphon with a fused proximal portion, considerably wide and long and distally with separate anal and

branchial tubes with transverse ribbing. Large siphonal muscle. A siphonal space bounded in front by the fusion of the proximal portion of the siphon with the inner surface of the mantle lobes somewhat anterior to their posterior margins. Anterior adductor muscle narrow and elongated. Posterior adductor muscle narrow and small. Foot very large, wide and linguiform. Fibres of the retractor pedis anterior muscle passing to the pedal integument. No protractor pedis muscle. Retractor pedis posterior muscle very small at its insertion. Labial palps narrow and triangular. Anterior lip placed beneath the posterior portion of the anterior adductor muscle. Gills narrow and elongated, extending into the branchial siphon. Inner gills united dorsally in the cloacal region. Well-developed branchial retractor muscles. Pyloric stomach not produced posteriorly beyond the coecum. Coecum of the crystalline style a long and wide tube extending in front to the antero-dorsal end of the visceral mass in a curve. Intestine fused with the coecum to the distal end of the latter. Posterior limb of the intestine with a large number of irregular folds. Rectum passing closely round the posterior adductor muscle to end in the anus after bending forward along the ventral aspect. Heart placed at the anterior end of the pericardial chamber. A bulbous arteriosus in the posterior aorta. Viscero-parietal ganglia placed beneath the bifurcation of the retractor pedis posterior muscle.

Subgen. *Solecurtellus*, nov.

1818. *Solen Dombeyi*, Lamarck, *Hist. Nat. Anim. Sans. Vert.*, VI, p. 58.  
 1874. *Solecurtus Dombeyi*, Reeve, *Conch. Icon.*, XI, fig. 30 a, b.  
 1889. *Tagelus Dombeyi*, Lamarck, Clessin, Martini-Chemnitz, *Conch. Cab.*, XI (*Solenacea*), p. 72.

The present subgenus is erected for the reception of *Solecurtus dombeyi*, Lamarck. The following diagnosis is drawn from Bloomer's anatomical note:—

*Animal.* Body comparatively elongated and somewhat narrow. Pedal aperture occupying the anterior margin and nearly the entire length of the ventral aspect of the body. Cruciform muscle typically cross-shaped and placed at the posterior end of the ventral surface close to the proximal end of the siphon. Siphonal space as in *Solecurtus*. Siphon with a short proximal portion and with separate anal and branchial tubes distally. Anterior adductor muscle elongated and deep. Posterior adductor muscle oval, of the same size as the anterior adductor muscle. Foot as in *Solecurtus*. Retractor pedis anterior fibres passing inside the longitudinal muscles. Retractor pedis posterior muscle very small at its insertion. Coecum of the crystalline style large and passing forward along the ventral side of the visceral mass. Posterior limb of the intestine forming a loose fold.

Gen. *Azor*, Gray.

- 1782-93. *Solen* (pars), Linné, *Syst. Nat.*, ed. XII, pp 3223, 3227.  
 1835. *Solen* (pars), Lamarck, *Hist. Nat. Anim. Sans. Vert.*, VI, pp. 51, 59.  
 1847. *Azor*, Leach, *Ann. Mag. Nat. Hist.* XX, p. 272.  
 1851. *Azor*, Leach, Gray, *Cat. Brit. Mus.*, VII, p. 62.  
 1858. Subgen. *Azor*, Gray (*Gen. Macha*), Adams, *Gen. Recent Moll.*, II, p. 347.  
 1874. *Solecurtus coarctatus*, Reeve, *Conch. Icon.*, XIX, fig 8.  
 1887. Subgen. *Azor*, Gray (*Gen. Solecurtus*), Fischer, *Man. Conch.*, p. 1107.  
 1889. *Solecurtus* (pars), Clessin, Martini-Chemnitz, *Conch. Cab.*, XI, (*Solenacea*), p. 85.

The anatomy of two species of *Azor* (*A. antiquatus* and *A. coarctatus*) has been described by Bloomer (16). I have a specimen of *A. coarctatus*, Gmel. from the Persian Gulf. The present diagnosis is drawn from the animal in my possession as well as from Bloomer's descriptions.

*Animal.* Body comparatively short, deep, and strongly constricted laterally near the centre of the ventral surface. Pedal aperture occupying the anterior margin and nearly half the ventral margin of the mantle lobes. Posterior half of the ventral margins of the mantle lobes fused to form a wide surface. Cruciform muscle typically cross-shaped. Siphonal tubes long and separate, with a very short fused proximal portion prolonged backwards. Strongly developed retractor siphonal muscles. Two longitudinal folds on the inner surface of each mantle lobe, which terminate in the pedal aperture anteriorly, and enclose a portion of the mantle cavity behind by their united posterior end, continuous with the ventral wall of the siphon. A tentacular fringe all round the anterior, ventral and posterior margins of the mantle from the anterior to the posterior adductor muscle.

Anterior adductor muscle deep and elongated, placed obliquely, much longer (from side to side) ventrally than dorsally. Posterior adductor muscle large and nearly rounded. Foot large, short and deep. Labial palps small, somewhat elongated and triangular in shape. Gills much elongated, narrow and prolonged into the branchial siphon; cloacal portion forming half the entire length of the gill. Inner lamella of the inner gill attached to the side of the visceral mass in front and to its fellow of the opposite side behind. Well-developed branchial retractor muscles. Stomach without central portion. Pyloric stomach produced posteriorly as a blind sac beyond the origin of the coecum. Coecum of the crystalline style short and straight, passing downward and slightly forward to the ventral aspect. Intestine with closely placed folds in the upper portion of its posterior limb. Viscero-parietal ganglia placed at the antero-ventral edge of the posterior adductor muscle.

The specimen of *A. coarctatus* at my disposal differs from Bloomer's specimen in the following points. The animal is somewhat smaller in size; both the siphonal tubes are shorter and the posterior end of the body is more tapering than in Bloomer's specimen.

Gen. *Tagelus*, Gray.

1817. *Siliquaria*, Schumacher, *Essai Nouv. Syst. Habit. des Vers Testace*, pp. 43, 129, pl vii, figs. 2, 3.  
 1851. *Macha*, Gray, *Cat. Brit. Mus.*, VII, p. 61.  
 1854. *Tagelus*, Gray, *Ann. Mag. Nat. Hist.* (2) XIV, p. 24.  
 1858. *Siliquaria*, Schum., Adams, *Gen. Recent Moll.*, II, p. 347.  
 1887. Subgen. *Tagelus*, Gray, Fischer, *Man. Conch.*, p. 1107.  
 1889. *Tagelus*, Gray, Clessin, Martini-Chemnitz, *Conch.*, Cab., XI (*Solenacea*), p. 68.

The anatomy of three species of *Tagelus*, Gray (*T. rufus*, Spengler, *T. gibbus*, Spengler, and *T. divisus*, Spengler) has been described by Bloomer (10, 15) in full detail. His researches clearly point out that the two former species are closely related to each other but differ a good deal from the last one (*T. divisus*), which is somewhat related to *Solecuretellus*. A separate subgenus (*Subtagelus*) is suggested for this species in the present paper.

*Animal.* Body somewhat elongated and rounded anteriorly. Pedal aperture very long and wide, extending from the antero-dorsal aspect of the anterior adductor muscle, through the anterior margin, to the posterior end of the ventral margin in a vertical line with the posterior adductor muscle. Ventral margins of the mantle lobes united at a single spot with the cruciform muscle placed in it. Cruciform muscle typically cross-shaped with the posterior or both pairs of the limbs short. The mantle lobes are free at their posterior margins from the point of concrescence to the posterior end of the posterior adductor muscle. Siphon consisting of two long separate anal and branchial tubes. Siphonal space separated from the general pallial chamber by two lateral processes extending from the posterior margins of the mantle lobes to the proximal end of the siphon. Retractor siphonis muscle well-developed. Anterior adductor muscle unequally divided into two portions. Posterior adductor muscle irregularly oval or triangular, and united posteriorly with the mantle lobes and the proximal portion of the siphon. Retractor pedis posterior muscle connected with the posterior adductor muscle by its long bifurcated portions. Foot large, comparatively short and very deep. Retractor pedis anterior fibres passing inside the longitudinal muscles. Gills united dorsally at their margins beyond the foot. Anterior lip beneath the posterior division of the anterior adductor muscle. Pyloric stomach produced posteriorly beyond the origin of the coecum. Coecum of the crystalline style long, wide and produced forward and upward in a curved course to the dorsal aspect of the visceral. Limb of the intestine forming closely placed folds above. Viscero-parietal ganglia placed underneath the bifurcation of the retractor pedis posterior muscle.

The anatomical study of the genus by Bloomer (15) distinctly shows that it is somewhat related to *Solecuretellus*. It has distinctly been shown by Bloomer [(15), p. 219; (12), p. 80] that *S. rufus* is anatomically more closely related to *S. dombeyi* than to *T. gibbus*, and that the two genera resemble each other in the structure of the gills.

Subgen. *Subtagelus*, nov.

1851. *Macha divisus*, Spengler, Gray, *Cat. Brit. Mus.*, VII, p. 160.  
 1854. *Tagelus* (pars), Gray, *Ann. Mag. Nat. Hist.* (2) XIV, p. 24.  
 1874. *Solecurtus bideus*, Reeve, *Conch. Icon.*, XIX, fig. 35.  
 1887. *Tagelus divisus*, Spengler, Clessin, Martini-Chemnitz, *Conch. Cab.*, XI (*Solenacea*), p. 79.

*Animal.* Body similar to *Tagelus*. Mantle lobes strongly muscular. Pedal aperture resembling that of *Tagelus*. Cruciform muscle a simple broad transverse band. Anterior adductor muscle large and simple (not divided). Posterior adductor muscle large and triangular. Foot comparatively large, deep and muscular, protruding obliquely downward and forward. Protractor pedis muscle well-developed. Retractor pedis anterior and posterior muscles short. Strongly developed elevator muscles. Pyloric stomach not produced posteriorly beyond the origin of the coecum.

The above diagnostic characters, drawn from the anatomical description of Bloomer (15), clearly shows that the present animal is more primitive than the members of the genus *Tagelus*. The undivided anterior adductor muscle and the simple band-like cruciform muscle may be cited as evidence for the above conclusion. It may also be suggested that the present subgenus (which might almost be considered a genus) is closely connected to the ancestral form which has given origin to *Tagelus* on the one hand and to the type of Psammobiidae on the other.

## CONCLUSION.

Although the little knowledge we had on the soft parts of the members of the Solenidae has been greatly enhanced by the anatomical researches of Bloomer, supplemented by my own study on the small collection of the Zoological Survey of India, we are as yet not in a position to discuss and arrive at a definite conclusion regarding the phylogenetic question of the family, unless more material comes into the hands of malacologists to be worked out by them than is the case at present. The relation between the three subfamilies is still obscure, but they seem to form fairly natural and definite groups taken by themselves. The presence of a short stout foot with a flat disc-like anterior end, and the absence of a cruciform muscle in *Novaculina* point to the comparatively primitive nature of the animal; the non-plicate gills have no taxonomic value more than as specific or subgeneric characters as shown by Ridewood (pp. 161-2). The animal is, however, otherwise specialised, and might be considered to have early separated from the ancestral stock—perhaps earlier than the appearance of the ancestral forms of the other two subfamilies.

The great width of the body from side to side seen in *Novaculina*, certainly a primitive character again, has been retained in the ancestral forms of Solecurtinae and has been handed down to its members. This ancestral type of Solecurtinae must have acquired the peculiar connection between the intestine and coecum of the

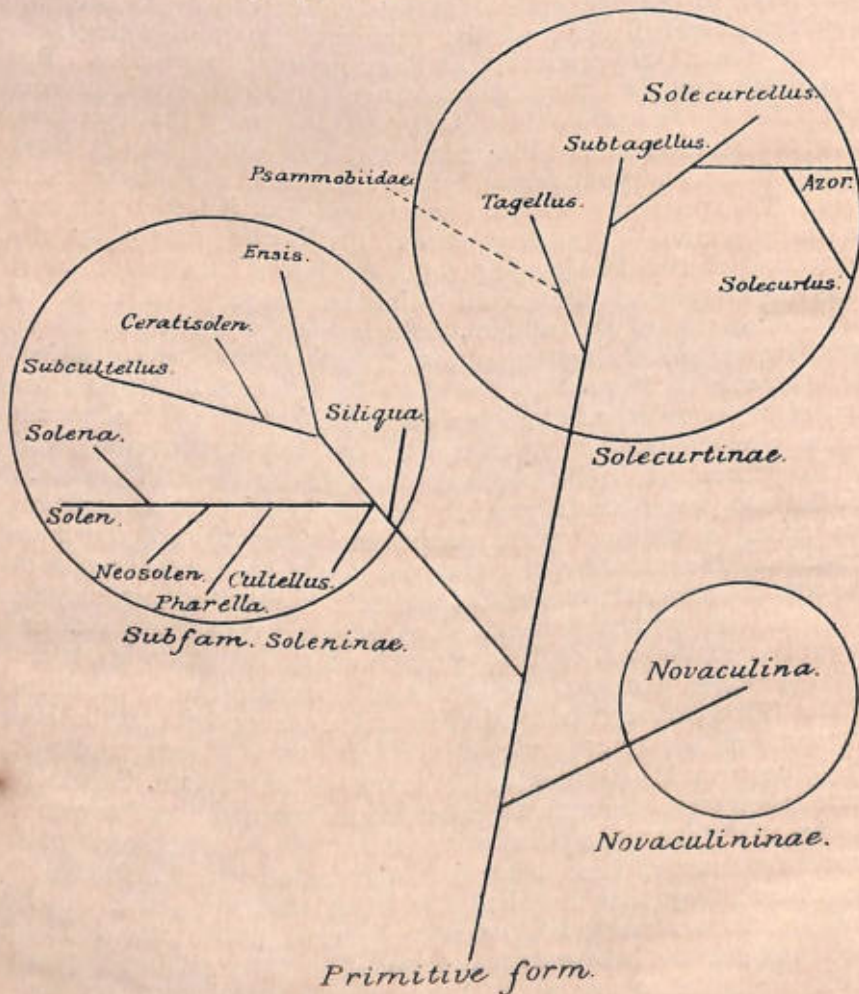
crystalline style. The question arises whether the coecum of the crystalline style has primarily originated from the side of the intestine as a side groove and has only secondarily separated from it to form a distinct and separate tube, or the coecum has primarily arisen as a ventral outgrowth of the stomach and has only secondarily acquired a connection with the intestine by the fusion of their walls. The researches of Barrois (2) have conclusively shown that the epithelial structure of the coecum of the crystalline style and intestine are quite different from each other whether they are fused together or not. Lately Bloomer has arrived at a similar conclusion, also corroborated by my own histological study on *Neosolen* and *Novaculina*.

M. Martin (*Jenaisch. für Naturwiss.* LII, 1914, pp. 363-444) has studied the relation of the crystalline style with the intestine and has found that the coecum of the crystalline style and the beginning of the intestine form together a single short wide tube in *Nucula* and in many Filibranchia. Hence, the condition found in one of the primitive types of Pelecypoda may be considered primarily at least in the present class. But it is quite probable that the condition might have arisen from one with a coecum distinct and separate from the intestine, as is still found in many Prosobranchia, and which was perhaps present in the ancestral forms before the evolution of the present class. The peculiar condition in the subfam. Solecurtinae may be easily derived from that found in *Nucula* simply by the elongation of the short conjoined portion into a long narrow tube, otherwise retaining the same primitive stage. The coeca of *Novaculina* and of the subfam. Soleninae differ from the above primitive type in being separate and distinct from the intestine. But the case of *Novaculina* seems to be different in origin from that of the members of the Soleninae. In *Novaculina*, the coecum seems to have separated at an early stage from the intestine, and in the process might have passed through a stage still found in *Modiolaria* (see Martin's paper). In the Soleninae, the condition has arisen at a later epoch secondarily from that of the Solecurtinae. The presence of connective tissue uniting the walls of the coecum and intestine, as distinctly shown by Bloomer, may be set forth as strong evidence for such a hypothesis, viz. the separation of the wall of the coecum from the intestine has taken place secondarily from a condition seen at present in the members of the Solecurtinae, the connective tissue being left as the last remnant of a former continuity of the two. Consequently it might be argued that the ancestral forms of the subfam. Soleninae have arisen from one with the intestine and coecum fused together (as in all Solecurtinae), but still without the development of a cruciform muscle, there being not a trace of it in the subfam. Soleninae; they then acquired the lateral flattening of the body and lost the connection between the coecum and intestine. It is also probable that the ancestral forms of both the subfamilies had their mantle lobes free along their ventral margins or just con-

crested at their posterior ends, as seen at present in *Tagellus*, and the fusion of the two mantle lobes gradually extended to the anterior end as the various genera originated from them. The fam. Psammobiidae, closely related to Solecurtinae, might have arisen from the same ancestral forms after the differentiation of a cruciform muscle in the fused ventral margins of the mantle lobes. The evolution of the muscle can at present be followed in the different genera of the subfam. Solecurtinae, the primitive condition as a simple transverse band being found in *Tagellus*.

Returning to the subfam. Soleninae, we find the genera *Siliqua* and *Ceratosolen* differing from the others in having simple non-plicate gills with irregular interlamellar junctions; but the plication of the gills has no taxonomic value more than as a sub-generic character as shown by Ridewood (26, pp. 161-2).

The relation between the genera of the three subfamilies may be thus provisionally represented:—



## SYNOPSIS OF THE GENERA.

- a. Body flattened laterally with a narrow ventral surface; no cruciform muscle ... Subfam. Sole-ninae.
- a<sup>1</sup>. Gills plicate.
- a<sup>2</sup>. Siphons fused to a single piece.
- a<sup>3</sup>. No fourth aperture.
- a<sup>4</sup>. Body and gills narrow and elongated.
- a<sup>5</sup>. Anterior adductor muscle narrow and elongated ... *Solen.*
- b<sup>5</sup>. Anterior adductor muscle rounded ... *Solena.*
- b<sup>4</sup>. Body and gills short and deep ... *Neosolen.*
- b<sup>3</sup>. A fourth aperture ... *Ensis.*
- b<sup>2</sup>. Siphons separate.
- a<sup>3</sup>. A fourth aperture continuous with pedal aperture.
- a<sup>4</sup>. Body elongated; two long siphonal tubes ... *Ceratisolen.*
- b<sup>4</sup>. Body comparatively short; two short siphonal tubes ... *Subcultellus.*
- b<sup>3</sup>. No fourth aperture; siphonal tubes short.
- a<sup>4</sup>. Gills short and deep; anterior lip immediately behind the anterior adductor ... *Cultellus.*
- b<sup>4</sup>. Gills long and narrow; anterior lip separated from anterior adductor muscles by an interval ... *Pharella.*
- b<sup>1</sup>. Gills non-plicate ... *Siliqua.*
- b. Body widened laterally, with a wide ventral surface.
- a<sup>1</sup>. Gills non-plicate; no cruciform muscle ... Subfam. Nova-culininae (*Novaculina*).
- b<sup>1</sup>. Gills plicate; a cruciform muscle ... Subfam. Sole-curtinae.
- a<sup>2</sup>. Ventral margins of the mantle lobes fused to form a surface; cruciform muscle cross-shaped.
- a<sup>3</sup>. Ventral surface long; a long and wide common proximal portion of the siphon; no tentacular fringe along the mantle margin... *Solecurtus.*
- b<sup>3</sup>. Ventral surface short; a short common proximal portion of the siphon; a tentacular fringe along the mantle margin ... *Azor.*
- b<sup>2</sup>. Ventral margins of the mantle lobes not fused, except at the posterior end.
- a<sup>3</sup>. A short common proximal portion of the siphon; anterior adductor muscle simple; cruciform muscle cross-shaped ... *Solecurellus.*
- b<sup>3</sup>. No common proximal portion of the siphon.
- a<sup>4</sup>. Anterior adductor muscle simple; cruciform muscle band-like ... *Subtagelus.*
- b<sup>4</sup>. Anterior adductor muscle divided into two portions; cruciform muscle cross-shaped ... *Tagelus.*

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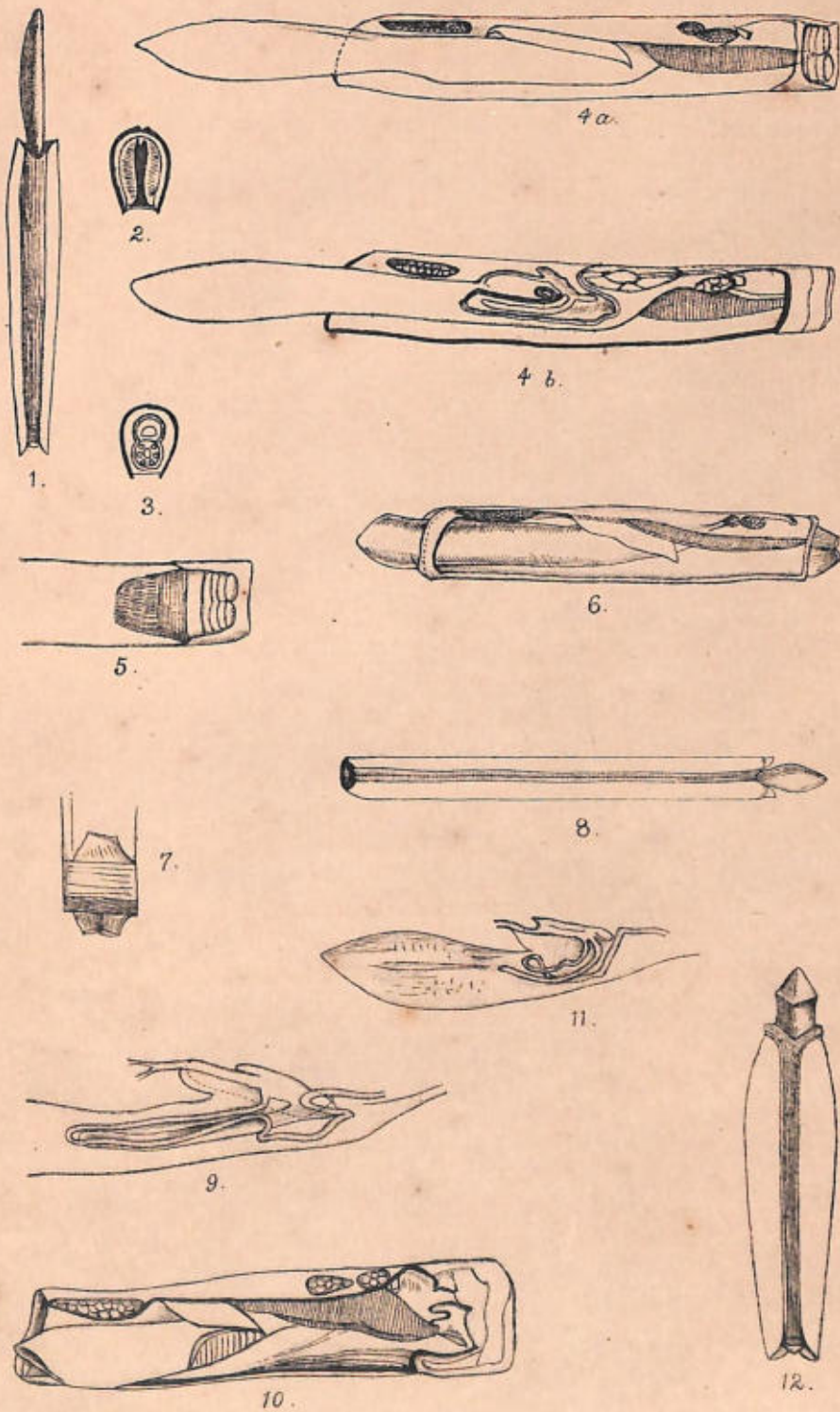
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EXPLANATION OF PLATE II.

- FIG. 1.—Animal of *Solen kempi*, Preston, ventral view,  $\times 2$ .  
,, 2.—Animal of *S. kempi*, Preston, anterior view,  $\times 3$ .  
,, 3.—Posterior view of *S. kempi*, Preston,  $\times 3$ .  
,, 4.—Animal of *S. kempi*, side view (*a*) and (*b*),  $\times 3$ .  
,, 5.—Posterior portion of *S. kempi*, showing retractor siphonis muscle,  $\times 3$ .  
,, 6.—Animal of *S. gravelyi*, side view,  $\times 3$ .  
,, 7.—Animal of *S. gravelyi*, posterior portion showing retractor siphonis muscle,  $\times 3$ .  
,, 8.—Ventral view of *S. gravelyi*,  $\times 3$ .  
,, 9.—Semi-diagrammatic section of the visceral mass of *S. gravelyi*.  
,, 10.—Animal of *S. sp.* from Japan, side view,  $\times 10$ .  
,, 11.—Section of visceral mass of *S. sp.* from Japan, showing the alimentary canal. Semi-diagrammatic.  
,, 12.—*Neosolen aquae-dulcioris*, ventral view,  $\times 2$ .



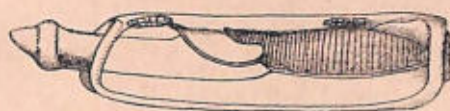
E. Ghosh del.

A. Chowdhary lith.

ANATOMY OF THE SOLENIDAE.

EXPLANATION OF PLATE III.

- FIG. 13.—*Neosolen aquae-dulcioris*, side view,  $\times 2$ .  
,, 14.—*N. aquae-dulcioris*, side view,  $\times 2$ .  
,, 15.—Animal of *Cultellus subellipticus*, Dunker, side view,  
 $\times 3$ .  
,, 16.—Alimentary canal of *C. subellipticus*.  
,, 17.—Ventral view of *Azor coarctatus*,  $\times 2$ .  
,, 18.—Animal of *A. coarctatus*, side view,  $\times 1$ .  
,, 19.—Animal of *A. coarctatus*, side view,  $\times 2$ .  
,, 20.—*Novaculina gangetica*, Benson, ventral view,  $\times 2$ .  
,, 21.—*N. gangetica*, Benson, side view (animal),  $\times 2$ .  
,, 22.—*N. gangetica*, Benson, side view (animal),  $\times 2$ .  
Mantle lobe of one side removed.  
,, 23.—*N. gangetica*, Benson, alimentary canal (diagram-  
matic).



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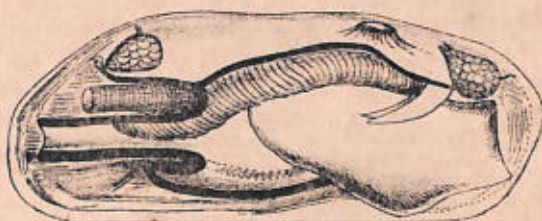
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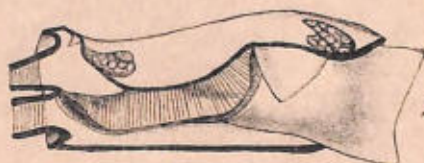
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E. Ghosh del.

A. Chowdhary lith.

ANATOMY OF THE SOLENIDAE.

XII. NOTE ON THE OCCURRENCE IN THE  
RIVER GANGES OF THE AMPHIPOD,  
*AMPELISCA PUSILLA* SARS.

By DR. CHAS. CHILTON, *Canterbury College, New Zealand.*

Some time ago I received from Dr. N. Annandale a tube containing some Amphipods collected in the river Ganges at Buxar, about 600 miles from the mouth, by T. Southwell, Esq. These were sent for comparison with the Amphipods from the Chilka Lake Survey which I was then examining. The specimens from Buxar proved to be *Ampelisca pusilla* Sars, a species which was also represented by many specimens from several localities in the Chilka Lake. This species was originally described by Sars<sup>1</sup> from the seas off the coast of Norway at depths from 180 to 370 metres. These northern specimens had the eyes imperfectly developed, without any trace of the corneal lenses. In 1910 Stebbing<sup>2</sup> with some hesitation referred to this species a single specimen obtained by the "Thetis" off Wata Mooli on the east coast of Australia, but stated that in this specimen the corneal lenses appeared to be present. They are also present in the specimens both from the Chilka Lake and from Buxar, but from the very close resemblance in all other respects of the specimens, both male and female, to the descriptions and figures given by Sars, I feel quite confident that they are rightly referred to *Ampelisca pusilla*. The imperfection in the eyes of the northern specimens is probably to be associated with their occurrence at considerable depths in the ocean. In the specimens from Buxar the eyes in most of the specimens were distinctly red, though they had been for a considerable time in spirit, in some the whole eye with its two corneal lenses being red, in others the red colour being somewhat patchy.

As I have stated in my report on the Chilka Lake Amphipoda<sup>3</sup> I think *Ampelisca chevreuxi* Walker from Ceylon should be considered as a synonym of *Ampelisca pusilla*.

So far as I am aware, the numerous species of *Ampelisca* have hitherto been recorded from marine localities only, and the occurrence of this species in fresh water in the river Ganges seems therefore worthy of a special note. In the Chilka Lake it occurs at several localities at some of which the water is probably brackish or perhaps quite fresh at certain seasons of the year.

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<sup>1</sup> Crustacea of Norway, I, Amphipoda, p. 181, pl. 63, fig. 2.

<sup>2</sup> Amphipoda of "Thetis" Expedition, *Australian Museum Mem.* 1V, p. 576.

<sup>3</sup> *Mem. Ind. Mus.* V (in the press).

The occurrence of the species in such widely separated localities as the Arctic Seas, India and Australia will doubtless help to throw light on the causes that have led to the distribution of this and other Amphipods. In this connection it should perhaps be mentioned that in the Chilka Lake *Ampelisca pusilla* occurs along with *Paracalliope fluviatilis* (G. M. Thomson), a species which is common in fresh and brackish waters in New Zealand and has also been recorded under the name of *Pherusa australis* Haswell from Botany Bay, east coast of Australia. Quite recently I have received specimens also from the Philippine Islands.

XIII. ON *MESOCOELIUM SOCIALE* (Lühe).

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This species of Trematode appears to be widely distributed throughout the tropical and sub-tropical zones: it was first discovered and described by Lühe (1901, p. 171) from *Bufo melanostictus* Schneid. from the East Indies; subsequently Odhner (1911, p. 88, footnote) obtained specimens, also from *Bufo melanostictus*, in material sent to the Berlin Museum from the island of Biliton in the Dutch East Indies between Sumatra and Borneo, and the same author also records its occurrence in a species of *Bufo* obtained by Fiebrig in Paraguay.

This Trematode was first found by me in a specimen of *Bufo melanostictus*, caught in the compound of the Indian Museum, Calcutta, in May, 1919; subsequent examination of other specimens of this toad obtained from the same locality proved that at this period of the year infection with the parasite is heavy and wide spread and in Table I I give a record of my observations during the months of May and June, 1919.

TABLE I.

Record of occurrence of *Mesocoelium sociale* (Lühe) in *Bufo melanostictus*.

Date.	Host.	No. of Specimens examined.		<i>Mesocoelium sociale</i> Lühe.	REMARKS.
May 14 ..	<i>Bufo melanostictus</i> ..	2	adults ..	present ..	in both examples.
" 15 ..	" ..	3	" ..	present ..	in all three.
" 16 ..	" ..	1	" ..	present ..	30 specimens obtained.
" 17 ..	" ..	2	" ..	present ..	in both examples.
" 18 ..	" ..	1	" ..	present ..	50 specimens obtained.
" 23 ..	" ..	1	" ..	present ..	....
June 11 ..	" ..	3	immature, measuring 15-18 mm. in body length.	absent ..	....
" 13 ..	" ..	1			
" 18 ..	" ..	1	" ..	present ..	in large numbers.
" 21 ..	" ..	1	a young ♂	absent ..	....
" 29 ..	" ..	2	adults ..	present ..	in large numbers.

A point of interest revealed by the above record is the curious fact that it was only in *adult* specimens of *Bufo melanostictus* that examples of the worm were found: in the case of the three immature examples examined on June 11th, and the young ♂ examined on June 21st, no trace of the Trematode was discovered, although in all cases the intestinal contents showed a rich protozoan fauna and in one of the small immature examples several young Nematode worms were present in the large intestine. It appears probable, therefore, either that infection with this parasite occurs late in life or, as seems to me to be more probable, that the period of infection is an annual one and had occurred some time prior to the month of June, and that in consequence specimens of *B. melanostictus* that had been hatched in May or June—after the annual period of infection—were found to be free from the parasite. That the period of infection is not only an annual one but is moreover one of short duration is indicated by the fact that a further series of 5 adult examples of this toad caught in the museum compound in January, 1920 were found to be free from the parasite.

The anatomical locality, in which the worms were obtained by me, was in every case the upper portion of the small intestine. Lühe in his original description states that the worms were found "in the greater part of the small intestine, and especially in the upper part." I never found a single example in the large intestine. In every case the worms were adhering to the mucous membrane by means of their oral suckers but when the intestine was slit up and spread out in water, they quickly relaxed their hold and dropped to the bottom of the dish.

#### *External Characters.*

The body of the worm is capable of a considerable degree of extension and contraction and its shape varies accordingly. It is always more or less compressed and flattened dorso-ventrally and when fully contracted, or after fixation in Schaudin's fluid, its outline is an elongate oval with both ends bluntly rounded and the lateral margins roughly parallel with each other. When in this condition, my specimens agree with the original description (Lühe, 1901, p. 71), but during the process of extension in the living specimens the anterior region of the body lying in front of the acetabulum becomes narrow and somewhat tapered, whereas the posterior part situated behind the acetabulum undergoes considerably less change in shape, probably on account of the dense coils of the uterus contained in it. In this extended state the outline of the body is bottle-shaped.

The examples examined by me show a much greater range of measurement than is given by Lühe, who states that the length is  $1\frac{1}{4}$ —2 mm. and the greatest breadth 0.55—0.90 mm. In Table II I have given the measurements of a series of individuals: in each case the worm had been fixed in Schaudin's fluid and was in consequence in a contracted state; every example contained

ripe ova, though in the smaller examples only a few were present, whereas in the large ones the coils of the uterus were densely crowded.

TABLE II.

Dimensions of *Mesocoelium sociale* (Lühe) in millimeters.

Measurement.	1	2	3	4	5	6	7
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Total body-length .. ..	0.684	0.842	0.982	1.702	2.018	2.06	2.21
Greatest breadth .. ..	0.403	0.349	0.438	0.860	0.596	0.706	0.737
Oral sucker .. { Length ..	0.139	0.140	0.143	0.225	0.219	0.228	0.263
.. { Breadth ..	0.125	0.140	0.132	0.214	0.228		
Acetabulum .. { Length ..	0.121	0.093	0.107	0.168	0.175	0.175	0.210
.. { Breadth ..	0.125	0.121	0.114	0.178	0.193		
Pharynx .. { Length ..	0.064	0.050	0.054	0.086	0.096	..	..
.. { Breadth ..	0.064	0.057	0.064	0.107	0.105	..	..
Distance of end of intestinal caeca from posterior end of body. }	0.161	0.236	0.314	0.564	0.632	..	..
Caeca extend back in body length	$\frac{2.29}{3.00}$	$\frac{2.15}{3.00}$	$\frac{2.04}{3.00}$	$\frac{2.00}{3.00}$	$\frac{2.05}{3.00}$	..	..

In the case of a living example the body when extended showed a length of 2.65 mm. and a breadth of 0.30 mm., but when fully contracted the length was only 1.18 mm. and the breadth had increased to 0.65 mm.: in this example both suckers gave a measurement of 0.18 mm. in the transverse diameter, but the oral sucker was somewhat elongate in shape and had an antero-posterior length of 0.235 mm.

The oral sucker occupies the rounded anterior end of the body and, as is only natural, varies in size in specimens of varying degrees of growth, being smaller in specimens with a small body-length and larger in those whose growth and development has proceeded further. Its general outline is found to vary in different individuals; in some cases, as in Examples 1, 3 and 4 in Table II, its antero-posterior length is greater than the transverse diameter, whereas in others, such as example 5, it is the transverse measurement that is the greater. This difference is probably directly correlated with the degree of extension or contraction of the anterior end of the body, in the extended condition the long diameter being antero-posterior, while in the contracted state it becomes transverse. The mouth is subterminal in position and it leads back into the cavity of the oral sucker: around its margin in young immature specimens is a double ring of small papillae, but as the worm grows these appear to become proportionately smaller and in the largest examples seem to have disappeared entirely.

The acetabulum is situated on the ventral surface, where it forms a well-marked projection, about one-third of the body-length from the anterior end: its exact position varies according to the degree of growth to which the specimen has attained. As Cort (1919 (b), p. 295) has pointed out in the case of *Margeana californiensis*, during development "there is relatively a much greater growth of the post-acetabular region, undoubtedly correlated with the development of the coils of the uterus to hold the enormous numbers of eggs produced." Exactly the same phenomenon occurs in this species, and, in consequence, as the body-length increases the relative position of the acetabulum moves steadily towards the anterior end. In specimens having a body-length of 1.0 mm. the proportion of pre- and post-acetabular regions is 38:62; while in specimens which have attained a body-length of 2.0 mm. the pre- and post-acetabular regions have a relative proportion of only 30:70. This sucker is somewhat smaller than the oral sucker, the proportional sizes being about 5:4, and a study of the measurements given in Table II above show that at any rate in fixed and contracted specimens it is slightly oval in outline, its long-axis lying in the transverse diameter.

The skin is provided in the anterior two-thirds of the body with numerous fine posteriorly-directed spines, which are arranged in transverse rows, those of one row alternating in position with those of the row in front and behind: in the posterior third of the body the cuticular spines gradually thin out and finally disappear altogether. In addition to this cuticular armature the skin on the dorsal surface of the anterior region of the body is provided with a number of scattered unicellular glands: these gland-cells are somewhat irregular in shape, but usually possess an elongate pyriform outline; they are composed of refractile, finely-granular protoplasm and appear to possess a short narrow neck or duct, which opens by a small pore to the exterior. Exactly similar cutaneous glands have been described and figured by Looss in several closely-related species, e.g. in *Opisthoglyphe ranae* (Frölich) [Looss, 1895, p. 86, fig. 155] and in *Haplometra cylindracea* (Zed) [Looss, 1895, p. 66, fig. 149], both of which are placed by Odhner in his Family Lepodermatidae: also in *Pleurogenes claviger* (Rud) [Looss, 1895, fig. 171 A] and *P. medians* (Olss.) [Looss, 1895, figs. 36 and 187, C.], in *Lecithodendrium glandulosum* (Looss) [Looss, 1900, p. 66, fig. 43], *L. obtusum* (Looss) [Looss, 1900, p. 78, fig. 53], *L. hirsutum* (Looss) [Looss, 1900, p. 69, figs. 45, 47], and *L. sphaerula* (Looss), [Looss, 1900, p. 81, fig. 57] and in *Anchilotrema sanguineum* (Sons.) [Looss, 1900, p. 107, fig. 75], all of which Odhner places in the Family Lecithodendriidae. It seems probable that the presence of these unicellular cutaneous glands is of frequent, if not of universal, occurrence in the members of the Lepodermatidae and Lecithodendriidae and other closely related families, and that they are the persistent remains of the cystogenous cells that are present in the larval, cercarial stage [but see Looss, 1895, p. 124].

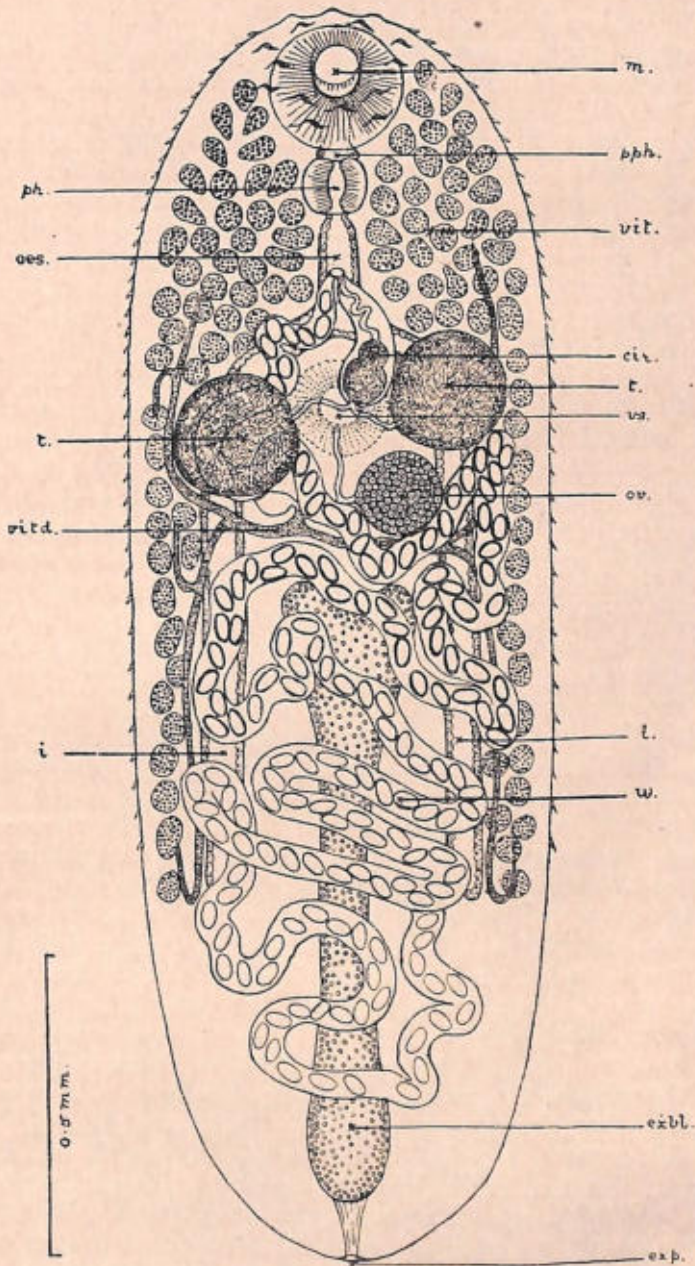


FIG. 1.—Dorsal view of *Mesocoelium sociale* (Lühe) slightly compressed.  
*cir.*, cirrus sac; *exbl.*, excretory bladder; *exp.*, excretory pore; *i.*, intestinal caecum; *m.*, mouth; *oes.*, oesophagus; *ov.*, ovary; *ph.*, pharynx; *pph.*, prepharynx; *t.*, testis; *u.*, uterus; *vit.*, vitelline gland; *vitd.*, vitelline duct; *vs.*, ventral sucker.

*Internal anatomy.*

The oral sucker leads back into a short and wide pre-pharynx (fig. 1, *pph.*) with thin walls, and this is followed by a well-developed muscular pharynx (*ph.*). Lühe in his original description states that this organ is rounded with a diameter of 0.075-0.100 mm.: in my examples it was only in the smaller specimens (vide Table II) that the organ presented a rounded outline; in all the larger specimens the pharynx was oval, the long axis being in the transverse diameter. The diameter ranges from 0.064 mm. in the smallest example to 0.105 mm. in the largest. At first sight it appears as if the pharynx did not increase in size proportionately with the rest of the body, for in example 5, although the total body-length is three times as great as in example 1, the diameter of the pharynx has only increased by 50 per cent.; but, as I have already pointed out, this increase in the body-length mainly affects only the post-acetabular region and a comparison of the other measurements shows that, so far as they are concerned, the proportional increase in size is approximately also 50 per cent. Behind the pharynx is a short wide oesophagus (*oes.*), the wall of which is plentifully provided with muscles. The tube is lined by a layer of cells having a finely granular protoplasm, and outside this lies a double muscular coat; the internal layer consists of circular fibres surrounding the tube, and outside this is a layer of oblique, strong muscle-fibres (fig. 2 *esm.*), which are attached to the oesophageal wall and diverge outwards and forwards, blending with the supporting parenchymatous tissue of the body: external to this again is a further layer composed of a number of pyriform cells (*oesg.*), with oval or rounded nuclei. Monticelli (1893, p. 30) has described this layer of cells in other trematodes as the salivary gland; it is unfortunate that he should have used this term, for Looss (1895, p. 140) has described true "salivary glands," the ducts of which pass forwards to open just behind the mouth, in *Pleurogenes claviger* (Rud.) and *Heterolope leptostoma* (Olss.). In the former species the salivary gland consists of 5-6 large granular nucleated cells lying behind the pharynx on either side of the oesophagus; from each of these cells a fine duct extends forwards, and they open in a row just behind the mouth, the orifice of each duct being visible as a small refractile spot.

In *Mesocoelium sociale* (Lühe) true salivary glands (fig. 2 *salg.*) also occur, situated behind and to the outer side of the pharynx at the level of the bifurcation of the oesophagus. Each gland consists of about ten pyriform cells, with round clear nuclei and granular protoplasm: these glands are very difficult to see owing to their being surrounded by follicles of the yolk-gland, but their position is shown in fig. 2. From each cell a fine duct arises (*sald.*); these pass forwards in a bundle lateral to the pharynx and reach the side of the oral sucker; they then sweep round its dorso-lateral aspect and open in a transverse row on the *anterior* lip of the mouth, the terminal portion of each duct appearing in

optical section, exactly as Looss describes, as a round refractile spot. It is extremely interesting to note that these gland-cells and ducts agree exactly as regards their appearance and distribution with the "stylet-gland" cells of the Polyadenous group of the Xiphidiocercariae (*vide* Cort, 1914, p. 53 and figs. 68 and 69), and I have no doubt that the two structures are identical.

About midway between the pharynx and the anterior margin of the acetabulum the oesophagus divides into two wide intestinal caeca (fig. 1 *i*), the lumen of which is lined with finely granular

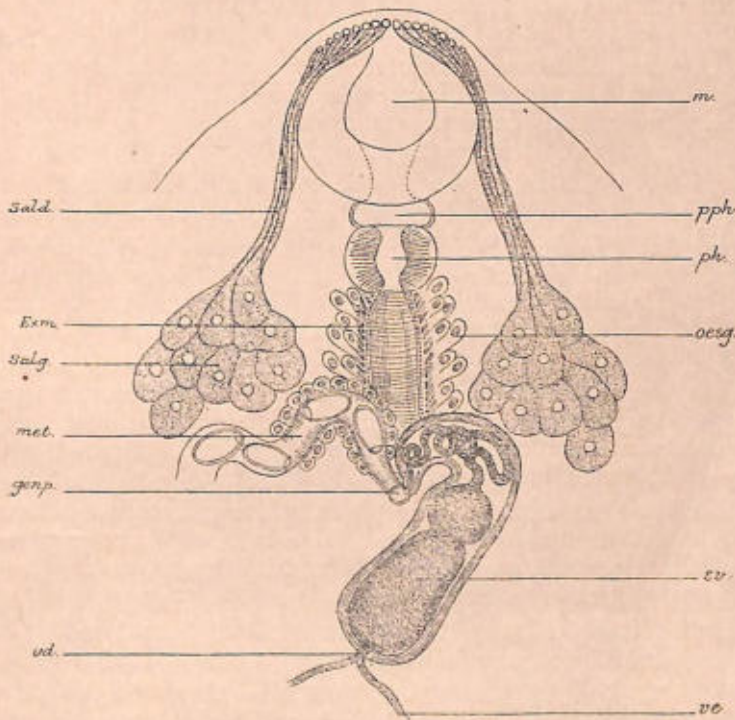


FIG. 2.—Anterior region of *Mesocoelium sociale* (Lühe).

*exm.*, external muscle-fibres of oesophagus; *genp.*, genital pore; *m.*, mouth; *met.*, metraterm; *oesg.*, oesophageal gland cells; *ph.*, pharynx; *pph.*, prepharynx; *sald.*, ducts of salivary glands; *salg.*, salivary gland; *s.v.*, seminal vesicle; *vd.*, vas deferens; *ve.*, vas efferens.

cells. Each caecum passes backwards and outwards around the acetabulum and is then continued back along the sides of the body to a point about one-third of the total body-length from the posterior end. Lühe in his original description states that they extend back three-quarters of the body-length, but here again there seems to be some difference in different individuals, according to the degree of development that has been attained. A reference to Table II shows that in smaller specimens the caeca extend proportionately further back in the body than they do in the larger

examples, as Cort (1919, p. 295) found also to be the case in *Margeana californiensis*.

The genital organs, with the exception of the coils of the uterus, lie in the anterior half of the body and are closely grouped around the acetabulum. A pair of testes (fig. 1. *t*) lie, one on each side, at about the level of the acetabulum: the right testis is as a rule situated rather more anteriorly than the left and is at the level of the anterior acetabular margin, whereas the left testis is usually opposite the posterior margin; but this difference of level appears to depend on the position of the ovary. Lühe in his original description figures the ovary on the right side of the body, and the right testis anterior to the left; in the majority of specimens examined by me this was the condition found but in a number of cases, roughly about 30 per cent. of those examined, the ovary lies on the left side of the body and in these cases it is the left testis that is the more anterior. Lühe further describes the testes as being triangular or oval and he figures the one lying anterior to the ovary as triangular, and the one on the other side of the body as oval. Johnston (1912, p. 336) in his table for the determination of the species of *Mesocoelium* gives "Testes triangular" as one of the diagnostic features of this species, but in all cases examined by me these organs have a rounded outline, when viewed from above: in transverse sections they are seen to be somewhat flattened dorso-ventrally and so present an oval appearance. From each testis a delicate narrow vas efferens arises: these ducts pass forwards and medianwards and unite together close to the base of the seminal vesicle to form a very short vas deferens (fig. 2 *vd.*), which pierces the cirrus-sac at its posterior end. The genital pore (*genp.*) is situated in the middle line of the body about midway between the two suckers and a little in front of the point of bifurcation of the oesophagus (*vide* fig. 1): the cirrus-sac (fig. 1 *cir.*) is large and thick-walled and extends backwards from the genital orifice to a short distance behind the anterior margin of the acetabulum; it is usually slightly curved and is deflected towards the right side of the body. Although Lühe makes no mention of this organ in his original description, he figures it quite correctly. The posterior half of the cirrus-sac is occupied by a large bi-lobed seminal vesicle (fig. 2 *sv.*), which in adult examples is full of ripe spermatozoa: in front of this lies the cirrus, which is long and narrow and is usually coiled up within the sac. The prostate gland appears to be somewhat diffuse; it extends backwards around the anterior end of the seminal vesicle and forwards around the cirrus nearly as far as the genital orifice.

The ovary (fig. 1 *ov.*) lies usually on the right side of the body behind and somewhat to the inner side of the right testis at about the level of the posterior border of the acetabulum, though, as I have remarked above, in about 30% of cases it lies on the left side. In this respect *Mesocoelium sociale* (Lühe) shows a variability that is exactly similar to that found by Johnston in *M. mesem-*

*brinum* (*l.c.* 1912, p. 332). In mature specimens the ovary is considerably smaller than the testis: in all my examples its outline is circular and from the median and posterior aspect arises a short wide oviduct (*fig. 3 ovd.*). After a short course the oviduct receives on its posterior aspect the duct from the large pear-shaped receptaculum seminis (*r.s.*), and immediately beyond this point it gives off Laurer's canal (*l.c.*), which turns forwards and upwards and opens on the dorsal surface above the acetabulum: the oviduct is then continued on across the middle line and receives posteriorly the common vitelline duct (*vitd.*); it then enters Mehlis' gland (*Mg.*) and dilates to form the ootype (*oot.*). On leaving the ootype the uterus (*u.*) turns forwards for a short distance and then bends sharply backwards towards the posterior end of the body, which is almost completely filled with

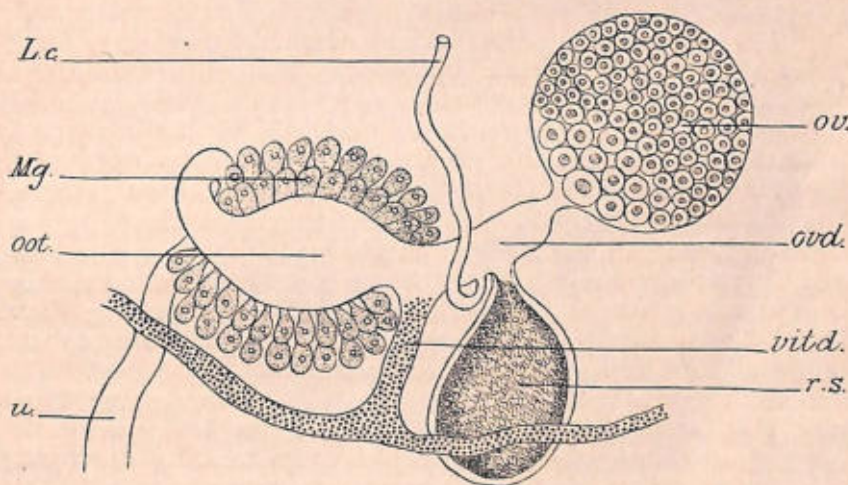


FIG. 3.—The female reproductive system of *Mesocoelium sociale* (Lühe).  
*La.*, Laurer's canal; *Mg.*, Mehlis' gland; *oot.*, ootype; *ov.*, ovary; *ovd.*, oviduct; *r.s.*, receptaculum seminis; *u.*, uterus; *vitd.*, vitelline duct.

its coils and convolutions (*fig. 1 u*): it finally turns forwards again and, passing ventrally to the testis on the side of the body opposite to that on which the ovary lies, it bends inwards towards the middle line and opens at the genital pore. The terminal portion of the uterus or metraterm (*fig. 2 met.*) is thick-walled and muscular; internally is a layer of circular muscle-fibres and immediately external to this is a layer of gland-cells, with oval or rounded nuclei

The vitellaria or yolk-glands (*fig. 1 vit.*) consist of a number of oval or rounded follicles, and extend from the side of the oral sucker, backwards along the sides of the body to the posterior extremity of the intestinal caeca: as a rule they do not extend backwards beyond this point, though in a few examples they are slightly more extensive. In the anterior region of the body in

front of the testes, the two glands spread inwards and almost reach the middle line in the region of the oesophagus; this mesial extension is greatest on the dorsal side of the body. Lühe states that in this region each gland may attain a breadth equal to one-third of the body-breadth, but in some of the specimens examined by me, they exceeded this. In the posterior region of the body, behind the acetabulum, the follicles of the yolk-gland lie almost entirely to the outer side of the intestinal caecum, between it and the lateral margin. Anterior and posterior branches of the vitelline ducts run respectively backwards and forwards in the lateral regions of the body and unite opposite the posterior margin of the ovary to form the main duct from each gland (fig. 1 *vitd.*). These ducts then pass inwards towards the middle line and where they join the lumen is slightly dilated, forming the vitelline reservoir from which the common duct passes to join the oviduct (fig. 3 *vitd.*).

The eggs are oval in shape and when first formed have a thin greyish transparent capsule, but as they mature the thickness of the capsule increases very considerably and the colour changes to a pale yellow and eventually to a brown tint. At one pole is a small but well-formed operculum with a slightly raised edge. The dimensions of the eggs appear to vary somewhat in different individuals and also in different stages of their development. Young immature eggs in the coils of the uterus lying most posteriorly are distinctly shorter and broader than the ripe eggs in the terminal portion of the uterus. Immature eggs have an average measurement of 0.034 mm. in length and 0.027 mm. in breadth. The measurements of mature ova usually fall within the limits given by Lühe, namely, a length ranging from 0.038 mm. (I presume that the measurement of 0.0038 as given in his original description is a misprint) to 0.040 mm. and a breadth of from 0.024 mm. to 0.026 mm. In certain individuals, however, eggs are occasionally found which show a much greater range of variation; in one young specimen containing only a comparatively few eggs, these were found to vary from 0.037 mm. in length  $\times$  0.028 mm. in breadth to 0.050 mm. in length  $\times$  0.021 mm. in breadth. Cort (1915, p. 26) has recorded an instance of the eggs of *Pneumonæces similiplexus* Stafford showing a considerable range of variation in dimensions in specimens obtained in different localities, but the present phenomenon falls in an entirely different category, and seems to be more nearly related to the egg-variation described by Leiper (1918, p. 246) in a single female of *Schistosoma haematobium* in which ovulation had only just commenced.

The excretory system is extremely well-developed (fig. 4): a long tubular excretory-bladder (*b*), usually containing a large number of small globular refractile granules of excretory material, passes forwards from the posterior end to a point about the middle of the body-length and a short distance behind the level of the ovary: it is somewhat narrow in its middle third; posteriorly

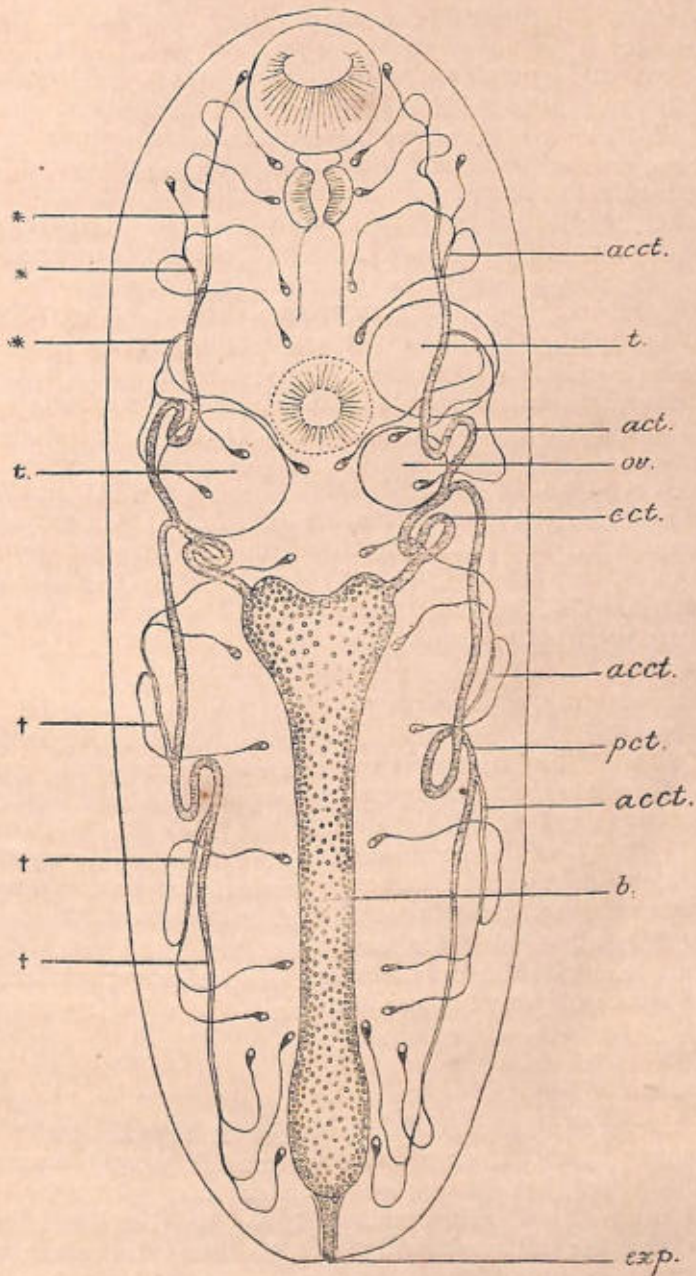


FIG. 4.—The excretory system of *Mesocoelium sociale* (Lühe).

*acct.*, accessory collecting tube; *act.*, anterior collecting tube; *b.*, excretory bladder; *cct.*, common collecting tube; *exp.*, excretory pore; *ov.*, ovary; *pct.*, posterior collecting tube; *t.*, testis.

On the left side of the figure the three anterior accessory collecting tubes are shown \* and the three posterior tubes †.

it is somewhat dilated and from this dilated portion a short canal passes backwards to the excretory pore (*exp.*), which is situated at the extreme posterior end of the body. Anteriorly the bladder becomes somewhat dilated and it terminates in two very short and wide lateral diverticula. From each diverticulum a short common collecting tube (*cct.*) can be traced forwards and outwards to a point opposite the posterior margin of the acetabulum, where it divides into anterior (*act.*) and posterior (*pct.*) collecting tubes, running forwards and backwards respectively in the lateral region of the body. Both anterior and posterior collecting tubes receive three accessory collecting tubes (*acct.*), each of which is formed by the union of three capillary vessels originating in three flame cells: of these capillary vessels two unite together to form a single trunk and this is then joined by the capillary of the third flame cell, thus showing what Cort (1919, p. 290) has termed the "two-one" arrangement in the capillary groups. The excretory system of this species is summarised in the formula  $2 \times 6 \times 3$ , and in fig. 4 I have shown the distribution and arrangement of the capillary groups and collecting tubes. A comparison of this figure and those given by Cort of the excretory systems of *Cercaria polyadena* (*l.c.*, 1919 (a), p. 277) and *Margeana californiensis* (*l.c.*, 1919 (b), p. 293) shows that in all three the systems are identical.

As almost the whole of my researches on this species, *Meso-coelium sociale* Lühe, were confined to the study of living examples, it was found to be impossible to work out the nervous system in detail. On either side of the oesophagus lies a ganglionic mass which is connected across the middle line with its fellow of the opposite side by a short stout commissure running dorsally to the alimentary canal: a pair of large ventral nerves can be traced backwards on the ventral aspect, extending as far as the posterior ends of the intestinal caeca, and a smaller dorsal pair of nerves can be made out on the upper aspect of the body; while several smaller nerves appear to pass forwards around the oral sucker towards the anterior end of the body.

#### *Development.*

At the present time nothing is known regarding the larval development of this species. Cort (1919 (b), p. 295) has put forward the view that *Margeana californiensis*, which he places in the subfamily Brachycoeliinae Looss, is developed from a cercaria that in all probability will be found to belong to the Polyadenous group of the Xiphidiocercariae. This sub-group of cercariae was created by Cort (1914, p. 53) to accommodate certain forms that possess quite distinctive characters dividing them off from other of the Xiphidiocercaria groups. Omitting certain entirely larval characters, the Polyadenous cercariae were shown by him to possess the following anatomical features:—

- (1) Acetabulum smaller than the oral sucker.

- (2) Stylet glands, six or more on each side, between the acetabulum and the pharynx.
- (3) Excretory bladder bicornuate.
- (4) Very short prepharynx and small pharynx. Oesophagus (when developed) short to, of medium length. Intestinal caeca (when present) reaching to posterior end of the body.

Subsequently (1919 (a), p. 275) he described the excretory system in detail in *Cercaria polyadena* and showed that it possesses the  $2 \times 6 \times 3$  formula.

All the arguments that Cort adduces in support of his view regarding the development of *Margeana californiensis* apply with equal force to *Mesocoelium sociale* Lühe: here likewise the relative size of the two suckers, the characters of the digestive tract, the type of excretory bladder and the  $2 \times 6 \times 3$  type of excretory tubules and flame cells render it probable that this species also possesses a Polyadenous cercaria as its larval stage; and moreover the presence in the adult worm of true salivary glands, as I have shown above (p. 86), comparable in every way with the stylet-gland of the cercaria, serves to still further strengthen the belief that in the case of this species also the cercaria will be found to belong to the Polyadenous sub-group of the Xiphidiocercariae.

#### Classification.

The genus *Mesocoelium* was created by Odhner (1911, p. 88) in order to accommodate this species, which was described by Lühe (1901, pp. 171—173, fig. 5) under the name *Distomum sociale*, and he includes the genus in the subfamily Dicrocoeliinae Looss, though, at the same time, he points out that in many respects this species approximates closely to the sub-family Brachycoeliinae Odhner (*nee* Looss). A year later Johnston (1912, pp. 329—341, figs. 13, 14, 15, 69—76) described three more species (*Mesocoelium mesembrinum*, *M. megaloon*, and *M. oligoon*), which he refers to this genus and all of which he found inhabiting the intestine of certain species of Anura. On p. 340 he gives in a tabular form the main features of this genus and of both sub-families for the purpose of comparison, and he arrives at the conclusion (p. 336) that "amongst known distomes, it is to *Brachycoelium crassicolle* R. that the four species of this genus appear to be most closely related"; while on p. 338 he admits that "of all the Brachycoeliinae, the various species of *Mesocoelium* appear to approach more closely to the Dicrocoeliinae than any others of their subfamily." In many respects *Mesocoelium* appears to be a connecting link between the two subfamilies: as regards the spiny integument, the relative sizes of the oral and ventral suckers, and the habitat of the various species, i.e. the intestine of amphibia, *Mesocoelium* agrees with the diagnosis of the Brachycoeliinae; on the other hand in respect of the situation and arrangement of the genital organs, the position of the ovary behind the testes, the juxtaposition of these latter to the

acetabulum, and the opening of the genital pore in the immediate neighbourhood of the bifurcation of the intestine this genus agrees with the *Dicrocoeliinae*; and as regards the distribution of the yolk-glands and the length of the intestinal caeca the conditions existing in the present known species of *Mesocoelium* are intermediate between or a combination of the conditions existing in the two subfamilies, though the length of the intestinal caeca more nearly approximates to the conditions found in the *Dicrocoeliinae* and especially is this the case in *M. megaloon* Johnston and *M. sociale* Lühe.

The resemblance between the genera *Mesocoelium* and *Dicrocoelium* becomes still more marked if we accept the view first put forward by Looss (1899, p. 632), and later accepted by Braun (1902, p. 97), and confine the limits of the genus *Dicrocoelium* "to forms with leaf-like shape, with testes lying near or obliquely behind each other and symmetrically developed yolk-glands," relegating the more elongate forms to Looss' provisional genus *Lyperosomum*. Johnston himself admits (1912, p. 341) that *Mesocoelium* agrees with the *Dicrocoeliinae* as regards the position of the ovary behind the testes, and he gives this as one of the diagnostic features of the genus. The fact that the ovary may in a certain proportion of cases lie on the left side of the body, as he found in *M. mesembrinum* and as I have shown above also occurs in *M. sociale* Lühe, instead of being on the right as is usually the case, does not seem to me to have any bearing on the matter and his criticism that we cannot therefore regard the positions of the ovary "as of dominant importance in referring the genus to its subfamily" is invalid. In no specimen of this genus examined by me or by any previous observer, not excluding Johnston himself, is it recorded that the ovary has ever been seen to lie *in front* of the testes. We have here a constant anatomical feature that in my opinion definitely separates the genus *Mesocoelium* from the subfamily *Brachycoeliinae*, in which the ovary invariably lies in front of the testes, and completely justifies its inclusion by Odhner in the subfamily *Dicrocoeliinae* Looss.

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XIV. NOTES FROM THE BENGAL FISHERIES LABORATORY, No. 7.

ON SOME INDIAN TORPEDINIDAE FROM THE ORISSA COAST.

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(Plates VI, VII.)

The present paper deals with some Torpedinidae that I have had a chance of collecting and observing at irregular intervals during the past two years at Puri, on the Orissa coast of the Bay of Bengal. For the sake of completeness, I have also gone over the entire collection of these forms in the Zoological Survey of India (Indian Museum, Calcutta). It has thus been possible to clear up certain doubtful points regarding the nomenclature, synonymy and variation of the various forms dealt with here. A description of a fairly advanced stage of embryos of *Narcine indica*, Henle, obtained by dissection out of a gravid female, and of the structure of the gravid uterus is also included.

Four of the six Indian genera of Torpedinidae were found at Puri; these are *Torpedo*, *Narcine*, *Narke* and *Bengalichthys*. Of the other two, *Narcobates* is a deep-sea genus and is not likely to occur near the coasts, while the occurrence of the other (*Temera*) in Indian waters is still problematical.

For the facilities regarding material and literature afforded by the officers of the Zoological Survey of India I am greatly indebted to them. My thanks are also due to Mr. J. Clinton Bond, Curator, McMahan Museum, Quetta for kindly sending me for examination a co-type of *Torpedo zugmayeri*, Englh., a species discovered in recent years on the Mekran coast of Baluchistan. It may be of interest to mention here that this is the only specimen of this species preserved in any of the Indian Museums.

**Torpedo**, Houttuyn.

1764. *Torpedo*, Houttuyn, *Nat. Hist.* VII, p. 453.

1909. *Torpedo*, Annandale, *Mem. Ind. Mus.* II, p. 42.

1913. *Narcacion*, Garman, *Mem. Mus. Comp. Zool. Harvard* XXXVI, p. 304.

Garman's valuable memoir, in which he has proposed to replace the generic name *Torpedo* by *Narcacion*, calls for some remark. *Narcacion* is one of the various names used by Klein, a pre-Linnean writer, in his *Historia Piscicum Naturalis* (1740-1744). The names were later accepted and published in an anonymous work commonly known as *Neuer Schauplatz* (1775-1781). In this work the authorities for generic and specific names are given, and

this in Garman's opinion amounts to republication after 1st January, 1758, the date of the development of the System of Linnaeus in the tenth edition of his *Systema Naturae*. No author, however, has accepted Garman's version; Jordan and Evermann,<sup>1</sup> after considering the additional arguments of Garman, are of the opinion that the generic names of Klein in *Neuer Schauplatz* are of very doubtful eligibility, as even in this work the Linnean code is not adopted for species, and further because the dictionary is an anonymous publication with an "elliptical and disorderly" method of exposition. In view of these facts it does not seem desirable to displace such well established names as *Torpedo* by Klein's nomenclature.

There is a further difficulty regarding the author of the name *Torpedo*. Günther<sup>2</sup> assigned it to Dumeril,<sup>3</sup> who established the genus in 1806 with *Raja torpedo* as the type. Houttuyn (*loc. cit.*) had in 1764, however, used the name *Torpedo* without assigning a type, but his description of the fish fixes the Electric Ray—*Raja Torpedo*, Linn. as the type. I have, therefore, accepted Houttuyn as the author of the genus *Torpedo*.

#### *Torpedo marmorata*, Risso.

1870. *Torpedo marmorata*, Günther, *Brit. Mus. Cat. Fishes* VIII, p. 450.

1909. *Torpedo marmorata*, Annandale, *Op. cit.*, p. 42.

1913. *Narccacion marmoratus*, Garman, *Op. cit.*, p. 305.

Garman's work, in connection with his description of the distribution of this species, calls for some further criticism. Except in a few instances, he has ignored Annandale's valuable papers<sup>4</sup> on the Indian Elasmobranchs. For example, he gives the distribution of *T. marmorata* as "Mediterranean Sea and Eastern Atlantic," leaving out the record of the occurrence of this species at Puri on the Orissa coast. There is in the collection of the Zoological Survey another specimen taken near Vizagapatam on the same coast. Zugmayer<sup>5</sup> has also recorded the occurrence of this species (with a closely allied one) on the Oman and Mekran coasts of Baluchistan. The species, therefore, has a wide distribution in the Indian seas.

The closely allied species *T. zugmayeri* described by Engelhart<sup>6</sup> from a female specimen collected by Dr. E. Zugmayer off Baluchistan on the Mekran coast is quite distinct from *T. marmorata*, as I have satisfied myself by the examination of a male specimen of this species preserved in the Quetta Museum. It is distinguished from *T. marmorata* in having semilunar instead of circular spiracles, much smaller though more numerous spiracular

<sup>1</sup> *Genera of Fishes*, pp. 35-37. Leland Stan. Univ. Pub. California (1917).

<sup>2</sup> *Brit. Mus. Cat. Fishes*, VIII, p. 448 (1870).

<sup>3</sup> *Zool. Analyt.*, p. 102 (1806).

<sup>4</sup> *Mem. Ind. Mus.* II, pp. 1-60, pls. i-v (1909), and *ibid.*, III, pp. 1-6 (1910).

<sup>5</sup> *Abh. Kön. Bayer. Akad. Wiss. München* XXVI, Bd. 6, pp. 1-35 (1913).

<sup>6</sup> *Zool. Anz.*, Bd. XXXIX, Nr. 21-22, p. 647 (1912).

papillae, proportionately much smaller tail, by general colouration and a much heavier build.

### Narcine, Henle.

1878. *Narcine*, Day, *Fishes of India* II, p. 733.

1909. *Narcine*, Annandale, *Op. cit.*, p. 43.

1913. *Narcine*, Garman, *Op. cit.*, p. 246.

In the paper cited Annandale recorded three species of this genus from Indian seas, viz. *N. timlei*, *N. brunnea* and *N. mollis*. Garman, however, has shown that the true *N. timlei* is not an Indian form, being confined to the East Indies and Japan. He thinks that the Indian species is what was described as *T. indica* by Henle,<sup>1</sup> a conclusion with which I agree. In the same work he has also described a new species from Colombo, Ceylon under the name *N. firma*. I have not seen this form, there being no representatives of it in the Calcutta collection.

Garman, in his key for the identification of the various species of the genus *Narcine*, states that in *N. tasmaniensis* and *N. mollis* the spiracles are "at a short distance from the orbits," whereas in his description of *N. mollis* he describes them as being "near the orbits." Llyod<sup>2</sup> in the original description states that they are situated close to the orbits and this is the condition in the unique type, which I have examined. Garman's key in view of the above is incorrect. The four Indian species can, however, be distinguished from one another as follows:—

- |     |   |                         |
|-----|---|-------------------------|
| I   | Origin of first dorsal opposite the ends of ventrals.   |                         |
|     | (i) Dorsal surface spotted  | ... <i>N. indica</i> .  |
|     | (ii) Dorsal surface uniform brown   | ... <i>N. brunnea</i> . |
| II  | Origin of first dorsal slightly behind the ends of the ventrals, dorsal and ventral surfaces of the body uniformly coloured | ... <i>N. mollis</i> .  |
| III | Origin of first dorsal behind the ends of the ventrals by about its own basal length  | ... <i>N. firma</i> .   |

### *Narcine indica*, Henle.

(Plate VII, figs. 4-9).

1834. *Narcine indica*, Henle, *Op. cit.*, p. 35, pl. ii, fig. 2.

1841. *Narcine indica*, Müller and Henle, *Plagiostomes*, p. 130.

1878. *Narcine timlei*, Day, *Op. cit.*, p. 733 (in part, not the figure).

1909. *Narcine timlei*, Annandale, *Op. cit.*, p. 44.

1913. *Narcine indica*, Garman, *Op. cit.*, p. 209.

Annandale pointed out in his paper the confusion made by Day in including two distinct species in his description and figure of *N. timlei*, and separated the uniformly coloured Indian species under the name *N. brunnea*, retaining the name *N. timlei* for the spotted form. This latter, however, as has been pointed out above, should be known as *N. indica*.

<sup>1</sup> *Ueber Narcine*, p. 35, pl. ii, fig. 2 (1834).

<sup>2</sup> *Rec. Ind. Mus.* I, p. 8 (1907).

Garman's description of *N. indica* is incomplete and erroneous owing to his having ignored the question of variation in the outlines of the disc, the relative size of the eyes and spiracles, the size and proportion of the dorsal and the caudal fin and the colouration, so well discussed in Annandale's account of *N. timlei*. All these facts are fully borne out by the large series of specimens of this species in the collection of the Zoological Survey, as also by a large number of fresh specimens that I have examined at Puri and elsewhere. The species is fairly common round Puri and a large number of specimens is caught every day in the shore seine-nets.

Except for a doubtful specimen of *N. brunnea* found in an advanced state of decomposition on the Puri beach, I did not secure any specimen of this latter species.

### Narke, Kaup.

1826. *Narke*, Kaup, *Arch. Anat. Physiol.* p. 365.

1887. ? *Astrape*, Day, *Op. cit.*, p. 734.

1909. *Astrape*, Annandale, *Op. cit.*, p. 46.

1913. *Narke*, Garman, *Op. cit.*, p. 312.

Day recorded a single representative of this genus from Indian waters as *Astrape dipterygia*. It is doubtful, however, in view of the arguments stated further on, whether he had ever seen the true *N. dipterygia* of Indian waters. Müller and Henle's generic name *Astrape*<sup>1</sup> cannot stand owing to Kaup having described the same genus as *Narke* some fifteen years earlier.

Garman in his memoir combined Annandale's new genus *Bengalichthys* with *Narke* without giving any reasons. This point is fully discussed further in the account of *B. impennis*.

### *Narke dipterygia* (Bloch., Schn.).

(Plate VI, figs. 1, 2).

1870. *Astrape dipterygia*, Günther, *Brit. Mus. Cat. Fishes*, VIII, p. 454.

1887. ? *Astrape dipterygia*, Day, *Fishes of India*, p. 734 (in part, not the figure).

1889. ? *Astrape dipterygia*, Day, *Faun. Brit. Ind. Fishes* I, p. 46 (in part, not the figure).

Günther and Day included in the synonyms of this fish Shlegel's *N. japonica* but this has since been recognized as a distinct species by Jordan and Fowler,<sup>2</sup> Garman and others.

In his first work Day gave a figure of *N. dipterygia* prepared from a specimen from Malabar; this figure was later reproduced in the "Fauna" volume. The specimen is preserved in the collection of the Zoological Survey. The figures referred to above led me to doubt as to whether these could be that of the true *N. dipterygia*, for they rather resembled *B. impennis* in the shape and position

<sup>1</sup> *Sitzb. Akad. wiss. Berlin*, p. 117 (1837).

<sup>2</sup> *Proc. U. S. Nat. Mus.* XXVI, p. 656 (1903).

of the ventral or pelvic fins, but the eyes in this figure are shown as being fairly large and prominent. The doubt was confirmed by an examination of the original specimen, which is certainly a true *B. impennis*. The eyes in the specimen are exactly as in normal specimen of *B. impennis*, and Day's figures are wrong in this particular. The second specimen from Day's collection is from Madras and is also a specimen of *B. impennis*. These are the only specimens in Day's collection of fishes in Calcutta, and both belong to *B. impennis* but were wrongly identified as *Astrape dipterygia*.

In view of these facts, therefore, it seems a little doubtful whether Day's description of *A. dipterygia* does not really apply to *B. impennis*; this fact unfortunately is, however, not easy to decide, as in certain particulars, such as the proportions of the tail and disc, his description does not apply to either species. Both the specimens from Day's collection are in a poor state of preservation and therefore give a very imperfect idea of the normal appearance of *Bengalichthys*. In any case Day's identification does not affect the nomenclature or taxonomic position of either genus. As no complete description of *N. dipterygia* is available, I have thought it desirable to redescribe the species.

Disc subcircular, slightly shorter than the tail, snout short, rounded on the anterior margin. Nostrils small. Anterior valves confluent, forming a quadrangular flap with concave lateral margins, rounded at the sides posteriorly and with a median projection; this flap is free posteriorly, extending back over the mouth and covering the upper jaw entirely in both young and adult specimens; posterior valves well developed with a free triangular portion first curving backwards and then forwards in a half loop-like manner, and lying in the concavities on the sides of the anterior flap. Mouth small, protrusible, enclosed in a deep fold of skin and divided by a median projection on both the jaws, that of the lower jaw being more prominent than that of the upper. Teeth small. Eyes small but prominent, a little less than half the length of the spiracles. Spiracles large, abutting on the eyes, varying in outline according to the condition of preservation of the specimens, with a smooth raised margin. Gill-openings small; the last one particularly reduced. Dorsal fin rounded along the margins, with an elongated base, arising a little in front of the bases of the ventrals, and separated from the caudal by its basal length. Tail slightly longer than half the total length, with a well developed caudal, and a feebly developed fold on either side. Subcaudal rounded; supracaudal much larger, rounded in some specimens, in others ending in a point. Ventrals large; with a concave outer margin in the young, becoming nearly straight in full grown individuals; arising below the pectorals. Claspers short, stout, with a deep groove on the upper surface throughout their length and another on the outer side extending to not more than half the length. Pectorals broad, with straight fin-rays showing through the skin. Electric organs kidney-shaped, extending to a little in front of the eyes, formed of irregular quadrangu-

lar or pentagonal areas, distinctly marked on both dorsal and ventral surfaces.

Colour olive-brown dorsally; borders of the disc, ventrals, the posterior margin of the dorsal and the caudal creamy white; a circular white spot on each side behind the electric organs and a similar but larger one at the junction of the pectorals and the body on each side; ventral surface creamy white.

For the sake of comparison with *B. impennis*, photographs of the dorsal and ventral surfaces of a well-preserved specimen of this species (figs. 1, 2) from Puri, and those of one of *B. impennis* (figs. 3, 4) are reproduced on plate vi.

The species is widely distributed in Indian seas, there being specimens in the collection from the Sandheads, Orissa Coast, Bay of Bengal, off Colombo and from Bombay.

### Bengalichthys, Annandale.

1887. *Astrape*, Day, *Fishes of India*, p. 734 (in part), fig. 19.

1889. *Astrape*, Day, *Faun. Brit. Ind. Fishes I*, p. 46 (in part), fig. 19.

1909. *Bengalichthys*, Annandale, *Op. cit.*, pp. 47, 48.

1913. *Narke*, Garman, *Op. cit.*, p. 312 (in part).

As has been remarked already the two specimens from the late Dr. F. Day's collection in the Indian Museum identified as *A. dipterygia* really belong to this genus. Unfortunately these specimens escaped Dr. Annandale's attention at the time of his revision of the Indian Batoids, and the creation of his new genus *Bengalichthys*. His description of this genus was also short owing to his having only two specimens. Probably this, and the rather poor figure of the only species published by him, led Garman to unite the genus *Bengalichthys* with *Narke*. The two genera, however, are quite distinct and with a fair number of specimens before me, I have thought it desirable to redescribe the genus at some length, and publish good photographs of the only known species.

Head, body and electric organs united in a subcircular, fleshy disc, ending abruptly in front of the anus and including only a small anterior part of the ventral fins, snout broadly rounded, anterior narial valves confluent in a small quadrangular flap, extending up to the mouth but not covering it. Mouth small, protrusible, enclosed in a thick fold on the two sides. Eyes very small, degenerate, sunken. Spiracles large, with a smooth border without raised edges. Gill-openings small. Electric organs not distinguishable externally in fully grown specimens. Ventrals large, fleshy; lateral united with the tail and not enclosed by the disc as in *Narke*. Pectorals except for a narrow fringe entirely enclosed in the fleshy disc. One dorsal. Tail long, without any fold on lateral sides. Skin thick, fleshy, with large numbers of glandular pits on both dorsal and ventral surfaces.

*Type*: *Bengalichthys impennis*, Annandale, the only known species.

The genus, though closely allied to *Narke*, is certainly quite

distinct from it. As was pointed out by Annandale, probably as a result of adaptation to its presumable habits of wriggling and squirming at the bottom, the body has become very massive and fleshy, while the fins have been greatly reduced. The mouth, owing to a suctorial function, has become small, and is protrusible as a tubular structure. The eyes also have degenerated to minute structures sunk in pits, and probably functionless. All these features combined with the lateral situation of the ventrals on the tail, and the very much smaller anterior narial flap are sufficient characters for separating the genus from *Narke*.

### ***Bengalichthys impennis*, Annandale.**

(Plate VI, figs. 3, 4 ; pl. VII, figs. 1-3).

1887. *Astrape dipterygia*, Day, *Fishes of India*, p. 734 (in part), fig. 19.

1909. *Bengalichthys impennis*, Annandale, *Op. cit.*, p. 48, fig. 9, pl. iii (a), fig. 7.

1913. *Narke impennis*, Garman, *Op. cit.*, p. 315.

In addition to the original description by Annandale, the following points may be noted. The narial flap is very small and does not cover the mouth. The glandular pits are present on both the dorsal and ventral surfaces ; they are specially prominent on the border of the electric organs. The electric organs, though well developed and occupying the usual position between the head and the pectorals, are not visible externally, except in young individuals as pentagonal areas, through the thick skin. The pectoral "fringed ridge," mentioned by Annandale, consists of skin covering only the terminal joints of the fin-rays. It was found on dissecting out the skeletal parts in this region that the rays, instead of remaining quite straight, are retroverted upwards (pl. vii, fig. 1) for a considerable part of their length, and thus give double support to the fleshy margin of the disc ; the fins as such being reduced to the narrow fringe. The ventral fins have the greater part of their length situated behind the disc, but are enclosed, like the pectorals, in a thick muscular coating, and form lateral expansions of the tail in this region.

In the male specimens the claspers are well-developed structures but the greater part of their length is enclosed within the fin-folds. The free part shows the main channel and a small groove on either side on the dorsal surface (pl. vii, figs. 2, 3).

Besides the two original specimens of Dr. Day, one from Malabar and the other from Madras, there are in the collection of the Zoological Survey two specimens from Balasore Bay on the Orissa coast, and four from off Gopalpur, Madras. I also saw two partially decayed specimens on the Puri beach in January, 1920. It appears from these records that the species, though rare, is widely distributed in the Indian seas.

Annandale has described the colouration of the species at some length, and there is nothing further to note except that in fresh specimens it closely resembles that of *N. dipterygia*.

I. GRAVID UTERUS AND EMBRYOS OF *GARCINE INDICA*.

In January, 1919, while collecting at Puri, I secured a gravid specimen of *N. indica* measuring 31 cm. in length. On dissection the specimen was found to contain four embryos in its uterus.

The uterus shows certain peculiarities. The entire inner surface is covered with spatulate villi-like trophonemata (pl. vii, fig. 4). The covering of trophonemata is so thick that no part of the uterine wall is to be seen between them. In a square inch of the wall of the preserved uterus 198 villi were counted. A typical trophonema (pl. vii, fig. 5) is spatulate, and measures 7 mm. in length with an average width of 2 mm. near the tip and 0.5 mm. near the base. Examined under the microscope (pl. vii, fig. 6) the marginal arterial loop and the thick plexus of capillaries all over the surface is distinctly to be made out.

Structures of this type have been described for a number of Indian Batoids originally by Wood Mason and Alcock<sup>1</sup> and later by Alcock<sup>2</sup>; to the two authors we also owe the very appropriate name of "trophonemata." I do not propose going into the histological details of these structures, as these have been admirably described by Brinckmann<sup>3</sup> and Widakowich<sup>4</sup>; further, the material at my disposal would not permit my going into these details. It is, however, of interest to note that the trophonemata of this species greatly resemble those of *Torpedo ocellata*, described by Brinckmann. It may also be mentioned that the uterus was full of a yellowish milk-like secretion in which the embryos were enclosed.

But for the embryos of *Torpedo marmorata* described by De Sanctis<sup>5</sup> in fair detail, no good description of Torpedinid embryos has been published. De Sanctis in his valuable paper divides the embryos into five stages:—

- (1) *Embrione squaliforme, opleurotrema,*
- (2) *Embrione Raiiforme, oipotrema,*
- (3) *Embrione Torpediforme ad archi incompleti,*
- (4) *Embrione topedinetta bianca ad archi completi, and*
- (5) *Embrione topedinetta macchiata e senza filli esterni branchiali.*

The specimens (pl. vii, figs. 7, 8) described below are of interest in that they belong to a stage intermediate between stages 4 and 5 of De Sanctis.

Disc ovoid, incomplete, owing to anterior region of pectorals not having fully developed and fused with the disc. Snout prominent, knob-like, rounded at the end. Nostrils small. Anterior narial valves quite separate from one another, not having fused as yet; posterior valves very small and not fully developed. Mouth small, nearly straight, protruding above the surface and

<sup>1</sup> *Proc. Roy. Soc. London* XLIX, p. 363 (1891).

<sup>2</sup> *Ann. Mag. Nat. Hist.*, (6), X, pp. 4, 5 (1892).

<sup>3</sup> *Mitt. Zool. Stat. Neapel* XVI, pp. 365-408, pls. xii-xiv (1903-1904).

<sup>4</sup> *Zeitschr. Wiss. Zool.* LXXXVIII, pp. 499-545, pls. xxx, xxxi (1907).

<sup>5</sup> *Atti R. Accad. Sci. Fis. Mat. Napoli* V, pp. 1-62, pls. i-iv (1873).

with well-developed longitudinal folds of skin surrounding it. Eyes large, protruding, much larger than the spiracles. Spiracles semi-lunar with a smooth margin. Dorsal fins small; second much better developed than the first. Pectorals horn-shaped, with a convex outer edge and with feebly developed fin-rays. Ventrals a little more than half the size of the pectorals. In a male specimen small elongate lobes of skin are separated off on the inner side as the clasper rudiments. Tail less than half the total length, with a feebly-developed caudal.

*Measurements of a ♂ specimen (in millimetres).*

Length of disc	..	..	27·8
Maximum breadth of disc	..	..	8·2
Length of snout	..	..	5·1
Interorbital distance	..	..	3·4
Mouth to vent	..	..	8·1
Tail	..	..	14·9
Length of yolk-stalk and yolk-sac			20·9

The yolk-stalk is well developed and enters the body a little in front of the anterior edge of the pectoral fins. The sac is a large, somewhat triangular, bag-like structure and has the lower surface thrown into folds. The branchial filaments (pl. vii, fig. 9), which are to be seen protruding out of all the gill-openings, are long but few in number at this advanced stage of the embryo.

The specimens preserved in rectified spirit, after fixation in formaldehyde (10%), are of a creamy colour, the yolk sac, however, is more yellowish.

ERRATUM

P. 104, line 1 for "*GARCINE INDICA*" read "*NARCINE INDICA*."

EXPLANATION OF PLATE VI.

*Narke dipterygia* (Bl., Schn.).

- FIG. 1.—Photograph of the dorsal surface of an adult, from Puri.  
,, 2.—Photograph of the ventral surface of the same individual.

*Bengalichthys impennis*, Annandale.

- FIG. 3.—Photograph of the dorsal surface of a rather young individual from Puri, Orissa.  
,, 4.—Photograph of the ventral surface of the same individual.



D. Bazeel Photo.

INDIAN TORPEDINIDÆ.

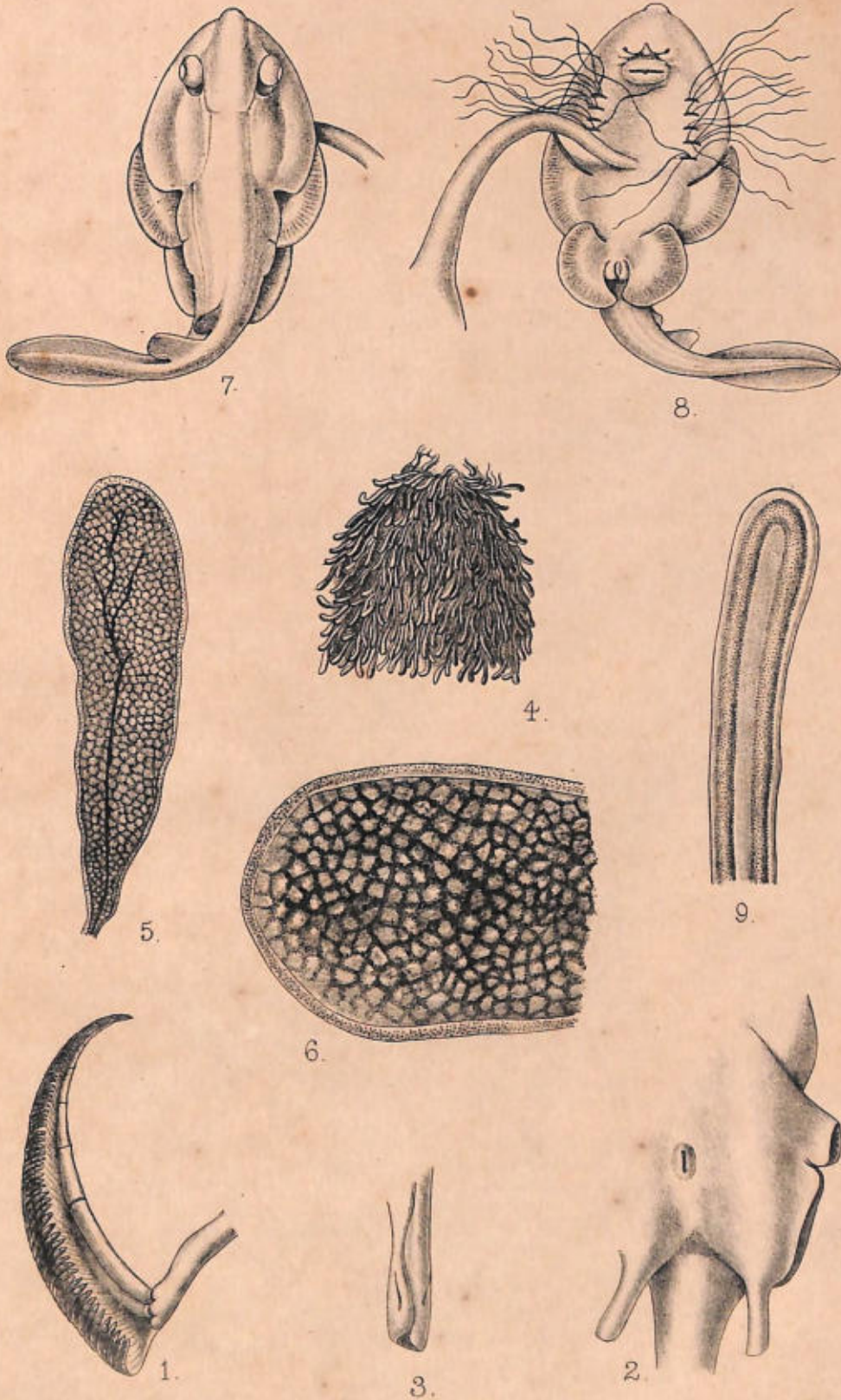
EXPLANATION OF PLATE VII.

*Bengalichthys impennis*, Annandale.

- FIG. 1.—Skeleton of the pectoral fin of a specimen showing the retroverted fin-rays.  
,, 2.—Pelvic fin region of a male specimen,  $\times 1\frac{1}{4}$ .  
,, 3.—Terminal part of a clasper of a male, seen from above,  $\times 1\frac{1}{4}$ .

*Narcine indica*, Henle.

- ,, 4.—Part of the uterine wall of a gravid female showing the trophonemata.  
,, 5.—A single trophonema enlarged.  
,, 6.—Terminal part of a trophonema seen under the low power of the microscope.  
,, 7.—Embryo seen from above. The branchial filaments are not shown.  
,, 8.—Embryo seen from the ventral surface.  
,, 9.—A branchial filament as seen with the low power of the microscope.



A. Chowdhary del. et lith.

INDIAN TORPEDINIDAE.

XV. MATERIALS FOR A GENERIC REVISION  
OF THE FRESHWATER GASTROPOD  
MOLLUSCS OF THE INDIAN EMPIRE.

INTRODUCTORY NOTE.

[Under the above title I propose, with the help of other members of the Zoological Survey of India, to issue a series of short papers embodying the main taxonomic results of our recent survey of the freshwater molluscs of India.<sup>1</sup> The definitions and limitations of the genera we have adopted are in many instances different from those hitherto accepted, and it will be as well that our views should be subjected to criticism, which we will welcome, before our final monograph is published. N. A.].

NO. I.—THE INDIAN GENERA OF MELANIINAE.

By N. ANNANDALE, D.Sc., F.A.S.B., Director, Zoological  
Survey of India.

It is convenient to separate the family Melaniidae or Tiaridae into two subfamilies, the Melaniinae (or Tiarinae) and the Paludominae, and to include in the former all the species with elongate narrow shells. Among the Indian forms with this type of shell only two genera have hitherto been generally recognized, namely *Faunus*, de Montfort and *Melania*, Lamarck (= *Tiara*, Bolten); but *Melania* has been divided into a number of subgenera, as to the names of which there has been considerable confusion. My conclusions may be introduced conveniently by a key to the genera I now recognize. Their status and limits will be discussed thereafter.

*Key to the Indian Genera of Melaniidae.*

1. Outer lip of shell forming a broad and prominent lobe defined above and below by well-developed canal-like prolongations of the aperture. Operculum thick, without spiral figure ... .. *Faunus*.
2. Outer lip not lobular, upper and lower canals of the aperture ill-defined or absent.
  - A. Shell very small (less than 1 cm. high), hairy, sculptured with spiral incised lines only. Operculum extremely thin, paucispiral, with the nucleus eccentric. Foot produced into a filamentous process behind. Marginal tooth of radula with three sharp denticulations and a pointed process near the base ... .. *Mainwaringia*.
  - B. Shell large or of moderate size, as a rule without hairs, with at least a trace of longitudinal grooves and ridges. Operculum at least moderately thick. Foot without posterior process.

<sup>1</sup> See Kemp and Gravely, *Ind. Jour. Med. Research*, VII, p. 252 (1919).

Radular teeth without basal process, either with more than three sharp denticulations or with three much broader blunt denticulations.

- i. Shell large, heavy, ovoid, with strong spines round the upper extremity of the body-whorl. Operculum without spiral figure, long, narrow, oval... .. *Melania (=Tiara).*
- ii. Shell as a rule more elongate, without, or with relatively feeble, spines. Operculum bearing a spiral figure.
  - a. Shell never very thick or large and as a rule relatively long and slender, tapering to a sharp point at the apex, with the aperture ovate and never produced above, the sculpture consisting of numerous longitudinal and spiral grooves which form by their intersection a reticulate or nodular pattern, rarely obsolescent. Spines sometimes present on upper extremity of body-whorl. Operculum relatively large, ovate, paucispiral, with the nucleus situated near the inner lower margin and the spiral figure occupying only a small part of the surface. Mantle bearing on its inner surface near the margin a row of digitiform processes. Radular teeth relatively long, with numerous sharp denticulations... .. *Melanoides.*
  - b. Shell as a rule large heavier and broader, with more solid sculpture or nearly smooth, more or less biconical in outline and with the aperture frequently produced slightly both above and below. Spines never present on the upper margin of the body-whorl. Operculum relatively small, subcircular, with a spiral figure that occupies most of its surface. No processes on or near edge of mantle. Radular teeth relatively short with fewer and blunter denticulations ... .. *Acrostoma.*

*Faunus* and *Mainwaringia* do not belong to the freshwater fauna as both are estuarine. The geographical range of the former is wide but in the main insular, while *Mainwaringia*<sup>1</sup> is known only from the Gangetic delta. The synonymy and diagnosis of the two freshwater genera may be discussed further.

#### Genus *Melanoides*, Olivier (*nec* H. and A. Adams).

1807. *Melanoides*, Olivier, *Voy. l'Emp. Ottoman*, II, p. 40.  
 1854. *Plotia*, *Melania*, *Tarebia*, H. and A. Adams, *Gen. Recent Moll.*, I, pp. 295, 301, 304.  
 1874. *Melanoides*, *Melania*, s.s. (in part), *Plotia*, *Tarebia*, *Striatella*, Brot. *Conch. Cab.*, pp. 6, 7.  
 1885. *Melania* (s.s.), *Striatella*, *Melanella* (in part), *Tarebia*, *Plotia*, Nevill, *Hand List Moll. Ind. Mus.*, II, pp. 221, 231, 271, 272, 280.

<sup>1</sup> Annandale & Prashad, *Rec. Ind. Mus.*, XII, p. 251, fig. 5, pl. xx, fig. 8 (1919).

1897. *Stenomelania, Melanoides, Plotia, Tarebia*, von Martens in Weber's *Zool. Ergebn. Reis. Niederl. Ost-Ind.*, IV, pp. 40, 50, 62, 69.  
 1898. Neomelanien (in part), P. and F. Sarasin, *Sussw. Moll. Celebes*, p. 38.  
 1915. *Radina, Striatella, Melanella* (at least in part), *Tarebia, Plotia*, Preston *Faun. Brit. Ind., Freshw. Moll.*, pp. 10, 15, 32, 33, 35.  
 1919. *Melanoides*, Annandale and Prashad, *Rec. Ind. Mus.*, XVIII, p. 28.

There has been much confusion in nomenclature owing to the fact that H. and A. Adams used the name *Melanoides* in quite a different sense from that in which it had been introduced thirty-seven years earlier by Olivier, who applied it to a race or phase of the common "*Melania*" *tuberculata*. A reference to this author's "voyage" shows that Nevill (*op. cit.*, p. 248) was wrong in stating that the form of the name employed was "Melanoïde," a form that might not have been considered valid, and Preston has ignored von Marten's remarks on the subject.

*M. tuberculatus* (Müller), the type of this genus, is perhaps the most widely distributed of all the non-marine Gastropods that occur in India, for it is found in most parts of the Oriental and Ethiopian regions and even in parts of the Palaearctic and Australasian Regions adjacent to them. With this species a large number of Oriental forms must be associated generically on account of the fact that they possess the characters noted in the key. The Sarasins were the first authors to lay stress on the peculiarities of the radulae and opercula of these forms, but they were apparently not acquainted with the peculiarities of the mantle. They did not regard the structures they examined as of generic importance and associated species I retain in *Melania* with those here assigned to *Melanoides* in their group "Neomelanien."

The description given in the key, with the figures published in the various works to which I have referred, should render the recognition of species of the genus easy, if the animal as well as the shell be examined. The processes of the mantle are arranged in a small series along a line running parallel to the margin. As a rule they increase in size from left to right. When the animal is fully expanded they are elongate and pointed and often resemble small parasitic leeches protruding from the mouth of the shell. In preserved specimens they are as a rule contracted and much less conspicuous.

#### Genus *Acrostoma*, Brot.

1854. *Melanoides*, H. and A. Adams (*nec* Olivier), *Gen. Recent Moll.*, I, p. 296.  
 1874. *Melanoides, Acrostoma*, Brot, *op. cit.*, p. 7.  
 1885. *Melanoides, Acrostoma*, Nevill, *op. cit.*, pp. 248, 270.  
 1897. *Brotia*, von Martens, *op. cit.*, p. 33.  
 1898. Palaecomelanien, P. and F. Sarasin, *op. cit.*, p. 30.  
 1915. *Melanoides, Acrostoma*, Preston, *op. cit.*, pp. 21, 30.

I cannot find any difference of generic importance between the soft parts, radula, operculum or shell of *Brotia*, von Martens (= *Melanoides*, auct.) and *Acrostoma*, Brot. Indeed, in the single species I call *Acrostoma variabile* (Benson) an almost complete

gradation can be observed. In the type-species of *Acrostoma* (*A. hügelii*) the structure is similar in every respect to that of *A. variabile* and the shells of certain individuals of the latter are by no means unlike those of the former.

I have been able to find no trace of digitiform processes on or near the edge of the mantle in either living or preserved specimens of *A. variabile* or in preserved specimens of *A. hügelii*. In both, however, there is a peculiar arrangement of the pigment on the inner surface of the mantle. It is distributed in alternate longitudinal dark and pale streaks, the pale pigment in the living animal being of a bright yellow colour but fading to white in spirit.

Some of the largest of the freshwater Mollusca are included in this genus. It is usually found in running water, but *A. variabile* is common in ponds in Calcutta. The headquarters of the genus are in Burma and the Sunda Is., but the type-species has an apparently discontinuous range in Assam and South India, and *A. variabile*, though mainly Assamese and Burmese, extends for some distance up the Ganges.

I am not yet quite sure as to the generic position of the Burmese species assigned by Nevill and Preston to *Pachychilus*, Lea. They are probably dwarf forms of *Acrostoma* and do not seem to be closely related to the Central American species for which the genus *Pachychilus* was originally used.

#### Genus *Melania*, Lamarck.

- (1798. *Tiara*, Mus. Bolten.)  
 1799. *Melania*, Lamarck, *Prodromus*.  
 1854. *Tiara*, H. and A. Adams, *op. cit.*, p. 294.  
 1874. *Tiara*, Brot., *op. cit.*, p. 7.  
 1884. *Tiara*, Nevill, *op. cit.*, p. 278.  
 1897. *Melania*, s.s., von Martens, *op. cit.*, p. 66.  
 1898. Neomelaniens (in part), P. and F. Sarasin, *op. cit.*, p. 38.  
 1915. *Tiara*, s.s., Preston, *op. cit.*, p. 10.

The distribution of this genus is mainly insular and largely Pacific. Within the limits of the Indian Empire it is found only in the Nicobars and (doubtfully) in one of the Anadaman Islands. I know nothing of the animal, but the shell and operculum are very distinct from those of *Melanoides* or *Acrostoma*. Troschel<sup>1</sup> and P. and F. Sarasin (*op. cit.*) describe and figure the radular teeth of species of *Melania* as very like those of *Melanoides*, with which the latter authors associate these species in their group of Neomelaniens. The type-species is *Helix amarula*, Linn. Those interested in the revival of forgotten generic names may refer to Dall's<sup>2</sup> account of the *Museum Boltenianum*, reviewed in the *Ann. Mag. Nat. Hist.* (8) XVI, p. 232 (1915) by "B.B.W."

<sup>1</sup> Troschel, *Geb. der Schnecken. z. Begründung ein. nat. Classification*, I, pl. viii (Berlin: 1856-1863).

<sup>2</sup> Dall, *Misc. Publ. Smithsonian Inst.* No. 2360 (1915). Not available to me.

## NO. II—THE INDIAN GENERA OF VIVIPARIDAE.

By N. ANNANDALE, D.Sc., F.A.S.B.

Until recently all the Indian species of this family have been placed in the genus *Vivipara*, Montfort; but in 1918<sup>1</sup> I separated certain forms from Upper Burma and the Shan States under the name *Taia*, while still more recently<sup>2</sup> I have described three fossil or subfossil subgenera of this genus from the same country. In the present paper I give reasons for regarding one of these (*Temnotaia*) as generically distinct and put on record the occurrence of a living species in Upper Burma. An examination of the animal of Benson's *Paludina lecythis* proves that it and its allies must also be separated from *Vivipara*. I propose for them the new generic name *Lecythroconcha*.

*Key to the Indian Genera of Viviparidae.*

1. Columellar callus of shell broad and plate-like.
  - A. Sculpture usually consisting of prominent nodular, squamose or spinulose spiral ridges and of coarse longitudinal striae. Operculum with an internal scar of oval or ovate outline and without a rounded boss in the centre of the scar. Mantle of adult with a rather feeble sphincter muscle and a smooth or lobular margin ... .. *Taia*.
  - B. Shell smooth or with incised spiral lines. Operculum as in *Taia*. Soft parts and radula unknown ... .. *Temnotaia*.
2. Columellar callus not plate-like. Sculpture minute or including smooth spiral ridges.
  - A. Shell of small or moderate size, conical or conoidal. Operculum as in *Taia*. Mantle with the sphincter muscle moderately developed and prominent; its margin bearing in the young well-developed digitiform processes, which persist in the adult of some species ... .. *Vivipara*.
  - B. Shell large and globose. Operculum with a well-defined funnel-shaped pit on the external surface corresponding to a smooth, prominent rounded boss in the centre of the internal muscular scar, which is ring-shaped and poorly developed. Mantle sphincter very strong and prominent; mantle itself greatly thickened and highly muscular, bearing three digitiform processes in the young, smooth in the adult ... .. *Lecythroconcha*.

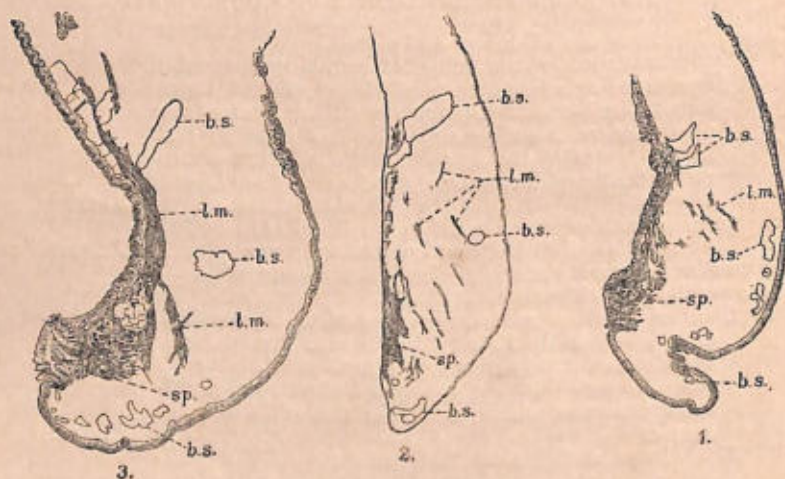
An examination of the mantle in these genera shows that it provides good generic characters. In all it is highly vascular, but in *Taia* and *Vivipara* it is thin and has a comparatively feeble musculature, while in *Lecythroconcha* it is much thickened and has both longitudinal and transverse muscles very strongly developed. In all three genera the transverse muscles are congregated on the outer surface a short distance above the margin. It is probable that all the Oriental species of the family have digitiform pro-

<sup>1</sup> *Rec. Ind. Mus.*, XIV, p. 123 (1918).<sup>2</sup> *Rec. Geol. Surv. Ind.*, L, p. 231 (1919).

cesses<sup>1</sup> on the extreme edge of the mantle in the young. In those species in which the shell of the adult possesses smooth spiral ridges of a dark colour (notably *Vivipara oxytropis*) the processes persist in the adult, but in those that have smooth unicolourous shells they become small and inconspicuous or disappear altogether. In *Taia*, in which the spiral ridges are never quite smooth, but as a rule nodular, squamose, or even spinulose, there are no such processes in the adult, and they are also absent in the somewhat similar Chinese genus *Margarya*; but apparently temporary lobes of the mantle-edge can be thrust into the small concavity at the base of each nodule, scale or spine. I hope to elaborate this point on another occasion.

#### Genus *Vivipara*, Montfort.

This genus is so well known that it is unnecessary to give a full description. The Indian species fall naturally into four



Vertical sections through the mantle-edge of Indian Viviparidae.  
1. *Vivipara oxytropis*. 2. *Taia intha*. 3. *Lecythoconcha lecythis*.  
b.s. blood-space; l.m. longitudinal muscle; sp. transverse sphincter.

groups, which may be named after the type-species of each as follows:—

**VIVIPARAE BENGALENSES.** The shell is normally of moderate size, occasionally large, as a rule thin but thickened in certain phases. The whorls of the spire are not greatly swollen and the suture is not deeply impressed. The outline is ovate, but varies considerably. Spiral bands darker than the rest of the shell are always present, though sometimes obsolescent. They are never very numerous and vary considerably in breadth. In some forms these bands become thickened to form ridges and there is often a

<sup>1</sup> I can find no reference to these processes in the European forms. Er-langer (*Morph. Jahrb.*, XVII, pl. xxii: 1891), and other authors figure the edge of the mantle in the fully formed embryo as smooth.

tendency for the outline of the body to become biangulate owing to two of them assuming the form of carinae. Corresponding to these bands there are on the edge of the mantle an equal number of small digitiform processes. The operculum is thin, sharp round the periphery and with the internal muscular scar moderately developed. The radular teeth are normal. Their denticulations are by no means large and the central lobular process of the free edge of the central tooth is broad and quadrate or triangular.

I believe that all described Indian forms<sup>1</sup> of this group can be comprised in the single species *Vivipara bengalensis* (Lamarck), of which several distinct races and phases can be distinguished. Major Sewell and I hope to describe it in detail shortly. It is found in all parts of the plains of the Indian Empire at which there is perennial still water.

**VIVIPARAE OXYTROPIDES.** The shell is large or small, thin, acuminate and more or less distinctly biconical. The whorls of the spire are not at all swollen and the suture is less impressed than in *V. bengalensis*. Dark spiral bands are present. They are always more or less thickened, at any rate in the young, and in the typical species form prominent ridges in the adult. The peripheral band forms a prominent keel, separating the shell into two regions. The region below it is obliquely flattened on the ventral surface. The operculum and radula resemble those of *V. bengalensis*, but in the typical species the marginal processes of the mantle are much larger in the adult.

Only one species of this group has as yet received a name, viz. *V. oxytropis* (Benson), but another, smaller and less specialized species, awaits description. The former is apparently endemic in the Manipur valley, while the latter occurs in the plains of the eastern part of Assam.

**VIVIPARAE DISSIMILES.** The shell is always small, rather high and narrow, never very sharply acuminate, moderately thin or thick, with the whorls of the spire swollen and the suture deeply impressed. There are no dark spiral bands or prominent spiral ridges, but a minute spiral sculpture of punctured lines can often be detected. There is often a broad but rather obscure pale transverse bar on the body-whorl. The operculum is thicker than in the other three sections and the muscular scar better developed. Round the periphery of the operculum there is often a thickened spongy ridge. The edge of the mantle is smooth in the adult. The central lobe of the central tooth of the radula is rounded.

Most of the forms that belong to this group are classified by Nevill<sup>2</sup> as varieties of *V. dissimilis* (Müller), but I think that he has included several species. Pilsbry<sup>3</sup> regards the characters of the operculum as subgeneric and has given the subgeneric name

<sup>1</sup> *V. nagaensis*, Preston may be distinct, but I have not seen the species. I have another (undescribed) from Manipur.

<sup>2</sup> Nevill, *Hand List Moll. Ind. Mus.*, II, pp. 27-30 (1885).

<sup>3</sup> Pilsbry, *Proc. Ac. Nat. Sci. Philadelphia*, LIII, p. 188 (1901).

*Idiopoma* to a Burmese species, *V. henzadensis*. These characters, however, are adaptive and are not found either in all species of the group, or even in all individuals of the species in which they are present. They are connected with the habit of aestivation in drying mud, the Viviparæ dissimiles being found mainly in bodies of water liable to desiccation. The species are widely distributed in the plains of Peninsular and North-Western India and in the drier regions of Burma.

**VIVIPARÆ SINDICAE.** Shells of this group are distinguished by their very pale colour, by the absence of distinct spiral bands and by the thinness of the operculum, in which the muscular scar is very feebly developed. Nothing is known of the anatomy.

The only Indian species is *V. sindica* (Nevill) from Sind, but another occurs in Seistan. Kobelt has caused great confusion in the *Conch. Cab.* by basing his description<sup>1</sup> and figures of this form on the type-series of Nevill's *Paludina dissimilis sindica*, which I regard as a distinct species, and conversely describing and figuring specimens from Seistan as *sindica*. His *hilmendensis* is, therefore, an absolute synonym of *sindica* (Nevill). I propose for the Seistan species the name *V. helmandica*.

#### Genus *Lecythoconcha*, nov.

*The shell* is of large, sometimes of relatively gigantic size, but never very thick; it is smooth or with obscure and never very prominent sculpture and always translucent when fresh; it is globose in form, with broad swollen whorls, and often bears a striking superficial resemblance to that of *Pachylabra* (Ampullariidae). The colour is uniform or nearly so, as a rule rather bright olive green, often with irregular blackish longitudinal lines. The aperture is large and patent, subcircular or broadly ovate. The columellar fold is not strongly developed, the umbilicus narrowly perforate and the outer lip thin.

*The operculum* is large, thin, horny, stiff and brittle. Externally it is marked with fine but prominent concentric ridges and bears a deep, funnel-shaped pit in a subcentral position. On the internal surface this pit is represented by a smooth, prominent rounded boss, which is surrounded by a smooth or minutely granular area representing the muscular scar.

*The animal* differs from that of *Vivipara* in the greatly thickened and very muscular free edge of the mantle, the sphincter muscle running along it is very prominent and unusually well developed. There are three marginal processes in the young, but none in the adult.

*The radula* is identical with that of *Vivipara*.

*Type-species.* *Paludina lecythis*, Benson.

*Geographical Range.* The range of the genus probably extends from Manipur (and possibly Sylhet) in the west through

<sup>1</sup> This description was originally published in *Nachr. Malak. Ges.* LX, p. 161 (1908).

Upper Burma and across China to the Philippines, Formosa and Japan, but I am not sure as to the generic identity of some of the Far Eastern species.<sup>1</sup> The only one of those of which I have been able to examine the soft parts is *Vivipara chinensis* (Gray) from Yunnan. This species, from which I regard *L. lecythis* as specifically distinct, agrees in the structure of the mantle and operculum with the type-species of the new genus.

All the Asiatic genera of the Viviparidae are closely similar in anatomy, but the structure of the mantle-edge and its sphincter is characteristic.

#### Genus *Taia*, Annandale.

1918. *Taia*, Annandale, *Rec. Ind. Mus.*, XIV, pp. 123, 160.

1919. *Taia*, *id.*, *Rec. Geol. Surv. Ind.*, L, p. 231.

I have already discussed this genus in the papers cited and here need only give my reasons for regarding the subfossil *Temnotaia incisa* as generically distinct. In the key on page 111 I have pointed out the distinctive characters of the mantle.

#### *Temnotaia*, Annandale (1919).

1919. *Temnotaia* (subgenus of *Taia*), Annandale, *Rec. Geol. Surv. Ind.*, L, p. 231.

The discovery of a recent specimen<sup>2</sup> of *Temnotaia* in the old collection of the Indian Museum renders it advisable to enlarge the original description slightly and to separate the species generically from *Taia*.

The shells of the genus thus proposed are rather narrowly ovate, externally smooth and without prominent spiral sculpture but bearing rather coarse longitudinal striae and either microscopic spiral striae or well-defined incised lines. There are  $5\frac{1}{2}$  to  $6\frac{1}{2}$  whorls, and the spire is exerted and acuminate. The mouth of the shell is ovate, with the outer lip thin and not at all expanded and the columellar margin flattened, plate-like and polished, resembling that of *Taia*. In the only fresh specimen examined there are no dark spiral bands and the external surface is highly polished. The operculum is thin and resembles that of *Taia*. Nothing is known of the radula or soft parts.

Only two species have as yet been discovered, namely *T. incisa* (Annandale), found in an apparently subfossil condition in the Chindwin watershed, and *T. bhamoensis* (Nevill) from north-eastern Burma. The genus may thus be regarded as characteristic of the fauna of Upper Burma. It is apparently related to the Indo-Chinese *Chlorostracia*, Mabille, but the shell is much less globose and the mouth narrower.

<sup>1</sup> For one, the common species in Lake Biwa, Japan, I am proposing a new genus in a paper to be published in the *Journal of the Asiatic Society of Bengal*.

<sup>2</sup> This specimen is labelled as the type-specimen of Nevill's *Paludina dissimilis*, subvar. *bhamoensis*, but the resemblance to the Viviparae dissimiles is quite superficial and the structure of the mouth entirely different.

XVI. DESCRIPTIONS OF SOME ORIENTAL  
DIPLOPODA POLYDESMOIDEA OF THE  
SUBFAMILY PYRGODESMINAE.

By F. SILVESTRI.

The subfamily Pyrgodesminae of the Diplopoda Polydesmoidea comprise small species which are peculiar on account of the processes, tubercles or granules on the dorsum: because the head is concealed, or almost concealed, dorsally by the collum and the cauda by the preceding segment; because the dorsal surface of the trunk is provided with setae or papillae that often become so encrusted with dirt as to mask the form of the body and to make the apparent colour the same as that of the ground.

Some species are myrmecophilous or termitophilous.

The Oriental Region is certainly rich in genera and species of this group, but until to-day we have short descriptions of only two genera: *Pyrgodesmus* Poc. and *Lophodesmus* Poc. I should like, by kind permission of Dr. N. Annandale, to call the attention of collectors of Oriental Myriopods to this group and I give here descriptions and figures of *Pyrgodesmus* and five new genera.

Gen. *Pyrgodesmus* Poc.

(Figs. I-III).

Pocock, *J. Bombay Nat. Hist. Soc.* VII, 1892, p. 155, pl. ii, fig. 1-1b;  
Silvestri, *Ann. Mus. Genova* (2) XVI (XXXVI), 1896, p. 192.

Corpus capite, collo, segmento anali et segmentis aliis 19 compositum, lateribus subparallelis, postica aliquantum attenuatum nec in globum nec in spiram, sed tantum arcuatim aliquantum contractile.

Caput omnino obtectum antice spatio brevi, lateraliter spatium longiore a collo separatum, fronte ad verticem transverse parum elevata, media usque ad torulorum libellam etiam elevata, lateraliter praesertim a torulis ad marginem valde depressa, clypeo ante incisuram posticam lateralem incrassato elevato, antrorsum aliquantum angustato, margine antico medio tridentato, superficie setis brevioribus numerosis et seriebus duabus anticis setarum parum brevium aucta.

Antennae articulo quinto quam ceteri longiore et crassiore setis et sensillis vide fig. III, 2.

Mandibulae dente apicali, dente minimo proximali supero aucto, lamina 5-dentata et laminis pectinatis 6 bene evolutis instructae.

Hypostoma vide fig. III, 3.

Collum parte praemarginali brevi subhorizontali, margina antico ipso late rotundato et sat profunde 10-lobato, superficie supera convexa processibus duobus submedianis sat longis et robustis armata.

Trunci segmenta 1-18 dorso convexo processibus duobus submedianis sursum et parum extrorsum directis in apice divisis instructa; processus segmenti 17<sup>i</sup> quam praecedentes inter sese magis approximati et segmenti 18<sup>i</sup> quam 17<sup>i</sup> magis etiam approximati, basi connati. Carinae laterales sat magnae subhorizontales, deorsum parum vergentes, parum supra sternorum libellam orientes, margine antico ad basim lobato, margine laterali profunde trilo-

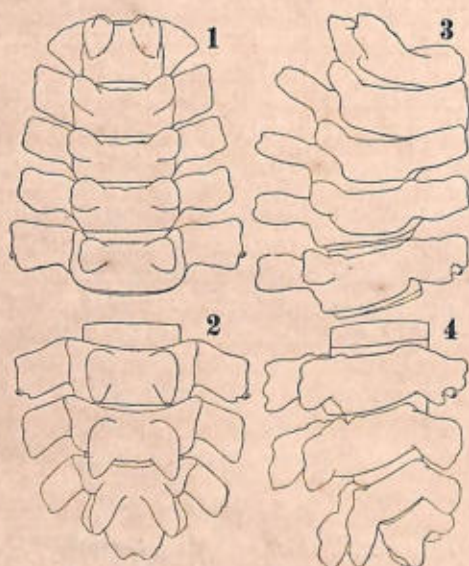


FIG. 1.—*Pyrgodesmus obscurus*, corpore humo induto: 1. corporis pars antica et 2. pars postica pronae; 3. corporis pars antica et 4. pars postica lateraliter inspectae.

bato, lobo secundo in segmentis secundo et segmentibus haud porigeris parum sinuato, lobo tertio laterali postico et in segmentis 2-3 omnino postico.

Segmentum 19<sup>um</sup> breve a segmento 18<sup>o</sup> obtectum, postice subtriangulare, lobatum, apice mediano infero brevioris setis consuetis 4 instructo.

Segmentorum superficies dorsualis areis sat numerosis, subrotundatis papillis brevibus nonnullis instructis, transverse subseriatis, praesertim postice signata, marginibus postico et antico papillis brevibus numerosis, processibus dorsualibus et carinarum marginibus papillis numerosis minus brevibus auctis.

Pori repugnatorii in segmentis 4,6,8,9,11,12,14 to 18 (=5,7,9,10,12,13,15-19 Auctorum) siti et in segmentis 4,6,8,9,11,12,14 et

15 a tuberculo brevi subcylindraco, in lobo laterali secundo carinarum sito, gesti, in segmentis 16-18 super carinarum superficiem sublateralem subposticam sese aperientes.

Pedes breves, sat robusti, articulo primo brevior seta infera sat longa, robusta (sed facile caduca), articulo secundo quam tertius aliquantum brevior et seta infera praeapicali robusta longa instructo, articulo quarto brevior, quinto quam quartus parum longior et parum angustior, trichobothrio apicali supero sat longo aucto, articulo sexto attenuato infra seta sat longa ante medium instructo, ungue terminali robusto.

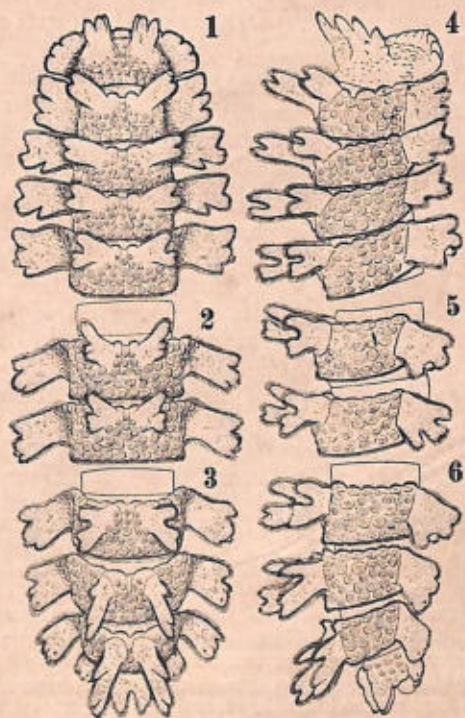


FIG. 11.—*Pyrgodesmus obscurus*, corpore humo denudato: 1. corporis pars antica; 2. segmenta octavum et nonum et 3. corporis pars postica prona; 4. corporis pars antica; 5. segmenta nonum et decimum; 6. corporis pars postica lateraliter inspecta.

Organum copulativum biarticulatum, articulo primo magno, lato et brevi, interne aliquantum excavatum unco consueto sat longo, articulo secundo hasta una simplici crassiuscula aliquantum arcuata constituto.

Typus: *Pyrgodesmus obscurus* Poc.

Observatio.—Genus hoc ad genera *Urodesmus* Por. et *Stilodesmus* O. F. Cook proximum est, sed ab ambobus carinis trilobatis, nec non maris organi copulativi articulo secundo hasta simplici constituto bene distinctum est.

**Pyrgodesmus obscurus** Poc.

Pocock, *Op. cit.* VII, p. 155.

Corpus humo indutum nigro-castaneum, humo denudatum nigro-castaneum, clypeo, maxima pro parte, antennis, tuberculis porigeris, praezonis, pedibus, valvulis analibus et processu mediano caudali stramineis.

Antennae articulo quinto c.  $\frac{2}{5}$  longiore quam latiore (55 : 32).

Collum antice late rotundatum sat profunde lobatum, caput antice mm. 0,195 superans, processibus dorsualibus submedianis,

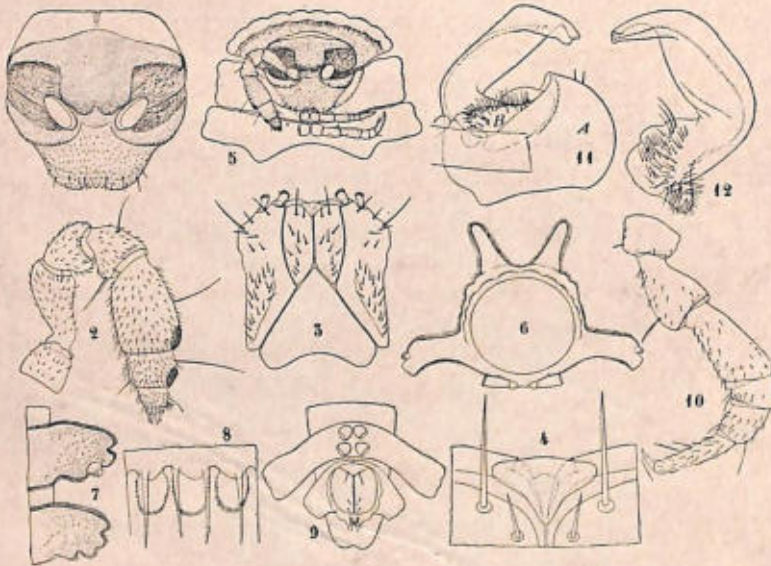


FIG. III.—*Pyrgodesmus obscurus*, 1. epicranium pronum; 2. antenna; 3. hypostoma ab infra maxillari; 4. ejusdem pars mediana antica magis ampliata; 5. corporis pars antica supina; 6. segmentum nonum postice inspectum; 7. segmentorum 12<sup>i</sup> et 13<sup>i</sup> latera; 8. segmenti noni marginis dorsualis postici particula; 9. corporis pars postica supina; 10. segmenti noni pes; 11. organi copulativi pars altera alteraliter inspecta; A. articulus primus, B. articulus secundus; 12. ejusdem articulus secundus.

a colli margina postice mensis, long. 0,65, in apice tripartitis et antice tuberculatis.

Trunci segmenta bene convexa metazonarum superficie areis numerosis subrotundis vix elevatis papillis brevibus nonnullis instructa, processibus dorsualibus submedianis longis (in segmento nono long. 0,40) in segmentis 1-3 in apice bifidis, in segmentis ceteris in apice profundiore bifidis et parte postica parum profunde etiam bifida, papillis piliformibus brevibus instructis, processibus dorsualibus segmenti 17<sup>i</sup> quam ceteri parum longioribus, retrorsum aliquantum directis et basi approximatis, processibus segmenti 18<sup>i</sup> quam praecedentibus brevioribus basi connatis retrorsum directis vix

trituberculatis, basi segmentum 19<sup>um</sup> medium obtegentibus et mm. 0,20 superantibus. Carinae laterales sat magnae parum supra sternorum libellam orientibus extrorsum et parum deorsum vergentibus, segmenti primi lateraliter trilobatae, lobo antico majore, segmentorum ceterorum usque ad 17<sup>um</sup> profunde trilobatae lobo porigero mediano aliquantum crassiore; carinae segmenti 18<sup>i</sup> perparvae et subintegrae. Metazonarum margo dorsualis adiectus in laminis brevis subovalibus serratis divisus et serie setarum robustarum, quam laminae longiorum ante laminarum basim auctus.

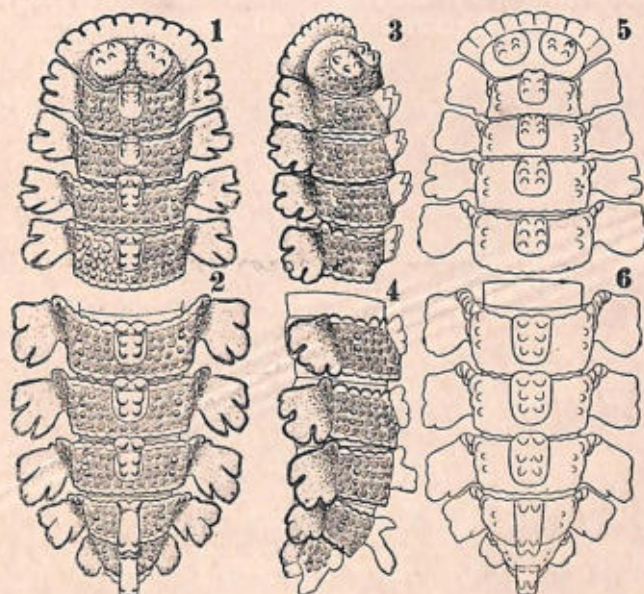


FIG. IV.—*Propyrgodesmus lobulatus*, 1. corporis humo denudati pars antica et 2. pars postica pronae; 3-4. eadem lateraliter inspectae; 5. corporis humo induti pars antica et 6. pars postica pronae.

Pori repugnatorii usque ad segmentum 15<sup>um</sup> a tuberculo brevi subcylindraco gesti, in segmentis 16-18 super carinarum partis lateralis subposticae superficiem sese aperientes.

Pedes vide fig. III, 10.

Organum copulativum articulo secundo simplici, crassiusculo arcuato ut fig. III, 11 et 12 demonstrat.

Long. corp. mm. 11,5, lat. segmenti noni cum carinis 2,4, sine carinis 1; long. antennarum 1,20, pedum segmenti noni 1,22.

*Habitat.*—Ceylan: exemplum typicum a Pocock descriptum ex *Punduloya*, exempla duo masculina a me inspecta ex Peradenyia mihi benignissime cl. E. Green dedit.

Gen. *Propyrgodesmus* nov.

(Figs. IV, V).

♀ Corpus, capite, collo, segmento anali et segmentis aliis 19 compositum, antice et postice parum angustatum, nec in globum nec in spiram sed tantum arcuatim parum contractile.

Caput omnino obtectum, antice spatio sat brevi, lateraliter spatio parum longiore a collo superatum, fronte ad verticem transverse parum elevata, per partem medianam usque ad torulorum libellam etiam elevata tuberculis parvis, lateraliter praesertim a torulis ad marginem lateralem depressa, media ad torulorum libellam tuberculis nonnullis parvis, clypeo ante inci-

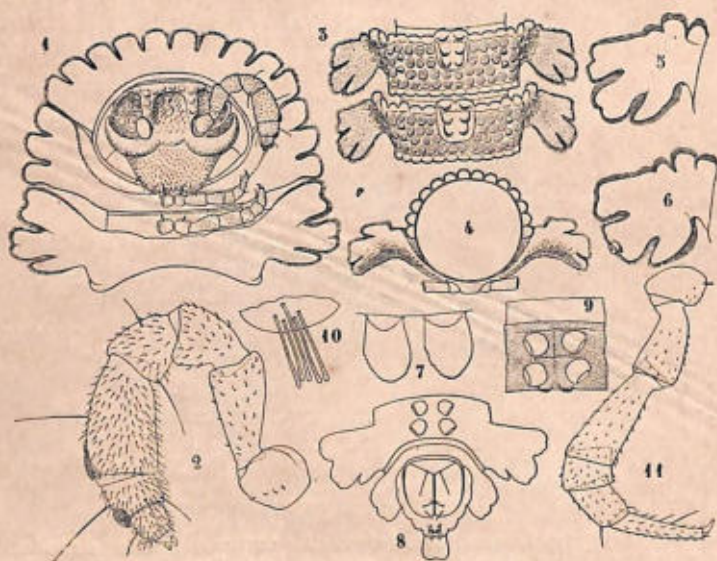


FIG. V.—*Propyrgodesmus lobulatus*, 1. corporis pars antica supina; 2. antenna; 3. segmenta decimum et undecimum prona; 4. segmentum nonum postice inspectum; 5. carina lateralis segmenti decimi; 6. carina lateralis segmenti undecimi; 7. segmenti noni marginis dorsualis postici particula; 8. corporis pars postica supina; 9. segmenti noni pars mediana ventralis; 10. segmenti noni lobi dorsualis postici particula; 11. segmenti noni pes.

suram posticam lateralem valde incrassato elevato, lateribus anticis convergentibus, margine antico profunde tridentato, superficie supera setarum parum brevium seriebus duabus anticis et setis aliis brevioribus posticis instructa.

Antennae articulo quinto quam ceteri longiore et crassiore, setis et sensillis vide fig. V, 2.

Collum parte praemarginali sat brevi subhorizontali, margine antico ipso late rotundato, sat profunde 10-lobato, cetera superficie supera convexa areis duabus submedianis parum elevatis, tuberculis quatuor parvis auctis, instructa.

Trunci segmenta dorso sat convexo, 1-15 area antica mediana parum elevata, supra tuberculis quatuor longitudinaliter biseriatis et in segmentis 1-2 tuberculis dictis inter sese confusis, superficie sublaterali tuberculis duobus parvis, superficie cetera areis parvis subrotundis papillis brevioribus instructis et per metazonarum marginem anticum et posticum lobulata, lobulis, medianis ante aream tubercularem setis, quam ceteri majoribus et antrorsum magis quam ceteri aliquantum productis. Area tubercularis in segmento 16<sup>o</sup> aliquantum longiore, in segmento 17<sup>o</sup> quam segmenti 16<sup>i</sup> longiore et retrorsum aliquantum producta, in segmento 18<sup>o</sup>

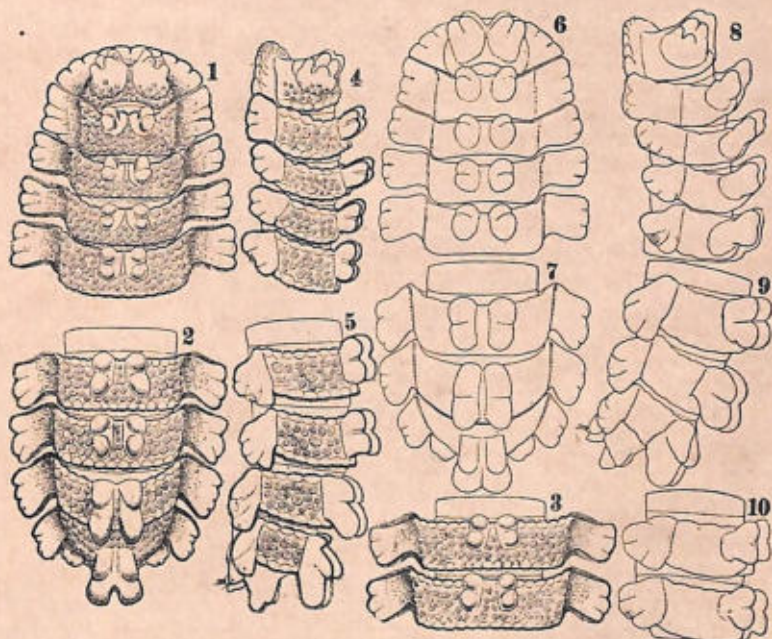


FIG. VI.—*Catapyrgodesmus ceylonicus*, 1. corporis humo denudati pars antica et 2. pars postica pronae; 3. segmenta octavum et nonum prona; 4. corporis humo denudati pars antica et 5. pars postica lateraliter inspectae; 6. corporis humo induti pars antica et 7. pars postica pronae; 8-9. eadem lateraliter inspectae; 10. segmenta decimum et undecimum humo induta lateraliter inspecta.

retrorsum producta et segmenti 19<sup>i</sup> partem medianam obtegente et aliquantum superante. Segmentum 19<sup>um</sup> postice lobulatum, cauda ipsa mediana brevior setis consuetis.

Carinae laterales magnae extrorsum et aliquantum deorsum directae basi angustata, margine laterali profundiore tripartito, lobis primo et secundo majoribus et externe paullum sinuatis; carinae segmenti 17<sup>i</sup> quam ceterae parum minores, segmenti 18<sup>i</sup> perparvae, subintegrae.

Metazonarum superficies dorsualis praeter lobos marginales et tuberculos etiam areis parvis subrotundatis plus minusve distinctis et papillis brevibus nonnullis instructis signata.

Tuberculorum, loborum marginalium et carinarum margines papillis piliformibus vix clavatis instructi.

Pori repugnatorii in segmentis 4, 8, 11, 14, 16-18 (=5, 9, 12, 15, 17-19 Auctorum) siti et in segmentis 4, 8, 11, et 14 a tuberculo brevissimo subcylindraceo in carinarum parte laterali mediana lobi secundi sito gesti et in segmentis 16-18 super superficiem sublateralem carinarum lobi secundi sese aperientes.

Sterna inter pedum basim angustiora.

Pedes breves, sat robusti, articulo primo breviora seta infera sat brevi, robusta (sed facile caduca), articulo secundo quam tertius aliquantum breviora, articulo quarto breviora, articulo quinto quam quartus parum longiora et parum angustiora, trichobotrio

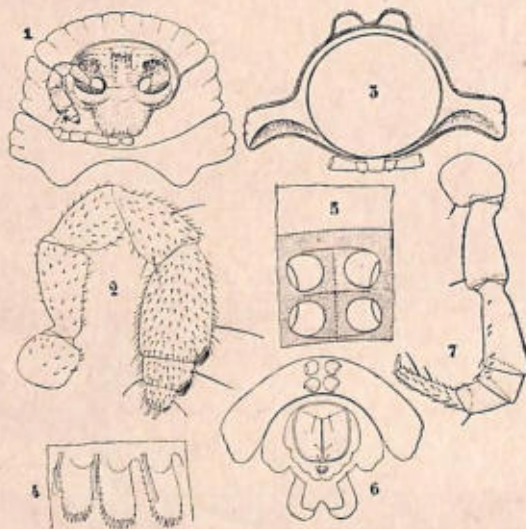


FIG. VII.—*Catapyrgodesmus ceylonicus*, 1. corporis pars antica supina; 2. antenna; 3. segmentum nonum postice inspectum; 4. segmenti noni marginis dorsualis postici particula; 5. segmenti noni pars ventralis mediana; 6. corporis pars postica supina; 7. segmenti noni pes.

apicali supero sat brevi instructo, articulo sexto attenuato infra seta sat longa ante medium instructo, ungue terminali robusto.

♂ Ignotus.

Typus: *Propyrgodesmus lobulatus* sp. n.

*Observatio.*—Genus hoc ad gen. *Pyrgodesmus* Poc. proximum est, sed metazonarum armatura et pororum formula praesertim distinctissimum est, a gen. *Catapyrgodesmus* mihi etiam metazonarum marginis antici et postici lobulis et segmento sexto poris repugnatoriis destitutum distinctum est.

### *Propyrgodesmus lobulatus* sp. n.

♀ Corpus humo indutum nigro-castaneum, humo denudatum fulvo-castaneum, clypeo, maxima pro parte, antennis, tuberculis

porigeris, praezonis, pedibus, apice caudali et segmento anali stramineis.

Antennae articulo quinto parum minus quam duplo longiore quam latiore (62 : 33).

Metazonarum limbus adiectus in laminis aliquantum longioribus quam latioribus, postice rotundatis et per marginem ipsum rotundatum minute serratis divisus.

Characteres ceteri vide generis descriptionem et figuras.

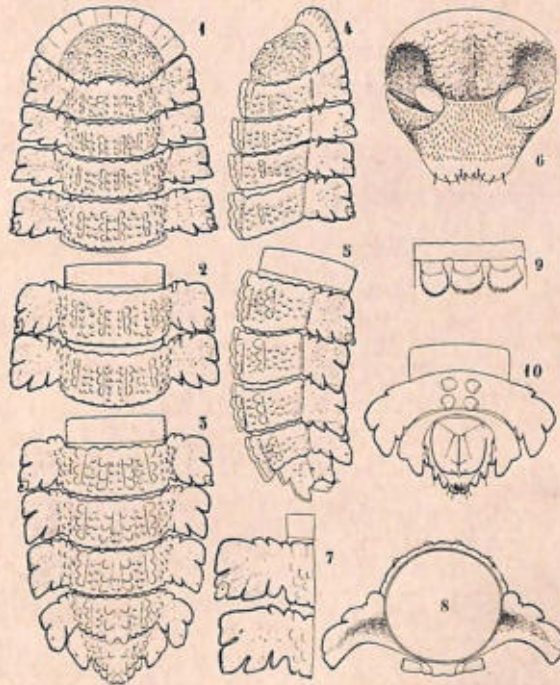


FIG. VIII.—*Lobiferodesmus papuasicus*. 1. corporis pars antica, 2. segmenta octavum et nonum et 3. corporis pars postica prona; 4. corporis pars antica et 5. pars postica lateraliter inspectae; 6. epicranium pronum; 7. segmenti octavi et noni latera; 8. segmentum nonum postice inspectum; 9. segmenti noni marginis dorsualis postici particula; 10. corporis pars postica supina.

Long. corp. mm. 17,5, lat. segmenti noni cum carinis 3, sine carinis 1,3; long. antennarum 1,50, pedum segmenti noni 1,75.

*Habitat.*—Cochin State: Forest Tramway, mile 10 to 14, alt. 0-300 ft. (F. H. Gravely legit).

#### Gen. *Catapyrgodesmus* nov.

(Figs. VI, VII).

♀ Corpus capite, collo, segmento anali et segmentis aliis 19 compositum, lateribus subparallelis antice vix, postice parum angustatum, nec in globum nec in spiram sed tantum arcuatim aliquantum contractile.

Caput omnino obtectum antice spatio brevi, lateraliter spatio parum longiore a collo superatum, fronte ad verticem lateraliter serie transversali tuberculorum parvorum, media usque ad torulorum libellam tuberculis parvis per partem submedianam aliquantum majoribus instructa, lateraliter a torulis ad marginem lateralem valde depressa, clypeo ante incisuram posticam lateralem incrassato elevato, lateribus antrorsum aliquantum convergentibus, margine antico medio tridentato, superficie supra setis brevibus sat numerosis et seriebus duabus anticis setarum parum brevium instructa.

Antennae articulo quinto quam ceteri longiore et crassiore, setis et sensillis vide fig. VII, 2.

Collum parte praemarginali antica sat brevi subhorizontali

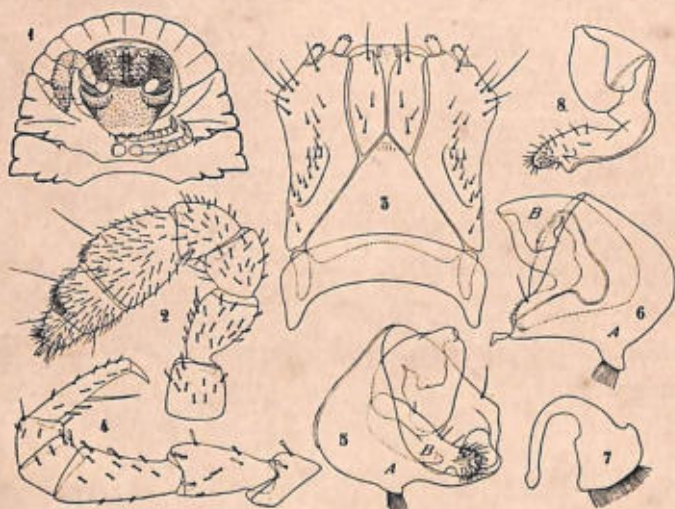


FIG. IX.—*Lobiferodesmus papuasicus*, 1. corporis pars antica supina; 2. antenna; 3. hypostoma; 4. segmenti noni pes; 5. organi copulativi pars altera postice inspecta et 6. antice inspecta; A. articulus primus, B. articulus secundus; 7. organi copulativi uncus; 8. organi copulativi articulus secundus.

margine ipso late rotundato, paullum profunde 10-lobato, cetera superficie supra convexa, areis duabus submedianis latis, elevatis in apice 4-tuberculatis aucta.

Trunci segmenta dorso bene convexo, 1-15 area mediana antica parum elevata 4-tuberculata, tuberculis longitudinaliter biseriatis crassis, superficie cetera areis parvis subrotundis numerosis, transverse subseriatis praesertim per marginem anticum et posticum. Area tubercularis segmenti 16<sup>i</sup> quam segmentorum praecedentium tuberculis majoribus et posticis retrorsum vergentibus et segmenti marginem posticum superantibus; area tubercularis segmenti 17<sup>i</sup> quam eadem 16<sup>i</sup> aliquantum majore et supra inspecta segmenti 18<sup>i</sup> et 19<sup>i</sup> partem medianam obtegens; area tubercularis segmenti 18<sup>i</sup> segmentum 19<sup>um</sup> parum superans. Carinae laterales magnae, extrorsum et paullum deorsum vergentes

basi quam latus externum parum angustiore, marginibus antico et postico integris, latere externo parum profunde trilobato; carinae segmenti 17<sup>i</sup> quam ceterae aliquantum minores, segmenti 18<sup>i</sup> perparvae, subintegrae.

Metazonarum superficies dorsualis per marginem anticum et posticum, per tuberculorum et carinarum margines papillis piliformibus subclavatis brevibus numerosis instructis et supra areas subrotundas etiam papillis nonnullis brevioribus instructa.

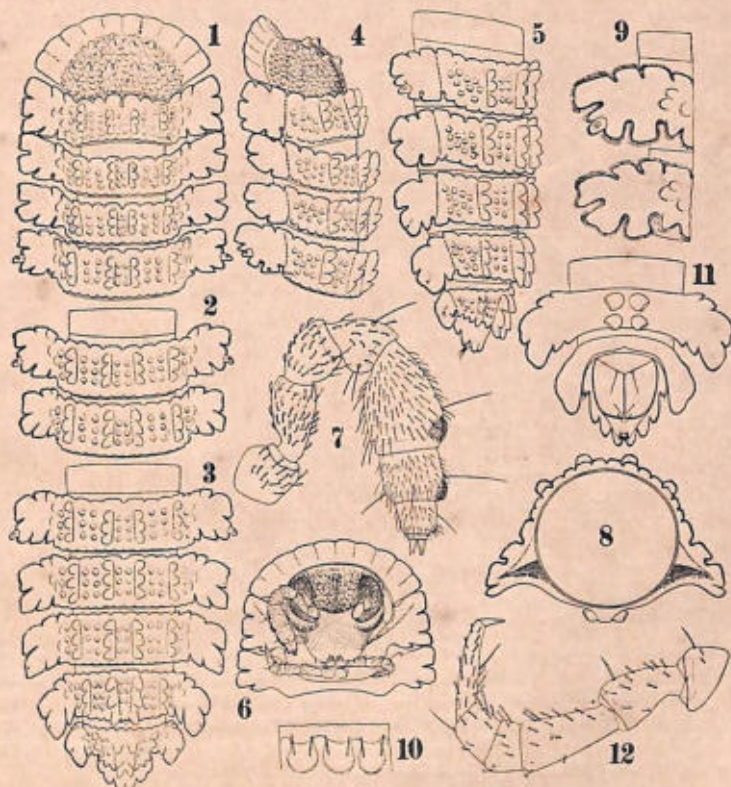


FIG. X.—*Lobiferodesmus superans*. 1. corporis pars antica; 2. segmenta octavum et nonum et 3. corporis pars postica prona; 4. corporis pars antica et 5. pars postica lateraliter inspecta; 6. corporis pars antica supina; 7. antenna; 8. segmentum nonum postice inspectum; 9. segmenti octavi et noni latera; 10. segmenti noni marginis dorsualis postici particula; 11. corporis pars postica supina; 12. segmenti noni pes.

Pori repugnatori in segmentis 4, 6, 8, 11, 14, 16-18 (=5, 7, 9, 12, 15, 17-19 Auctorum) siti et in segmentis 4, 6, 8, 11, 14 a tuberculo brevissimo subcylindraco in carinarum parte laterali postica lobi secundi sito gesti et in segmentis 16-18 super carinarum superficiem lateralem posticam sese aperientes.

Sterna inter pedum basim angustiora.

Pedes breves, sat robusti, articulo primo breviora seta infera sat brevi robusta (sed facile caduca), articulo secundo quam

tertius parum brevior et seta infera apicali etiam sat brevi, robusta instructo, articulo quarto brevior et parum angustior, trichobotrio apicali supero brevi instructo, articulo sexto attenuato, infra seta sat longa subdistali instructo, ungue terminali robusto.

♂ Ignotus.

Typus: *Catapyrgodesmus ceylonicus* sp. n.

Observatio.—Genus hoc a gen. *Pyrgodesmus* Poc. area tuberculari parva mediana in plerisque segmentisistente et pororum formula bene distinctum est.

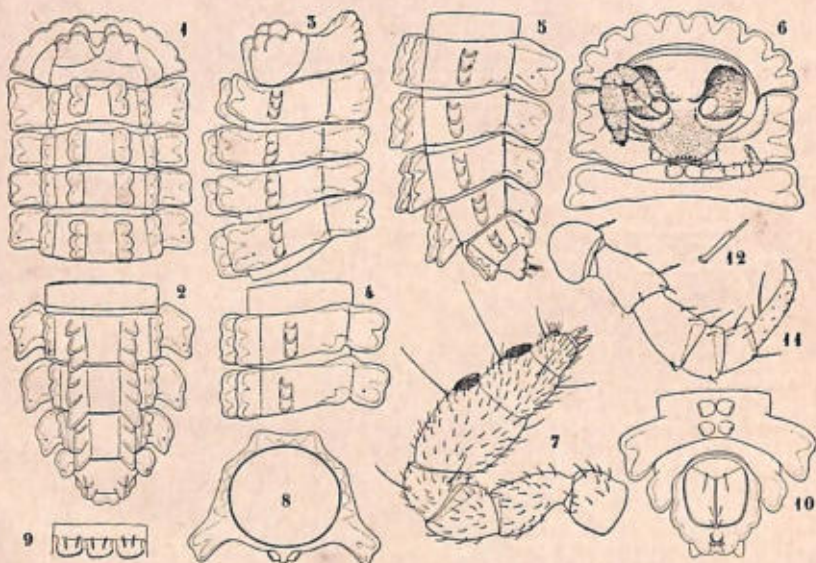


FIG. XI.—*Eustaledesmus parvus*, 1. corporis pars antica et 2. pars postica prona; 3. corporis pars antica; 4. segmenta decimum et undecimum et 5. corporis pars postica lateraliter inspecta; 6. corporis pars antica supina; 7. antenna; 8. segmentum nonum postice inspectum; 9. segmenti noni marginis dorsualis postici particula; 10. corporis pars postica supina; 11. segmenti noni pes; 12. ejusdem pedis articuli primi seta infera.

### *Catapyrgodesmus ceylonicus* sp. n.

Corpus humo indutum nigro-castaneum, humo denudatum fulvo-castaneum, clypeo, maxima pro parte, antennis, tuberculis porigeris, praezonis, pedibus, apice caudali et segmento anali stramineis.

Antennae articulo quinto parum minus quam duplo longiore quam latiore (65 : 37).

Collum antice paullum profunde lobatum, areis tubercularibus dorsualibus submedianis a colli margine postico mensis long. mm. 0,73.

Trunci segmenti 17<sup>i</sup> area tubercularis ab ejusdem segmenti margine antico mensa long. mm. 1,15.

Metazonarum limbus adiectus in laminis longioribus quam latoribus subrectangularibus per marginem posticum et externum serratis divisus et papilla piliformi clavata supra laminam quamquam instructus.

Characteres ceteri vide generis descriptionem et figuras VI-VII.

Long. corp. mm. 16, lat. segmenti noni cum carinis 2,8, sine carinis 1,56; long. antennarum 1,42, pedum segmenti noni 1,70.

*Habitat.*—Ceylon: Namunakuli. Exemplum typicum cl. E. Green legit et mihi dedit.

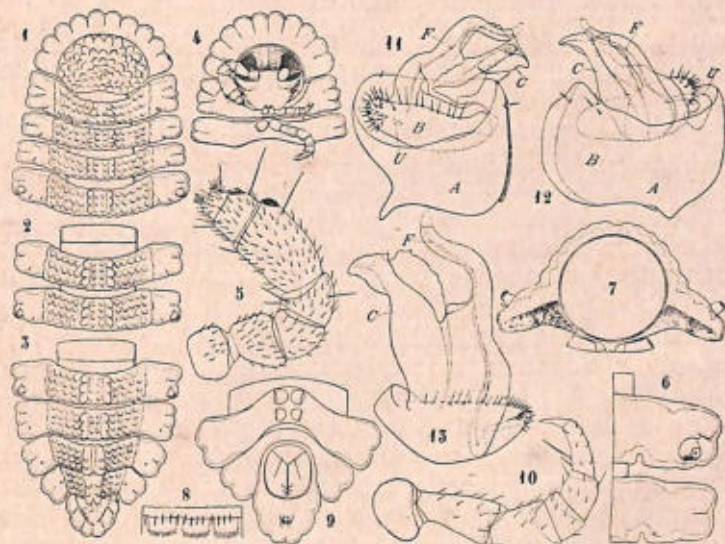


FIG. XII.—*Evurodesmus Bivoti*, 1. corporis pars antica; 2. segmenta septimum et octavum et 3. corporis pars postica prona; 4. corporis pars antica supina; 5. antenna; 6. segmentorum nonum et decimum latera; 7. segmentum nonum postice inspectum; 8. segmenti noni marginis dorsualis postici particula; 9. corporis pars postica supina; 10. segmenti noni pes; 11. organi copulativi pars altera postice et 12. antice inspecta. A. articulus primus, B. articulus secundus, C. hasta postica, F. pseudoflagellum canaliferum, U. uncus; 13. organi copulativi articulus secundus.

### Gen. *Lobiferodesmus* nov.

(Fgs. VIII-X).

♀ Corpus capite, collo, segmento anali et segmentis aliis 19 compositum, antice paullum postice parum angustatum, nec in globum nec in spiram, sed tantum arcuatim parum contractile.

Caput omnino obtectum antice spatio brevi, lateraliter spatio parum longiore a collo separatum, fronte ad verticem lateraliter serie transversa granulorum instructa, media usque ad torulorum libellam aliquantum granulosa, lateraliter a torulis ad marginem lateralem valde depressa, clypeo ante incisuram posticam lateralem

incrassato, margine antico medio tridentato, superficie supra serie transversali setarum submarginalium et setis duabus submedianis subanticis sat brevibus acutis, superficie cetera setis numerosis brevissimis clavatis instructa.

Mandibulae dente apicali dente minimo proximali supero aucto, lamina 5-dentata et laminis pectinatis 6 bene evolutis instructae.

Hypostoma vide fig. IX, 3; praesertim notandum est (saltem in genotypo) superficie interna submediana longitudinaliter aliquantum introrsum et deorsum producta.

Antennae articulo quinto quam ceteri longiore et crassiore setis et sensillis vide fig. IX, 2.

Collum parte praemarginali antica sat brevi, antrorsum et deorsum vergente margine ipso rotundato, parum profunde 10-lobato, cetera superficie supra granulis subaequalibus parvis obsessa et tuberculis plus minusve parvis 2+2 submedianis et 2+2 sublateralibus in serie longitudinali inter sese aliquantum remotis et dispositis instructa.

Trunci segmenta dorso bene convexo, 1-16 seriebus duabus longitudinalibus tuberculis tribus plus minusve evolutis et seriebus duabus sublateralibus tuberculis tribus quam submediani minoribus, metazonarum marginibus antico et postico paullum profunde lobulatis et superficie cetera areis vel granulis sat magnis vix convexis instructa. Tuberculi segmenti 17<sup>i</sup> et 18<sup>i</sup> quam idem praecedentes aliquantum majores et postici retrorsum aliquantum vergentes.

Carinae laterales sat magnae, parum supra sternorum libellam orientes, extrorsum et parum deorsum directae margine antico lobis parvis basalibus, margine externo profunde bilobato et lobo antico segmenti primi in lobis duobus a sulco sat profundo diviso, segmentorum ceterorum sinu minimo signato, margine postico profunde bilobato; carinae segmenti 17<sup>i</sup> quam praecedentes minores, segmenti 18<sup>i</sup> etiam quam 17<sup>i</sup> minores, perparvae.

Segmentum 19<sup>um</sup> supra manifestum, medium a tuberculis posticis segmenti 18<sup>i</sup> haud obtectum, margine postico subsemiovali 3+3—lobulato, processu caudali infero breviora a marginis lobis submedianis vix superato.

Metazonarum superficies dorsualis per tuberculos et granulos et praesertim per margines anticum et posticum papillis brevissimis clavatis instructa.

Pori repugnatorii in segmentis 4, 6, 8, 11, 14, 16-18 (=5, 7, 9, 12, 15, 17-19 Auctorum) siti et in segmentis 4, 6, 8, 11 et 14 a tuberculo longiusculo horizontali, apice oblique truncato, in carinarum parte laterali postica lobi secundi siti, aliquantum ante apicem supra gesti et in segmentis 16-18 super carinarum superficiem sublateralem subposticam sese aperientes.

Sterna inter pedum basim angustiora.

Pedes breves, sat robusti, articulo primo breviora seta infera quam ceterae plus minusve longiore, articulo secundo quam tertius parum breviora, seta apicali infera quam ceterae plus

minusve longiore, articulo quinto quam quartus paullum longiore et angustiore, trichobothrio supero instructo, articulo sexto elongato, seta longa infera submediana aucto, ungue terminali sat robusto.

Segmentum anale forma consueta.

♂ Organum copulativum biarticulatum, articulo primo magno interne excavato articulum secundum magna pro parte obtegente, unco consueto bene evoluto, articulo secundo brevi, simplici, aliquantum arcuato.

Typus: *Lobiferodesmus papuasicus* sp. n.

*Observatio*.—Genus hoc ad gen. *Catapyrgodesmus* Silv. proximum sed dorso seriebus quatuor (utrimque duabus) tuberculorum majorum, carinis antice, postice et lateraliter lobatis bene distinctum est.

#### *Lobiferodesmus papuasicus* sp. n.

Corpus fulvescens, clypeo, antennis, pedibus et segmento anali alutaceis.

Antennae articulo quinto parum minus quam  $1/3$  longiore quam latiore.

Collum tuberculis submedianis quam granuli superficiei ceterae parum majoribus et sublateralibus vix vel paullum majoribus instructum, margine antico bene rotundato, parum profunde lobato.

Trunci segmenta metazonarum tuberculis serierum longitudinalium in segmentis anticis parvis, a segmento octavo parum majoribus, in segmento 17<sup>o</sup> tuberculis posticis seriei submedianae quam praecedentes majoribus et eiusdem segmenti marginis postici libellam parum superantibus, in segmento 18<sup>o</sup> tuberculis posticis quam idem segmenti 17<sup>i</sup> paullum longioribus et supra inspectis segmenti 19<sup>i</sup> marginem posticum vix superantibus. Carinae laterales margine laterali profunde bilobato, lobo antico medio vix sinuato lobo postico in segmentis haud porigeris angulo postico subacuto.

Tuberculus porigerus segmentorum 4, 6, 8, 11 et 14 in angulo laterali postico carinarum situs.

Metazonarum limbus adiectus in laminis microscopicis parum longioribus quam latioribus postice serratis divisus.

Pedes setis subclavatis ut fig. IX, 4 demonstrat instructi.

♂ Organum copulativum vide fig. IX, 5-8.

Long. corp. mm. 9, lat. segmenti noni cum carinis 1,90, sine carinis 0,92; long. antennarum 0,84, pedum segmenti noni 0,90.

*Habitat*.—Nova Guinea; Sattelberg (L. Biro legit).

#### *Lobiferodesmus superans* sp. n.

♀ Corpus fulvescens, clypeo, antennis, pedibus et segmento anali alutaceis.

Antennae articulo quinto c.  $1/3$  longiore quam latiore.

Collum tuberculis submedianis quam granulis superficiei ceterae aliquantum majoribus, tuberculis sublateralibus quam

submediani parum minoribus, margine antico late rotundato parum profunde lobato.

Trunci segmenta metazonarum tuberculis serierum longitudinalibus sat magnis et in segmentis 17<sup>o</sup> et 18<sup>o</sup> quam praecedentes parum majoribus et posticis retrorsum parum vergentibus. Carinae laterales margine laterali profunde bilobato, lobo antico et lobo postico medio parum sinuatis.

Tuberculus porigerus segmentorum 4, 6, 8, 11 et 14 in parte laterali subpostica carinarum lobi postici situs est.

Metazonarum limbus adiectus in laminis microscopicis parum longioribus quam latioribus postice aliquantum rotundatis et serratis divisus.

Pedes setis vide fig. X, 12.

♂ Ignotus.

Long. corp. mm. 10, lat. segmenti noni cum carinis 1,96, sine carinis 1,18, long. antennarum 1,16, pedum segmenti noni 1,10.

*Habitat.*—Nova Guinea: Sattelberg (L. Biro legit).

*Observatio.*—Species haec a *L. papuasicus* Silv. tuberculis serierum submedianae et sublateralis parum majoribus, carinarum lobis marginis antici latioribus, marginis lateralis aliquantum diversis (cfr. fig. VIII, 7 et fig. X, 9), tuberculis porigeris posticis bene distincta est.

#### Gen. *Eustaledesmus* nov.

(Fig. XI).

♀ Corpus capite, collo, segmento anali et segmentis aliis 19 compositum, antice paullum, postice aliquantum angustatum, nec in globum nec in spiram sed tantum arcuatim paullum contractile.

Caput omnino obtectum parum elevata lateraliter brevissime, media usque ad torulorum libellam, externe inter torulos et marginem lateralem depressa; clypeo ante incisuram posticam lateralem parum incrassato et elevato, margine antico tridentato, superficie antice setis brevibus transverse biseriatis et cetera setis brevioribus instructa.

Antennae articulo quinto quam ceteri longiore et crassiore, setis et sensillis vide fig. XI, 7.

Collum parte praemarginali sat brevi subhorizontali, margine antico late rotundato, profunde 10-lobato, superficie cetera supra areis duabus latis, 4-tuberculatis, sursum et antrorsum vergentibus instructa.

Trunci segmenta dorso multo convexo, 1-3 processibus submedianis duobus brevibus bituberculatis et tuberculis tribus minoribus sublateralibus, 4-14 processibus submedianis duobus brevibus trituberculatis et tuberculis tribus minoribus sublateralibus, segmentum 15<sup>um</sup> tuberculis posticis submedianis quam idem segmentorum praecedentium longioribus tuberculis lateralibus minoribus, segmenta 16<sup>i</sup> et 17<sup>i</sup> tuberculis posticis submedianis quam idem segmenti 15<sup>i</sup> aliquantum longioribus et retrorsum ali-

quantum vergentibus, tuberculis sublateralibus minoribus, segmentum 18<sup>um</sup> tuberculis parvis supra inspectis segmenti 19<sup>i</sup> latera vix superantibus; segmentum 19<sup>um</sup> postice subovali, margine ipso parum profunde lobato, processu caudali infero, brevioro marginem lobatum haud attingente. Carinae laterales sat parvae extrorsum et deorsum directae, lateraliter primi segmenti profunde trilobatae, ceterae, praeter easdem segmenti 18<sup>i</sup> perparvas, profunde bilobatae, sed margines, praesertim antici et postici, papillis piliformibus sat longis obsessis ita ut inspectione superficiali vix lobatae appareant. Metazonarum superficies praesertim per tuberculorum superficies et margines anticum et posticum papillis piliformibus clavatis brevibus vestita.

Pori repugnatorii perparvi in segmentis 4,6,8,9,11,12 14-18 (=5,7,9,10,12,13,15-19 Auctorum) siti et super carinarum lobi postici basis superficiem sese aperientes.

Pedes breviores articulo primo quam ceteri brevioro infra seta crassiuscula et longiuscula instructo, articulo secundo tertium longitudine aequante et seta infera apicali crassiuscula et longiuscula etiam instructo, articulo quarto brevioro, quinto quam quartus parum longiore et angustiore, trichobothrio supero apicali longiusculo instructo, articulo sexto seta proximali longa aucto, ungue terminali robusto.

Lamina subanalis triangularis setis duabus posticis sat longis; valvulae anales lateraliter vix convexae.

♂ Ignotus.

Typus: *Eustaledesmus parvus* sp. n.

*Observatio*.—Genus hoc ad *Lophodesmus* Poc. aliquantum proximum est, sed pororum positione praesertim distinctum est.

#### *Eustaledesmus parvus* sp. n.

♀ Corpus fulvo-castaneum antennis, clypei parte distali, segmento anali umbrinis.

Antennae articulo quinto parum minus quam 1/3 longiore quam latiore (55 : 40).

Metazonarum limbus adiectus in laminis parum latioribus quam longioribus postice serratis divisus.

Characteres ceteri vide generis descriptionem et figuras XI.

Long. corp. mm. 5,6, lat. segmenti noni cum carinis 1,05, sine carinis 0,60, long. antennarum 0,70, pedum segmenti noni 0,55.

*Habitat*.—Ceylon: Namunakuli. Exemplum typicum cl. E. Green legit et mihi dedit.

#### Gen. *Evurodesmus* nov.

(Fig. XII).

♂ Corpus capite, collo, segmento anali et segmentis aliis 19 compositum, antice vix postice parum angustatum, nec in globum nec in spiram sed tantum arcuatim parum contractile.

Caput omnino obtectum antice spatio sat longo a collo superatum, fronte ad verticem lateraliter tuberculis nonnullis perparvis, media usque ad torulorum libellam granulis parvis instructa, lateraliter a torulis ad marginem lateralem valde depressa, clypeo ante incisuram posticam lateralem incrassato elevato, margine antico medio tridentato, superficie supra setis brevissimis sat numerosis et seriebus duabus anticis setarum brevium instructa.

Antennae articulo quinto quam ceteri longiore et crassiore, setis et sensillis vide fig. XII, 5.

Collum parte praemarginali antica longiuscula margine ipso late rotundato et sat profunde 10-lobato, cetera superficie serie transversali tuberculorum convexorum antice et tuberculis perparvis latiusculis parum convexis obsessa.

Trunci segmenta dorso convexiusculo 1-16 seriebus duabus submedianis tuberculis tribus parvis instructa et cetera superficie tuberculis perparvis longitudinaliter subseriatis instructa; segmentum 17<sup>um</sup> tuberculis submedianis inter sese approximatis et quam idem segmenti 16<sup>i</sup> parum majoribus; segmentum 18<sup>um</sup> tuberculis submedianis etiam inter sese approximatis et quam idem segmenti 17<sup>i</sup> parum longioribus. Carinae laterales sat magnae, parum supra sternorum libellam orientes, extrorsum et parum deorsum directae margine antico sinu submediano, margine carinarum 1<sup>ae</sup> et 16<sup>ae</sup> trilobato, margine laterali ceterarum bilobato et in carinis porigeris incisione postica laterali etiam affecto; margine postico ad basim sinuato; carinarum marginibus papillis brevissimis, per sinum anticum et posticum aliquantum longioribus, obsessis.

Segmentum 19<sup>um</sup> manifestum subsemiellipticum margine utrimque trilobato, processu caudali perparvo infero ab ejusdem segmenti parte dorsuali spatio longo superato.

Metazonae per margines anticum et posticum papillis piliformibus brevissimis numerosis auctae et per tuberculorum superficiem etiam papillis brevissimis instructae. Carinarum margines, ut dixi, papillis obsessis et earundem superficies papillis sat numerosis brevissimis aucta.

Pori repugnatorii in segmentis 4,6,8,9,11,12, 14-18 (=5,7,9, 10,12,13,15-19 Auctorum) siti et in segmentis 4,6,8,9,11,12,14 et 15 a tuberculo subconico truncato, in parte sublaterali carinarum lobo postico sito, gesti et in segmentis 16-18 super superficiem subposticam, a margine laterali gradatim magis remoti sese aperientes.

Pedes breves, sat robusti articulo primo brevior articulo secundo quam tertius paullum longiore, articulo quinto quam quartus parum longiore et angustiore, trichobothrio apicali supero sat brevi instructo, ungue terminali longo et sat robusto.

Organum copulativum biarticulatum, articulo primo magno excavata, partem proximalem articuli secundi complectente, articulo

secundo aliquantum longe a basi in hastis duabus diviso, quarum altera subtiliore ductum spermaticum gerit.

Species typica: *Evurodesmus Biroi* sp. n.

*Observatio*.—Genus hoc a ceteris subfamiliae hucusque notis segmento 19<sup>o</sup> postice longiore praesertim distinctum est.

#### ***Evurodesmus Biroi* sp. n.**

♂ Corpus luride fulvum, colli margine antico et carinis maxima pro parte, clypeo, antennis, ventre pedibusque avellaneis.

Antennae articulo quinto c.  $\frac{2}{5}$  longiore quam latiore.

Metazonarum limbus adiectus in laminis transverse rectangularibus, postice serratis divisus.

Characteres ceteri vide generis descriptionem et figuras XII.

Long. corp. mm. 4,55, lat. segmenti noni cum carinis 1,06, sine carinis 0,50, long. antennarum 0,54, pedum segmenti noni 0,52.

*Habitat*.—Nova Guinea: Sattelberg (Clar. L. Biro, cui speciem dico, exemplum typicum legit).

XVII. NOTES ON CRUSTACEA DECAPODA  
IN THE INDIAN MUSEUM.

XIV. ON THE OCCURRENCE OF THE CARIDEAN GENUS *DISCIAS*  
IN INDIAN WATERS.

By STANLEY KEMP, Sc.D., Superintendent, Zoological Survey  
of India.

(Plate VIII).

Among a collection of Decapod Crustacea which I made during a short visit to Port Blair in the Andaman Is. in the spring of 1915, there occur five specimens of a small prawn of rather unusual interest. The marine fauna of Port Blair proved so extremely rich that, in the time at my disposal, it was not possible to examine all the forms obtained with any degree of thoroughness and the remarkable nature of the specimens was thus not noticed at the time of their capture.

The specimens prove to belong to the little known genus *Discias*, described by Miss Rathbun in 1902 from three specimens obtained by the Hopkins Stanford Galapagos Expedition at Albermarle Id. in the Galapagos group. *Discias* shows little affinity with any other genus of Caridea and Miss Rathbun referred it to a new family, the Discidae, which hitherto has been known only from her original description. It is not a little remarkable that the genus should reappear in Indian waters, for the Andamans are separated from the Galapagos Is. by almost exactly half the circumference of the globe.

In the family Discidae, or, as I would prefer to call it, the Disciadidae, we find characters which appear to be primitive combined with others which indicate a high degree of specialization. The persistence of exopods on all five pairs of legs would seem to be a very primitive feature and the second maxillipeds are also less highly organized than in most Caridea. On the other hand the mandibles and maxillae are not primitive and the legs of the first pair, in the extreme reduction of the carpus and in the remarkable structure of the fingers, present characters which are without parallel in the Macrura and afford clear evidence of specialization.

Miss Rathbun considers that the family is related to the Atyidae and Hoplophoridae but, except for the exopods on the legs, I can find little to recommend this view. The molar and incisor processes of the mandible are separated in *Discias* by a deep cleft and the proximal endite of the maxilla is reduced.

In both these features the family differs from the Atyidae and Hoplophoridae and resembles more specialized forms which do not possess exopods.

The families of Caridea in which exopods exist on two or more pairs of pereopods do not, for the most part, show any very close agreement with one another in other respects, and this fact points to the conclusion that exopods persisted among ancestral forms while considerable modifications in other directions were effected.

The possibility that exopods in some instances may actually have reappeared cannot be dismissed as altogether improbable. They are of frequent occurrence in the larvae of Caridean families that do not possess them when adult, and it is not difficult to imagine that their occasional reappearance might be caused by a persistence of larval characters into the adult stage.

The presence of a series of exopods on the legs is thus by itself insufficient to determine true relationship among the Caridea and it appears probable that better indications of affinity are afforded by the structure of the mouth-parts, especially of the mandible and maxilla. In the latter characters *Discias* shows a marked resemblance to the Hippolytidae and Palaemonidae and, notwithstanding the differences in the first two pairs of pereopods, it is in these families, I believe, that the Disciadiidae find their nearest surviving allies. *Discias* is without doubt the most specialized Caridean genus that possesses a full series of exopods.

The species obtained in the Andamans is distinguished from that found in the Galapagos Is. by characters which are clearly not more than specific. Miss Rathbun's specimens were all females; in the collection from the Andamans both males and females occur, the former differing from the latter only in the normal modifications of the first two pairs of pleopods.

The specimens were all found together on a yellow sponge. In the absence of precise field observations it is not possible to say whether the association was fortuitous or whether the prawn and sponge are synoecious, though the remarkable chelae of the prawn suggest that it must have some peculiar mode of life.

#### Family DISCIADIDAE.

1902. Discidae, Rathbun, *Proc. Washington Acad. Sci.*, IV, p. 289.

#### Genus *Discias*, Rathbun.

1902. *Discias*, Rathbun, *l.c.*, p. 290.

#### *Discias exul*, sp. nov.

#### Plate VIII.

In general appearance the species bears some resemblance to small Pasiphaeids belonging to the genus *Leptochela*, but is immediately distinguished by the remarkable character of the first two pairs of legs.

The rostrum consists of a horizontal triangular plate, rather strongly depressed and reaching almost to the end of the second segment of the antennular peduncle. In dorsal view it is nearly twice as long as its basal breadth. It bears a blunt median ridge, not continued backwards on to the carapace, with a shallow groove on either side. Near the base the lateral margin is reflected upwards and in the distal two-thirds of its length it bears a series of minute teeth or serrations, some 10 to 15 in number.

The carapace is smooth and rounded; its breadth is about equal to its height and about two-thirds its length. The anterior



TEXT-FIG. 1.—*Discias exul*, sp. nov.

- |                    |   |
|--------------------|---|
| a. Antennal scale. | e. First maxilliped.                          |
| b. Mandible.       | f. Second maxilliped.                         |
| c. Maxillula.      | g. Third maxilliped.                          |
| d. Maxilla.        | h. Barbed spinule at end of                   |
|                    | ante-penultimate segment of third maxilliped. |

border on either side of the rostrum is occupied mainly by the very large semicircular orbit which is defined below by a strong antennal spine. The antero-lateral angles are broadly rounded.

The eyes are very large and nearly globular; the breadth of the hemispherical cornea is greater than the length of the stalk. The black ocular spot, found near the cornea in many Caridea, is not visible.

The antennular peduncle reaches almost to the end of the antennal scale and is stout, with a lanceolate lateral process which reaches a little beyond the middle point of the basal segment. The outer margin of this segment is not provided with a distal

spine; it is, however, somewhat produced and carries a few long setae. The second segment is broader than long and a little shorter than the third. The outer flagellum is thickened at the base where, on its outer side, it bears tufts of long setae. The flagella seem to have been broken at the tips, but both were certainly longer than the peduncle.

The basal segment of the antenna does not possess an external spine. The antennal scale (text-fig. 1a) is oval with convex inner and outer margins and with a blunt apex; it is about three times as long as wide. The outer margin is not thickened in the usual fashion and does not end in a spine. The midrib described by Miss Rathbun is not evident, though there is a slight median swelling due to the presence of the longitudinal muscle. The basal segment of the flagellum reaches almost to the middle of the scale. The flagellum itself is long, extending to the end of the fourth abdominal somite when reflected backwards.

The mandible (text-fig. 1b) is deeply cleft into two processes. The anterior or incisor process is pointed, not apically truncate as in Miss Rathbun's figure of the allied species. The posterior or molar process does not possess the grinding surface found in most Caridea, but is narrow and acute with a series of sharp teeth that extend backwards in a single row on the inner side. The mandibular palp is composed of two segments, the distal scarcely half the length of the proximal and bearing a single long feathered seta at the apex.

The proximal endite of the maxillula (text-fig. 1c) is broad-ended and the palp bears two long setae behind the apex. In the maxilla (text-fig. 1d) the proximal endite is greatly reduced and does not reach nearly to the level of the two lobes of the distal endite. The first maxilliped (text-fig. 1e) bears a bilobed epipod. The second maxilliped (text-fig. 1f) has a bilobed epipod and the exopod reaches beyond the end of the merus. The endopod is slender; the basis and ischium are fused, the merus long and narrow and the carpus very short; the dactylus is attached obliquely to the end of the propodus.

The third maxilliped (text-fig. 1g)<sup>1</sup> reaches almost to the end of the antennular peduncle. There is a small epipod (not shown in the figure) and the exopod reaches to the end of the antepenultimate segment. At the end of this segment on the inner side there is a small stout spinule with three barbs on its inner aspect (text-fig. 1h). The penultimate segment is a little more than two-fifths the length of the antepenultimate. The terminal segment is spatulate in form and one and three quarter times the length of the penultimate; it has transverse rows of plumose setae on its surface and spinules on its margins.

The first pereiopod (text-fig. 3a) does not reach quite as far forwards as the third maxilliped. The exopod extends beyond

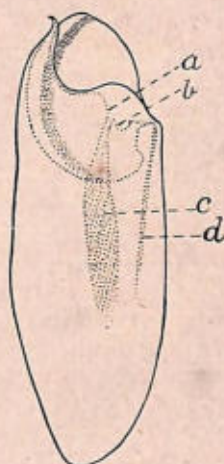
<sup>1</sup> The exopod in this figure is displaced to the left, the outer edge of the endopod being on the right.

the end of the merus. The basis and ischium appear to be fused. The merus is widest at its distal end and is about twice as long as its greatest breadth; on the inner side the distal margin is deeply hollowed to receive the hinder end of the chela, which projects backwards beyond the carpus. The carpus is exceedingly small and inconspicuous, consisting merely of a thin plate, oval when seen from below, lying between the merus and the chela. The chela itself is thick and heavy, less than three times as long as broad and fully one and a half times as long as the merus. As noted above, the posterior end of the chela, when the limb is straightened, fits into a cavity in the distal end of the merus. The structure of the fingers is difficult to make out satisfactorily. When seen from

below the chela presents the appearance shown in text-fig. 3*b*. Text-fig. 2 is a dorsal view of a chela which has been cleared in Eau de Javelle. The dactylus is a thin plate or disc, more or less circular in outline which, when it is closed, is ensheathed by more than half its total extent within the propodus. The dactylus is not flat, but saucer-shaped, and the cutting edge is semicircular, at the actual margin thin and transparent and with a band of closely-set striae parallel with the edge.

The second peraeopod (text-fig. 3*c*) reaches to the middle of the propodus of the first pair, with exopod extending beyond the end of the merus. The basis and ischium are fused, the merus is little more than three times as long as broad and the carpus is very short and more or less quadrate in outline. The chela is about three quarters the length of the merus and the dactylus about half the length of the palm. On the outer side of the fixed finger there are two long spines. There are two or three small spinules on the cutting edge of the dactylus and one in a similar position on the fixed finger. At the tip each finger bears three or four long, curved, interlocking spines (text-fig. 3*d*).

The last three pairs of peraeopods decrease successively in length; the third (text-fig. 3*e*) reach about to the end of the antennal scale, the fifth (text-fig. 3*f*) scarcely to the distal end of the merus of the first pair. The exopod in the third pair reaches a little beyond the middle of the merus, in the fifth pair to the end of

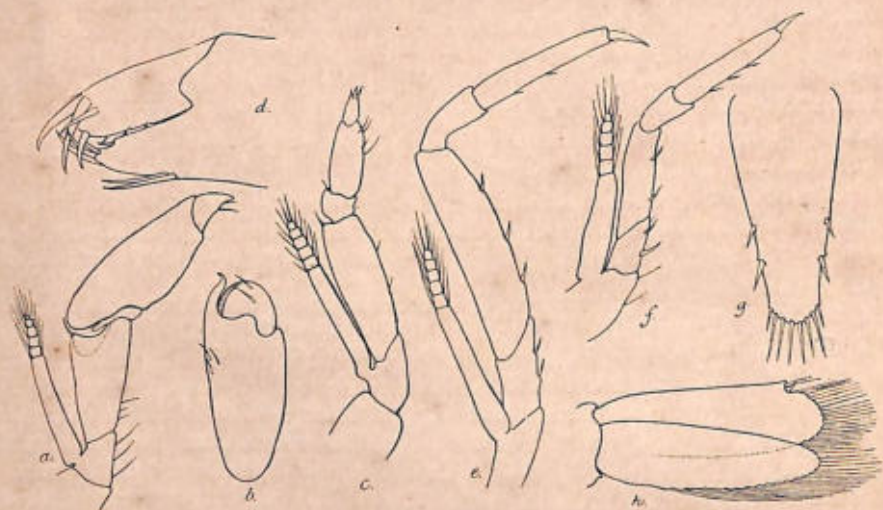


TEXT-FIG. 2.—*Discias exul*, sp. nov.  
Chela of 1st peraeopod in dorsal view.  
a. Distal end of palm on lower side of chela.  
b. Axis on which dactylus rotates.  
c. Protractor muscle.  
d. Retractor muscle.

the merus. There are large spines on the inferior margins of the ischium, merus and propodus, usually two on the ischium and two, three or four on the merus and propodus. The propodus is about twice the length of the carpus and three and a quarter to nearly four times the length of the dactylus, which is simple and sharp-pointed.

There are no epipods on the legs. The series of gills consists of five pleurobranchs, one situated above each peraeopod.

The abdominal somites are smooth and dorsally rounded; measured dorsally, the sixth is about one quarter longer than the fifth. In the male the endopod of the first pair of pleopods is oblong in shape with four long setae at its distal end. The



TEXT-FIG. 3.—*Discias exul*, sp. nov.

- |  |                     |
|--|---------------------|
| a. First peraeopod.                      | e. Third peraeopod. |
| b. Chela of first peraeopod, from below. | f. Fifth peraeopod. |
| c. Second peraeopod.                     | g. Telson.          |
| d. Fingers of second peraeopod.          | h. Uropods.         |

remaining pairs of pleopods are provided with an appendix interna and, in the male, there is an appendix masculina on the second pair.

The telson (text-fig. 3g) is rather broad. It bears two pairs of dorsal spinules, both situated in the distal half of its length. At the apex it is armed with four pairs of slender spines; of these the outermost are the shortest and the next pair the longest. The variation noticed by Miss Rathbun in the number of terminal spines does not seem to occur in this species. The outer uropod (text-fig. 3h) is about three and a half times as long as wide; the outer margin terminates in two short spines, the inner of which is movable.

The largest specimen is only  $7\frac{1}{2}$  mm. in total length. The eggs are large for so small an animal; they are rather shrunken

in the single ovigerous female, but appear to have been about 0·85 by 0·7 mm. in longer and shorter diameter. In life the specimens were colourless and semitransparent ; the eggs borne by the female were green.

*Discias exul* differs from Miss Rathbun's *D. serrifer* in a number of particulars. *D. serrifer* is a much larger species, 15 mm. in length, with a punctate carapace and with the antennal scale projecting further beyond the end of the antennular peduncle. The palmar portion of the chela of the first peraeopods is less than twice as long as broad in *D. serrifer*, but more than twice in *D. exul* and whereas the postero-inferior angles of the fifth and sixth abdominal pleura are rounded in the latter species, they are subacute in the former. In the tail-fan there are striking differences. The telson bears ten or twelve terminal spines in *D. serrifer* and there is a series of ten to twelve teeth on the external margin of the outer uropod ; in *D. exul* there are only eight spines at the apex of the telson and the margin of the outer uropod is unarmed.

The five specimens of *D. exul* were found on a yellow sponge ; they were obtained at low water on March 1st, 1915, at Port Blair in the Andaman Is., on the reef at the N. end of Ross I.

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EXPLANATION OF PLATE VIII.

*Discias exul*, sp. nov.

Ovigerous female in lateral view.



Harvey N. McCoy, Delaware College, Delaware

DISCIAS EXTL. SE. NOV.

Plate VII

XVIII. A LIST OF THE DRAGONFLIES RECORDED FROM THE INDIAN EMPIRE WITH SPECIAL REFERENCE TO THE COLLECTION OF THE INDIAN MUSEUM.

PART III.—THE GENUS *LESTES* AND ITS ALLIES.

By F. F. LAIDLAW, M.A.

(With Plate V).

The present part concludes my account of Indian dragonflies belonging to the sub-order Zygoptera. I have deliberately headed it "the genus *Lestes* and its allies," because at the present moment the precise status of the several sections into which the Zygoptera naturally fall is a matter of debate; and it is better on the whole to leave the exact rank to which this very distinct group is entitled, an open question.

As the number of species is not great, and as the group is fairly homogeneous, I have dealt with the systematic arrangement of the species on a somewhat different plan to that adopted in my previous papers. With regard to geographical distribution I have noted records under the heading of the several species.

I need scarcely point out that the Indian Lestine fauna is of exceptional interest, and is in all probability very imperfectly known. I list here some seventeen or eighteen recorded species, of which the museum collection contains twelve.

The following table will, I hope, be of assistance in identifying the Indian species of the group. At the same time it will serve to express my views on the classification of its members. Putting on one side *Megalestes*, which stands apart from the rest, I am inclined to the opinion that the genera proposed for certain aberrant species have probably not more than sub-generic value.

I regard the character afforded by the similarity or dissimilarity of the quadrangle of fore and hinder wings as of the first importance, following of course de Selys' main sub-division of the genus. Tillyard's genus *Austrolestes* is evidently nearly equivalent to Selys' "Deuxième section," but it should be noted that it can scarcely be separated on venational grounds from *Sympycna*. The only feature separating at least some of the Australian Lestines (*L. cingulata* Selys, e.g.) is the position of *Ac* at level of *Ax*<sub>1</sub>; whereas in all the Indian forms of de Selys' second section (but not in *Sympycna*

*paedisca* Eversm.) *Ac* lies about half-way between level of  $Ax_1$  and  $Ax_2$ .

But the position of *Ac* is variable in the first section of the genus, though not so far as I know in Indian species. Thus in *L. unguiculata*, Hagen from N. America it occupies precisely the same level as in *L. cingulata*, Selys. And therefore I am in some doubt as to the advisability of using this character in defining a genus, and as a matter of fact Tillyard does not so employ it.

As to the termination of the specific names. The generic name *Lestes* is a term not necessarily I think of the masculine gender. The specific name of the type-species *L. sponsa* Hansem, is definitely feminine; therefore I believe it correct to follow de Selys in employing for the specific names the feminine termination.

For venation I employ Tillyard's modification of the Comstock-Needham nomenclature;  $Ax_1$  and  $Ax_2$  for antenodal nerves, *Ms.* for the sector usually denoted by *Rs.*

- I. Petiolation of wing ceasing *before* the level of *Ac*. No supplementary sectors between *Ms* and  $M_3$ . *Ac* distinctly nearer the level of  $Ax_1$  than of  $Ax_2$ . MEGALESTES.
- II. Petiolation of wing commences *at* level of *Ac*. Supplementary sectors developed between *Ms* and  $M_3$ .
  - (a)  $M_2$  rises 8-8½ cells distal to nodus on forewing. *Ac* lies nearer level of  $Ax_1$  than of  $Ax_2$ . Wings coloured (in males of Indian species). OROLESTES.
  - (b)  $M_2$  rises not more than 6 cells distal to nodus in forewing.
- A. Quadrangle of fore and hinder wings equal. Inner side of quadrangle of hinder wing at least two thirds length of upper side.
  - \* *Ms* only slightly angled, in its distal half. Pterostigma at least twice as long as broad.
    - i. Synthorax without metallic markings.
 

Colour russet-brown, pterostigma unicoloured, yellow or brown ... ..	<i>Lestes umbrina</i> , Selys.
Thorax green, pterostigma dark, gray brown, its outer quarter paler ... ..	<i>Lestes thoracica</i> , sp. n.
Thorax brown, pterostigma longitudinally bicoloured (yellow and black), margin of wing sharply decurved beyond the pterostigma ...	<i>Lestes nodalis</i> , Selys.
    - ii. Synthorax with metallic green bands.
 

Bands very narrow; no black on head, pterostigma brown, three times as long as broad ... ..	<i>Lestes viridula</i> , Ramb.
Bands broader, about one-third width of mesepisternite, or more; securiform above. Head with black markings. Pterostigma about two and a half times as long as broad, black in adult. ... ..	<i>Lestes elata</i> , Selys.

Bands trilobed, about one-third width of mesepisternite. Head with black markings. Pterostigma about two and a half times as long as broad, black in adult ...

... *Lestes praemorsa*,  
Selys.

[In the last two species the colouring of the adult is largely black. *L. decipiens*, Kirby, a form I have not seen, appears to me to be a local race of *L. praemorsa*.]

iii. Synthorax almost entirely bronze-green above. Pterostigma transversely bicoloured, basal half brown, distal half whitish. Palaearctic species from Kashmir ...

... *Lestes barbara*  
(Fabr.)

Dorsum of synthorax with dorsal and humeral bands of yellowish colour. Pterostigma yellow. Very large species. Hinder-wing ♂ 38 mm. ...

... *Lestes orientalis*,  
Hagen.

\*\* *Pterostigma* not twice as long as broad.

Colouring grayish-white, marked with black, or dark cinnamon brown ...

... *Lestes* sp. ♂  
(?=*Platylestes platystyla*  
(Ramb.))

*Ms angled* ("sous-nodal anguleux").

"*Pterostigma* scarcely two and a half times as long as it is broad."

Colouring grayish yellow, almost without markings, segments 8-9 of abdomen black. ♀ Annal appendages ovoid, very depressed, as long as the last segment.

*Platylestes platystyla*  
(Ramb.)

B. Quadrangle of hinder-wing distinctly longer than that of fore-wing; its inner side not more than one-third the length of its upper side; its lower outer angle very acute.

a. Spines of legs relatively short, those of the posterior tibia scarcely as long as tarsal claws of the same legs.

Colouring blue and bronze-black.

Ratio of greatest breadth of wing to length 1 : 6.

... *Lestes cyanea*,  
Selys.

b. Spines of tibiae relatively long, those of the posterior pair longer than tarsal claws of same leg.

\* Colouring blue and bronze-black.

Ratio of greatest breadth of wing to length about 1 : 5; upper surface of head black (noirâtre) ...

... *Lestes gracilis*,  
Selys.

Upper surface of head bronze. ...

... *Lestes divisa*,  
Selys.

\*\* Colouring brown marked with green-bronze or bronze-black.

† Posterior prothoracic margin simple.

Pterostigma not inflated, its outer margin not oblique, only twice as long as broad; uncoloured ...

... *Lestes?* *bilineata*,  
Selys.

Pterostigma scarcely inflated, its outer margin not oblique, three times as long as broad ...

... *Lestes* sp. ♀.

†† Posterior prothoracic margin trilobed.

Pterostigma a little inflated, its outer margin oblique. *Ac.* nearly at level of *Ax*<sub>1</sub> ...

... *Lestes* (*Sympyena*)  
*paedisca*  
(Eversm.)

1. *Megalestes major*, Selys.†<sup>1</sup>

- Megalestes major*, Kirby, *Cat. Odonata*, p. 159.  
 " " M'Lachlan, *Ann. Mag. Nat. Hist.* (6)XVI, p. 20 (1895).  
 " " Martin, *Mission Pavie* (sep.), p. 18.  
 " " Ris, *Supplementa Entomologica*, No. 5, June 1916, p. 111.

This species, the only representative of its genus, was for long supposed to be confined to the southern slopes of the Himalayan range (see M'Lachlan, loc. cit.) Martin, however, has recorded it from Tonkin and Ris from Formosa.

The Museum collection contains 2 ♀♀ in spirit from Pashok, 5,000 ft., Darjiling District, 14.vi.16, scarcely adult ( $\frac{3458}{H1}$ ); and one ♂ from Bhim Tal, Kumaon, 19—22. ix. 06 ( $\frac{9787}{51}$ ) (N.A.). I have seen also 3 ♂♂ from the Indian Forestry Zool. Col. from Binsar, Kumaon, and one ♂ from Gopaldhara, Darjiling district, collected by Mr. H. Stevens.

The immature females have a large yellow mark occupying the middle of the dorsum of the prothorax; and on the synthorax there is a yellow stripe along each side of the mid-dorsal carina, and another along the line of the first lateral suture: whilst from the second lateral suture ventralwards the thorax is yellowish white. The dimensions of the female specimens are:

Length of hinder-wing 37.5 mm., of abdomen 44 mm.

2. *Orolestes selysi*, M'Lachlan.

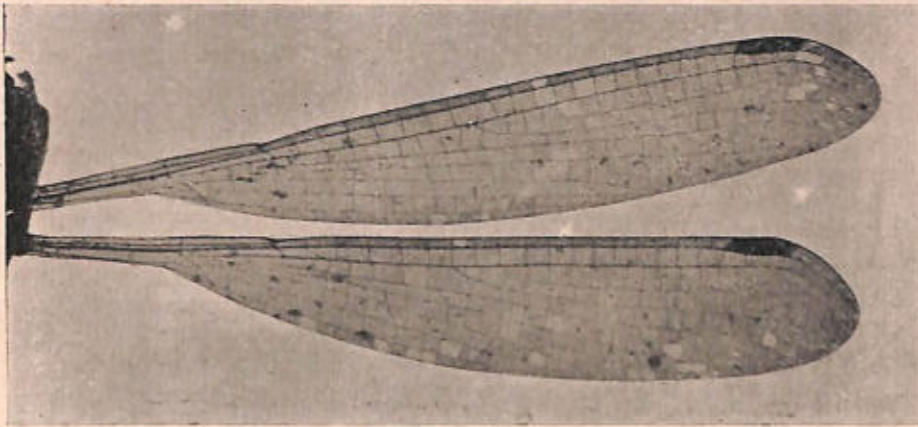
- Orolestes selysi*, M'Lachlan, *Ann. Mag. Nat. Hist.* (6) XVI, pp. 21-23 (1895).  
 " " Martin, *Mission Pavie* (sep.), p. 18.

I have not seen an example of this rare and splendid Lestine. I quote from M'Lachlan's account, "wings for the greater part opaque blackish in the male, petiolated up to the first basal post-costal nervule, which latter is placed nearer the level of the second than of the first antenodal nervule. Nodal sector commencing  $8\frac{1}{2}$  cellules after the nodus in anterior wings ( $7-7\frac{1}{2}$  after in the posterior); ultra nodal sector commencing 3-4 cells after the nodal. None of the sectors distinctly broken (angulose) excepting the inferior of the triangle at its apex (the ultra nodal and short sectors very slightly broken); one supplementary sector (and rudiment of another) interposed between nodal sector and median; pterostigma very large, dilated, more than four times as long as broad, surmounting 5-6 cellules. Quadri-lateral broad, lower side twice the length of the inner, the outer angle somewhat acute.  
 " Abdomen slender, spines of legs moderate.  
 " Head black above—prothorax olivaceous green.—Thorax above bronzy green, not metallic, somewhat paler (yellowish?) on

<sup>1</sup> Species so marked are in the Indian Museum, Calcutta.

“ either side of the dorsal crest; sides of thorax pale olivaceous  
 “ green.—The olivaceous colour of the sides of the thorax is  
 “ continued broadly on the sides of the first and second abdominal  
 “ segments, and narrowly along the sides of the third to the fifth  
 “ and part of the sixth segments; abdomen above with a large spot  
 “ occupying most of the first segment bronzy green, and the  
 “ second wholly of this colour; from the third to the tenth  
 “ bronze black, but there is a long bluish space on the third and  
 “ fourth, which are black only at base and apex. Legs black;  
 “ the femora brownish beneath.

“ ♂ Superior appendages black, quite one-half longer than the  
 “ tenth segment, slender, forcipate, the tips regularly incurved,  
 “ finely denticulate externally in the apical half; internally a  
 “ basal tooth, the usual dilatation commences in an obtuse and  
 “ ends below the apex in a large triangular tooth, inferior appen-



TEXT-FIG. 1.—Venation *Lestes*? sp. from Borneo (Coll. Sarawak Mus.).

“ dages scarcely one-fourth length of superior. Length of abdomen  
 “ 57 mm., of hind-wing 36-39 mm.”

I am enabled by the kindness of Messrs. H. and F. E. Campion to give a figure of a Bornean *Lestine*, undescribed I believe; a male in bad condition. This specimen agrees in venation with MacLachlan's account of *Orolestes selysi* very closely as may be seen by an examination of text-figure 1. The only differences are: (i) the absence of opaque colouring, and (ii) the shape of the quadrangle. MacLachlan's definition of the genus gives, “lower side twice the length of *inner*.” (The italics here are mine.)

Not having seen an authentic specimen of *Orolestes* I cannot speak with certainty on the matter, but I think it possible that for *inner* we should read *upper*. In that case the Bornean specimen would, except for wing-colour, fall into the definition of the genus *Orolestes*. In any case it seems to me that we may regard the species as intermediate between the true *Lestes* and *Orolestes*.

The markedly rectangular character of the venation should be noted. Like *Megalestes* this Himalayan form, with an allied species, has been recorded by Martin (*loc. cit.*) from Tonkin.

### 3. *Lestes umbrina*, Selys † (?).

(Pl. V, fig. 1).

*Lestes umbrina*, Selys, "Odonates de Birmanie." *Ann. Mus. Cw. Genova.* X (XXX), p. 497-498 (1890-91).

- 1 ♀ (Head, thorax and wings only). Cutch, W. India  
(*F. Stoliczka*)  $\frac{62.5}{20}^0$ ; Labelled by Selys "*Lestes umbrina*.  
Selys, Cutch. ♀."
- 1 ♂ Allahabad (*A. D. Imms*);—1907,  $\frac{64.5}{20}^2$ .
- 1 ♂ 1 ♀ Nagpur, C.P. (dry specimens), 1,000 ft., 10-v-15  
(*E. D'Abreu*).
- 4 ♂ 2 ♀ Nagpur, C.P. (in spirit), N.C.M., 10-v-95  
(*E. D'Abreu*).
- 1 (♂?) imperfect. Waltair, Madras Presidency., 23-iv-10  
(*S.W. Kemp*)  $\frac{63.0}{20}^3$ .
- 1 ♂ Allahabad (*A. D. Imms*).

Recorded by de Selys also from Hainan. I have identified the specimens listed above as *L. umbrina*, Selys with some misgivings. The ♀ specimen in the collection named by de Selys himself has largely influenced me in so doing; but unfortunately the specimen is very imperfect. I would point out, however, that there is a considerable resemblance between these specimens and the description of the species *L. concinna*, Selys (*Bull. Acad. Belg.* (2) xiii, p. 321; 1862), a resemblance to which de Selys has not called attention in his account of *L. umbrina*. Further, there are specimens in the British Museum of a *Lestes* apparently identical with the examples before me, collected by Everett in the Philippines, which have been labelled *L. concinna* by Kirby. So that it seems to me at least on the evidence available that the two names may be synonyms. On the other hand Selys' measurements of the hind-wing of his *L. concinna* show discrepancies, possibly due to a misprint. He gives the length of the hind-wing ♂ 28-31 mm., of the ♀ 19-22 mm.; and states that the colour of the pterostigma in the adult male is black, paler at the side and end. The specimen described was from Batavia. All the Indian Museum specimens have the pterostigma yellowish-brown except a very adult and imperfect specimen (? sex) from Waltair in which it is dark brown.

Unfortunately the accounts of the two species given by Selys are neither of them at all detailed.

The following description is based on spirit specimens from Nagpur, C.P.:—♂ *Head*: Under surfaces, bases of mandibles, and genae yellowish-white; the rest of the head and the eyes sandy yellow. In dried specimens the eyes have a dark brown colour.

*Prothorax* and *synthorax* almost uniformly sandy yellow, distinctly paler on the ventral surfaces, and in the most mature

specimens there is a distinct darkening of the mesepisternite near the mid-dorsal carina, where the colouring is of a more olive hue (this is more obvious in old pinned specimens than in spirit material).

*Legs* yellowish-white, with black spines and tarsal claws. The first pair of femora and tibiae have each a fine black externo-lateral line, of which only a trace is visible on the second pair of femora, none on the third pair.

*Abdomen*: Segments 1-8 sandy yellow, a slightly olive tinge dorsally, paler beneath. Except for the first segment, which is rather paler than the rest, the mid-dorsal line of each of these segments is marked with a very fine blackish line, and the basal and apical margins of each segment are also very narrowly marked with dark brown. On each segment from 2 to 7 the apex for a length of about a millimetre is a little paler than the rest, and lacks the olive shade; this paler area is separated from the remainder of the segment by a pair of minute, transverse, black dots lying on either side of the mid-dorsal carina, but not touching it. On segment 8 the mid-dorsal line is widened, and the sub-apical spots can scarcely be distinguished; 9-10 show progressive paling of colour distally, the apex of 10 and the anal appendages being of a creamy white colour. These segments are each marked with a fairly broad, black line dorsally.

*Anal appendages*: Upper part longer than segment 10 of abdomen, regularly incurved apically, with four or five fine black external denticles. Inwardly each carries a fairly stout spur, followed by a rounded shelf-like projection, lower pair barely one-half length of upper pair, triangular. The upper pair are a little darkened on the apices (see pl. V, fig. 1). The veins of the *wings* are brown in both sexes.

#### 4. *Lestes nodalis*, Selys. †

(Pl. V, fig. 2).

*Lestes nodalis*, Selys, "Odonates de Birmanie." *Ann. Mus. Civ. Genova* X (XXX), pp. 496-497 (1890-91).

1 ♂ (Head, thorax and parts of wings only). Assam-Bhutan Frontier. "Deshroi, River and jungle" (*S. W. Kemp*) 25-xii-10.  
"1893."

In addition to the points noted by Selys as serving to characterize this species, the black nodal point and the longitudinally bicoloured pterostigma, the sharp deflexion of the wing margin beyond the pterostigma is worth noting.

I am able to supply a figure of the anal appendages of the male (missing in the present specimen) from an example in the British Museum from Assam. De Selys (*loc. cit.*) has recorded a specimen from Yunnan.

5. *Lestes thoracica*<sup>1</sup>, sp. n. †

(Pl. V, fig. 3).

1 ♂ 1 ♀ (type and allotype). Agra, United Provinces of Agra and Oudh (*E.J. Hankin*) 1916 (from bottles labelled 7 and 9).

Type ♂ and allotype ♀ to be returned to the Indian Museum. Dr. Hankin remarks that the male has a green thorax, and slightly green eyes; whilst the female has the thorax sage-green and eyes blue.

In the preserved specimen the green colouring has faded to a dull gray-brown.

Both sexes have the pterostigma dark grayish-brown, with its outermost quarter grayish-white. The dark area has also a fine lighter border. The veins of the wings are dark brown.

♂ Length of abdomen 30+1 mm., of hind-wing 20 mm.

*Head*: Upper lip and genae dull yellowish-brown (probably green in life), the rest of the anterior and upper surface black, save for a small yellow triangle enclosing the ocelli.

Posterior surfaces pale yellowish-white.

*Prothorax*: Upper surface jet black, lower surfaces yellowish-white.

*Synthorax*: Entirely gray-brown (green, non-metallic during life), save that the mid-dorsal carina is black, as are also the alar sinuses. The ventral surface is paler than the dorsal.

*Abdomen*: Segments 1, 2 pale yellow at the sides and underneath; marked with a bronze-black band above. Segments 3-7 bluish-white underneath, each with a longitudinal, bronze-black band occupying the whole length of the segment dorsally. Segments 8, 9, 10 entirely bronze, the last two slightly black, pulverulent.

*Anal appendages* (Pl. V, fig. 3): Upper pair half as long again as the last segment, white in colour with black apices, which overlap each other. Each appendage has an inner basal tooth at about one-third of its total length, followed by a rounded projection, which carries fine black denticulations.

*Legs* white with black bands on the anterior surfaces of the femora and tibiae, tarsi black.

♀ Length of abdomen 28 mm., of hinder-wing 20 mm.

*Head*: Upper surface yellowish brown (probably sage-green in life) with small black markings on either side of the ocelli.

*Prothorax*: Yellowish-brown (when alive sage-green).

*Synthorax*: Sage-green above, paler at the sides and below, without a black line on the mid-dorsal carina.

*Abdomen*: Segments 1-7 with upper surface covered by bronze-black band, the colouring of this band is not very intense. Seg-

<sup>1</sup> I have lately received specimens of *L. thoracica* from Lake Chilka; and a long series of *L. nodalis* from Lower Burma.

ments 1 and 2 are pale yellow at the sides underneath; whilst 3-7 have the same parts greenish-white. Segment 7 has indications of a black median dorsal line, and 2-7 each have a fine pair of transversely placed black spots on either side of the mid-dorsal line, about one millimetre proximal to the apex of the segment. On 8, 9 and 10 the dorsal colouring becomes paler fading almost to white on segment 10, but each of these segments has a well-marked longitudinal black line above. Anal appendages white.

*Legs* as in the male.

This species is closely allied to *Lestes umbrina*, Selys, both in the general wing structure, and in the colour pattern of the female, as well as by the structure of the anal appendages of the male.

#### 6. *Lestes viridula*, Ramb. †

(Pl. V, fig. 4).

*Lestes viridulus*, Kirby, *Cat. Odonata*, p. 163.

1 ♂ For. Zool. Coll. Gondumri, Bhandara, C. P., 1-xii-12 (A. D. Imms), "in jungle."

1 ♀ (imperfect). Mowai, Bara Banki, United Prov., 2-x-10 (M. M. Khan)  $\frac{6488}{20}$ .

The species is characterized by the narrow green band on either side of the mid-dorsal carina of the synthorax, and by the angular 'elbow' of the anal appendage of the male (Pl. V, fig. 4),

#### 7. *Lestes elata*, Selys. †

(Pl. V, fig. 5 and text fig. 2).

*Lestes elatus*, Kirby, *Cat. Odonata*, p. 162.

" " *id. Proc. Zool. Soc. Lond.* 1891, p. 203.

" " *id. Journ. Linn. Soc. Zool.* XXIV, p. 565 (1893).

1 ♀ Barkul, Orissa, 100 ft. 1-3-viii-14, F.H.G.  $\frac{8223}{20}$ .

1 ♂ ad. 1 ♀ juv. Bangalore, Mysore, ca. 3000 ft., 4-6-x-16; N.A.

1 ♂ 3 ♀ ♀ immature, 2 larvae, Bangalore, Mysore, ca. 3,000 ft. 4-6-x-16. N.A.

"Adults from edge of small ditch, larvae from ditch; no other species seen in vicinity."

Recorded from Ceylon (Kirby) and Tranquebar, Madras Presidency (Selys). Apparently widely distributed in peninsular India.

I have been able to examine Kirby's specimens in the British Museum. They agree closely with those now before me. The variation of which Kirby speaks (*loc. cit.* 93) is evidently a mat-



TEXT-FIG. 2.—Thoracic colour pattern of *L. elata*, Selys ♀, Bangalore.

ter of age, and perhaps of sex; the females that I have seen are all very similar, as are the young males, whose thoracic colouring is identical with that of the females. The adult male, as in the species *L. praemorsa*, Selys, develops much black colouring.

The shape of the metallic-green bands of the thorax, which are, as Kirby remarks, securiform behind, are characteristic of the species, whilst the deeply angled margin of segment 10 also distinguishes it from *L. praemorsa* (see text-fig. 2 and Pl. V, fig. 5).

Since the above was written, I have received a young male of this species from Karachi, kindly sent me by Major F. C. Fraser.

### 8. *Lestes decipiens*, Kirby.

*Lestes decipiens*, Kirby, *Journ. Linn. Soc. Zool.* XXIV, pp. 565-566 (1893).

I could not find examples of this species in the British Museum. It is evidently very closely allied to *L. praemorsa*, Selys, and may be a local race. The British Museum has several examples of the latter species from Ceylon.

### 9. *Lestes praemorsa*, Selys. †

(Pl. V, fig. 6 and text-fig. 3).

*Lestes praemorsus*, Kirby, *Cat. Odonata*, p. 162.  
 " " Selys, *Odonates de Birmanie*.  
 " " Krüger, *Stettin Entomol. Zeit.* 1898, p. 130.  
 " " Laidlaw, *Proc. Zool. Soc. Lond.* 1902, p. 382.

- 1 ♂ ad. Sibsagar (S. E. Peal)  $\frac{0327}{20}$  (labelled by de Selys),  
 1 ♀ imperfect, Sibsagar, N.E. Assam (S.E. Peal)  $\frac{0328}{20}$  (labelled by de Selys).  
 2 ♂♂ 1 ♀ Sitong, ca. 4000 ft., near Mangphu, Darjiling district (S. Kemp) 6-vii-18.  $\frac{1509}{13}$ .

This species is I think closely allied to *L. elata*, Selys. Both of them agree in that the adult males undergo melanotic development, and in both the anal appendages are much alike.



TEXT-FIG. 3.—Thoracic colour pattern of *L. praemorsa*, Selys ♀, Darjiling district, 4,000 ft.

*L. praemorsa*, however, appears on our present knowledge to have a much wider range than its relative; and when better known I have no doubt that it will be possible to distinguish local races for it.

I have been able to examine specimens at the British Museum from the Celebes and Ceylon. Those from the former locality are at once distinguishable from the N. Indian examples by the difference in the thoracic pattern, which seems constant. The British Museum examples from Celebes seem to be distinct from the form for which de Selys pro-

posed the name *quercifolia*, but this form is also represented in the same collection. The thoracic pattern in the Sitong specimens, which are in better preservation than those from Sibsagar, is distinctly serrate. In an example from Ceylon the pattern is more irregular, this applies also to specimens from the Malay Peninsula (Skeat expedition), whilst in the British Museum material from the Celebes it is decidedly reduced.

#### 10. *Lestes barbara* (Fabr.). †

*Lestes barbarus*, Kirby, *Cat. Odonata*, p. 162.

Calvert, *Proc. Acad. Nat. Sci. Philadelphia*, 1898, p. 147.

1 ♂ Jhelum Valley, 5,200 ft., Kashmir, N. W. Himalayas,  
6-x-16 (H. T. Pease),  $\frac{4318}{H1}$ .

A widely ranging Palaearctic species.

#### 11. *Lestes orientalis*, Selys.

*Lestes orientalis*, Kirby, *Cat. Odonata*, p. 163.

" " *id.*, *Journ. Linn. Soc. Zool.* XXIV, p. 566.

This fine species, equalling the largest members of the group in size, appears to be especially characteristic of Ceylon and S. India. I have not seen an example.

#### 12. *Lestes* sp. (?=*Platylestes platystyla* (Ramb.)). †

(Pl. V, fig. 7 and text-figs. 4, 5).

1 ♂ "Found in collapsed condition on stairs of Museum building, Calcutta," 13-xi-17.

The type of *Platylestes platystyla* (Ramb.) is a unique female specimen described by de Selys. It is also the genotype.

The Museum specimen agrees fairly well in the important character of the short, squarish pterostigma with the genotype, save that in the male the pterostigma is distinctly less than twice as long as broad (the generic definition, based of course on a female, states that the pterostigma is *a peine deux fois et demie aussi long que large*).<sup>1</sup> Further in general the dimensions agree fairly well:—

*Platylestes platystyla* ♀ abd. 33 mm., hind-wing 23 mm.

Museum specimen ♂ abd. 32 + 1.5 mm., hind-wing 21 mm.

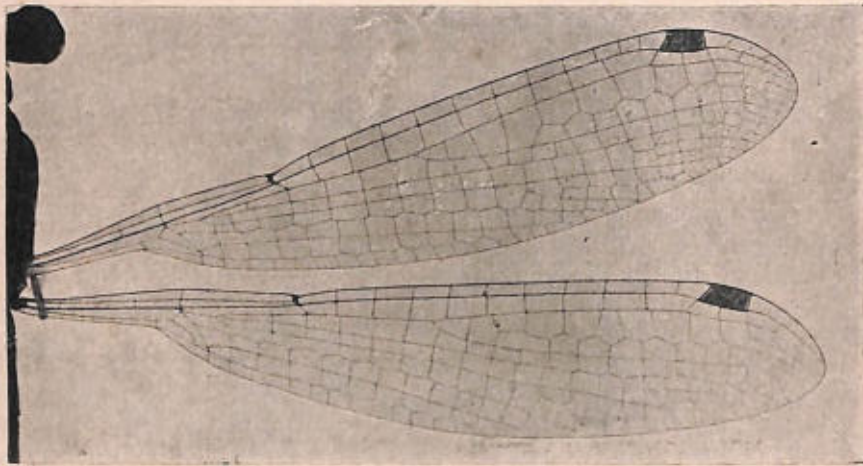
Lastly the colouring is not dissimilar though the male has black spots on the thorax not present in the type, and in general the male is not very unlike a *Platycnemis* in colouring and in the shape of the pterostigma.

This comparison with the type is made by de Selys. In the generic definition, however, he emphasises the point that the subnodal sector (*Ms*) is angulated, evidently in contrast with the non-

<sup>1</sup> I think Selys must have meant one and a half times.

angulated character of the same sector noted in his definition of *Sympycna* where it is said "le sous-nodal non anguleux ou à peine ondulé;" and of *Lestes* concerning which he makes the same remark.

Now an examination of the venation of the male specimen in question shows that the sub-nodal section (*Ms*) can scarcely be sharply contrasted with that of species of *Lestes* in that respect. Hence if the male be really conspecific with the type female the strongest character distinguishing the genus is annulled; the shape of the pterostigma alone is I think scarcely to be reckoned a generic character even though backed by certain sexual characters. Hence I prefer to leave the question of the identity of this fine specimen open, and hope that as it occurs in the neighbourhood of Calcutta examples of both sexes may soon be available for examination. I am, however, of the opinion that it is really the male of



TEXT-FIG. 4.—Venation of *Lestes* sp. (= ? *Platylestes platystyla* (Ramb.) from Calcutta.

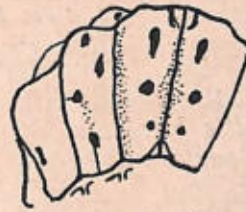
*Platylestes platystyla*. The following is a short account of the specimen:—

Wing petiolated to *Ac*, which lies about midway between level of  $Ax_1$  and  $Ax_2$ . Pterostigma short, its inner margin more oblique than its outer, not twice as long as broad, a little inflated at the middle of its length, black, its outer and inner margins paler; covering two cells, and with a well-marked brace vein. Quadrangles of fore and hinder-wings similar, inner side nearly equal in length to upper. *Ms* becoming somewhat angled from the level of a point midway between nodus and pterostigma (scarcely more so than in other species of *Lestes*).

*Head*: Upper lip and eyes olive-green; the rest of the head a light grayish-yellow, with three small black spots on the post-clypeus, and black marks at the base of the antennae and immediately in front of the anterior ocellus.

*Prothorax* grayish white below.

*Synthorax* of the same colour, becoming milky white on the sides and below. On either side of the mid-dorsal carina lies a row of three small black spots, and on the side of the synthorax between the humeral and the second lateral sutures there are some four irregularly placed black spots; in addition a band of colour darker than the ground colour is found along the mid-dorsal carina, and a similar band lies in front of the humeral suture.



TEXT-FIG. 5.—Thoracic colour-pattern of *Lestes* sp. ♂ from Calcutta.

*Legs* gray-white. The articulations, cilia and a line along the posterior sides of the femurs black.

*Abdomen* olive gray, passing on the hinder segments gradually to a warm dark cinnamon brown. Segment 2 has an anterior and posterior pair of very small, black spots on either of the mid-dorsal carina.

Segments 2-6 have an apical narrow black ring, 3-6 have also a pale basal ring incomplete dorsally, and a second pale ring, likewise incomplete above, near the distal end of the segment. Between this second ring and the black apical ring there lies a pair of minute black spots, one on either side of the mid-dorsal carina.

Segment 7 has a basal pale ring and deepens gradually in colour to its apex, which has a narrow black ring; 8-10 are progressively darker in colour, each has, about at its middle, on either side of the dorsal carina, a fine white spot, and each is marked with a black apical ring.

*Anal appendages*: Upper pair nearly as long as segment 8. Basal fourth velvety black, the rest of their length milky white. Gently and regularly curving inwards to meet at their apices. On the inner side, at the end of the first third of their length, is a blunt projection, and at the end of the second third is a sharply pointed tooth directed backwards and inwards. The apex is bluntly rounded. Lower pair more than half the length of upper pair, meeting each other apically where they are upturned; rather spatulate. Each carries at its base on the inner side a somewhat tubercular projection extending for over one-third of its length.

It is evident that the anal appendages of this species differ strongly from other Indian species referred to the first Selysian section of the genus. This supports my belief that the specimen belong to a distinct sub-genus.

### 13. *Platylestes platystyla* (Ramb.).

*Platylestes platystylus*, Kirby, *Cat. Odonata*, p. 164.

See also remarks by de Selys in his paper "Odonates de Birmanie." *Ann. Mus. Civ. Genova*. X (XXX), p. 499 (1890-91).

14. *Lestes gracilis*, Selys.

- Lestes gracilis*, Kirby, *Cat. Odonata*, p. 163.  
 " " *id.*, *Proc. Zool. Soc. Lond.*, 1891, p. 206.  
 " " *id.*, *Journ. Linn. Soc. Zool.*, XXIV, p. 566.  
 " " Ris, *Supplementa Entomol.*, No. 5, 1916, pl. i, fig. 4.

Dr. Ris has described (*loc. cit.*) three races of this species, viz. *L. gracilis birmanus*, Selys, described by de Selys very briefly in his *Odonates de Birmanie* under the heading of *L. divisa* (p. 495) and recorded by Ris also from Madura in S. India; secondly *L. gracilis gracilis*, Selys, from Ceylon, and lastly *L. gracilis peregrinus*, Ris, from Japan. He gives figures of the venation of the species. The anal appendages bear a fairly close general resemblance to those of *L. cyanea*, Selys.

15. *Lestes divisa*, Selys.

- Lestes divisus*, Kirby, *Cat. Odonata*, p. 163.  
 " " *id.*, *Journ. Linn. Soc., Zool.*, XXIV, p. 566.  
*Nec Lestes divisa*, Selys, *Ann. Mus. Civ. Genova X (XXX)*, p. 495 (1890-91), (*fide* Ris).

Not in the Museum collection. I have not seen an example of this or of the preceding species.

16. *Lestes cyanea*, Selys. †

(Pl. V, fig. 8 and text-figs. 6, 7).

- Lestes cyaneus*, Kirby, *Cat. Odonata*, p. 163.
- A. 5 ♂ ♂ 8 ♀ ♀ Kufri to Phagu, 8,000-9,000 ft., Simla Hills, 18-  
 v-16,  $\frac{2883}{H1}$   
 1 ♀ Same date and locality,  $\frac{2885}{H1}$   
 1 ♂ Kufri, Simla Hills, May 1917, 8,000 ft.  $\frac{7231}{H1}$   
 2 ♀ ♀ near pool on Tiger Hill, Darjiling dist., 3,300 ft.  
 26-vi-18,  $\frac{1313}{H1}$   
 1 ♀ immature, with exuviae. Nam Ting Pokhri, Sending  
 Spur, 4,600 ft., no date,  $\frac{1315}{H2}$   
 1 ♂ Darjiling, 7,000 ft. (labelled by de Selys),  $\frac{5667}{5}$   
 2 ♂ ♂ For. Zool. Coll. Chahullia, Takula, Kumaon, May  
 and June 1912 (*D. Imms*).  
 B. 2 ♂ ♂ Sitong Ridge, Darjiling, alt. *circ.* 4,700 ft., 22-  
 28-x-17,  $\frac{8033}{H1}$   
 2 ♂ ♂ 2 ♀ ♀ 3 larvae. Nam Ting Pokhri, Sending Spur,  
 4,600 ft., 22-x-17,  $\frac{8011}{H1}$

I have grouped these specimens in two series, the reason for which action I will explain in the sequel.

Dealing with series A in the first place. These specimens are all evidently typical examples of *L. cyanea*.

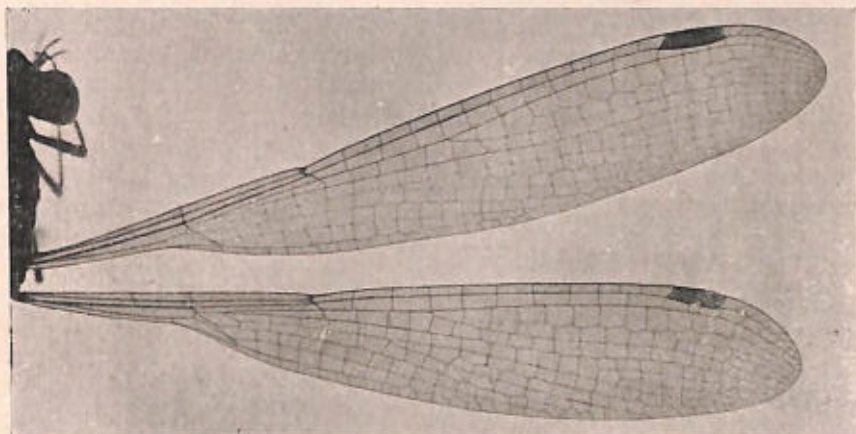
Below I give a short account of a male and female from the Simla Hills ( $\frac{2884}{HI}$ ) taken in May.

Pterostigma black, antenodals on front wing 12-13.

♂ *Head*: Upper lip and anteclypeus with bases of mandibles and genae pale bright blue, otherwise dorsal surfaces black. Eyes gray-blue above passing to pale olive colour below.

*Prothorax*: Black dorsally, with a small median spot of bright blue, and a pair of lateral spots of the same colour. Ventrally greenish-white.

*Synthorax*: The dorsum is bronze-black with violet reflex. The mid-dorsal carina is finely marked with greenish-blue.



TEXT-FIG. 6.—Venation of *Lestes cyanea* ♂ from Sitong Ridge, Darjiling.

There is a narrow ante-humeral band of bright blue, limited externally by the humeral suture, and incomplete above. Laterally the colour is blue marked with a bronze-black band running upwards obliquely from the anterior half of the mesinfraepisternite, bounded anteriorly by the humeral suture. At its summit this band turns backward past the wing bases giving off a fine branch, which descends as a narrow black blue along the second lateral suture. The black band also encloses a small blue mark immediately behind the top of the humeral suture.

The wing bases themselves are marked with spots of blue; the under surfaces are pale greenish white.

*Abdomen*: Segments 1-6 vivid blue above, paler beneath, and marked with black as follows:—

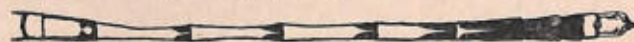
Segment 1 has a transverse basal line dorsally, and a pair of black lateral lines incomplete posteriorly; separating the bright blue of the dorsum from the paler ventral colouring.

Segment 2 has lateral bands of black meeting a fine black apical ring. These bands enclose the blue of the dorsum and are widened suddenly towards the hinder end of the segment so as nearly to cut off a small circular area of the blue from the rest of the blue colour.

Segments 3-6 have a very fine apical ring of black and apical lateral triangles, with their bases resting on the apical ring. These triangles are progressively longer from 3, where they occupy about one-sixth of the length of the segment to 6, where they occupy very nearly one-half. Segment 7 has the blue colouring so encroached on by the black lateral triangles that the blue is reduced to a basal ring from which a blue line runs black along the mid-dorsal carina. In 8 only the carina is left blue, and 9 is entirely black save for indication of a fine blue line at the base of the carina, 10 is blue, its marginal denticulations black.

Legs black anteriorly, greenish-brown posteriorly; tarsi and spines black.

*Anal appendages*: Upper pair about equal in length to segment 9 of abdomen; curved gently towards each other but at the apices curved outwards again, and rather acutely pointed. Each has at the end of its basal third a small internal blunt projection, and at about the junction of the middle and distal thirds a sharply pointed, backwardly directed spur. Lower pair one-quarter length of upper pair or less, bluntly conical, with rounded apices. (See pl. V, fig. 8.)



TEXT-FIG. 7.—Abdominal colour-pattern of *L. cyanea* Selys ♂. Not drawn to scale, Kufri 8,000 ft., May.

♀ *Head, prothorax and synthorax* with colour pattern identical with that of male, but the blue is replaced by a yellowish-green ground colour.

*Abdomen*: Segments 1-9 bronze-black above, greenish-white at the sides. Segment 1 has a median dorsal, squarish mark of light blue. 2 has a narrow median line of the same colour running along the dorsal carina, not quite attaining either end of the segment. Segments 3-7 have each of them a basal ring of blue immediately behind the basal margin of the segment, which is fairly ringed with black. The blue ring on 3 is very narrow, scarcely wider than the marginal ring of black. In the mid-dorsal line this blue ring is continuous with a very narrow blue line which runs along on either side of the mid-dorsal carina, which itself is exceedingly finely marked with black. On 4-6 the blue ring is progressively wider, in 6 it occupies the anterior fifth of the segment, and in each case it gives off a short median projection backwards, and is divided by the black blue of the mid-dorsal carina. In segment 7 the ring is rather of a bluish green colour, and it is narrower, equal only to about one-third of the width of that on segment 6.

Segments 8-9 are entirely bronze-black, and segment 10 is blue, its posterior margin with a deep angular incision (as also in the male) with a small basal spot of black, and small lateral spots of the same colour.

*Legs* as in the male, *anal appendages* white, shorter than the last segment.

Length of hinder-wing ♂ ♀ 24 mm., of abdomen ♂ 35+1.5 mm., ♀ 33 mm.

The specimens grouped under heading B have puzzled me greatly. They are all very immature, so much so that a specimen pinned for examination has shrivelled and has the abdomen hopelessly contorted. So far as I can make out they are all identical in structure, venation, and colour pattern with *L. cyanea*. But the *colouring* is different, the blue of *L. cyanea* being replaced by a shade of brown, which in the more nearly mature specimens is fairly dark.

Lastly as will be seen from the measurements given below the size is smaller. The pterostigma is brown.

Again the time of year when these specimens were taken was later than that on which the specimens of series A were caught for the most part, and the elevation less; October as against May, June, and 4,600 ft. as against 8,000 ft.

However, lately I have received from Dr. Annandale ♀ ♀ ( $\frac{1313}{H_2}$ ) from Tiger Hill, Darjiling, which are typical *L. cyanea* from a height of only 3,300 ft. and a very immature ♀ ( $\frac{1315}{H_2}$ ) probably taken about the same date (June) which in colouring shows little difference from the immature females of series B. Hence I conclude on present evidence, that probably the B series are merely young examples of *L. cyanea* that have not attained the adult pigmentation; and that the smaller size of the single ♂ fit for measurement is possibly due to incomplete expansion of the wings.

But it would be well worth while for collectors on the spot to determine whether or not there exists any seasonal form such as is possibly indicated by these specimens.

The wing figured and the anal appendages of the male are both taken from the least immature male of series B. As already stated I can find no structural differences separating them from series A.

Length of hinder-wing ♂ 22 mm., of abdomen c. 33 mm.

#### 17. *Lestes* sp. †

(Text-fig. 8.)

2 ♀ ♀ Cherrapunji, Assam, 4,400 ft., 8-x-14,  $\frac{8204}{20}$ .

Length of abdomen 23.5 mm., of hinder-wing 19 mm.

These interesting little specimens are exceeding like a *Sympycna* in appearance. Mr. H. Champion, who was kind enough to

examine one of them for me, expressed the opinion that it bore a strong resemblance to that genus. This is in fact the case; the simple posterior margin of the prothorax and the shape of the pterostigma being the most important structural characters which separate it. The specimens are I think certainly very closely related to *L. bilineata*, Selys, but show some differences in detail.

*Wings*: Very narrow, hyaline with an uniform brown tinge, and with dark brown venation. Pterostigma bicoloured, its inner three-quarters dark brown, the outer quarter and the distal marginal vein yellowish white. This vein is much less oblique than is the inner marginal vein. The pterostigma is about three times as long as it is broad.

Ratio of greatest breadth of wing to greatest length about 1 : 5.

*Head*: Anterior surfaces yellow, dorsal surfaces including the post clypeus bronze-black, margin of occiput finely lined with yellow, posterior surface bronze-black.

*Prothorax*: Anterior lobe yellow, middle lobe yellow with a large bronze-black spot on either side, posterior lobe bronze-black; yellowish-white below.

*Synthorax*: Pale brownish-yellow, almost white below. On the dorsum is a broad bronze-black band with violet reflex, not separated so far as colour goes from its fellow of the opposite side by the mid-dorsal carina. This band is widened a little at about the middle of its height, and again at its upper end, where it lies against the ante-alar sinus. There are also three small isolated black spots on either side on the mesepimerite.

*Abdomen*: Pale brown passing to yellowish-white below.

Segment 1 has a square dorsal patch of bronze-black; 2 has a bilobed band of the same colour, contracted at its middle, and with its hinder lobe bifid. Segments 3-5 have each a pair of antero-lateral and postero-lateral bronze-black spots, the anterior pair on 5 being very small.



TEXT-FIG. 8.—Colour pattern of segments 2-3 of abdomen of *Lestes* sp. ♀ from Cherrapunji.

Segments 6-9 are without definite markings, but the brown colour of the dorsum is definitely darker than in the preceding segments and has a slightly metallic lustre. Segment 10 is yellowish white as are the anal appendages, which are cylindrical and a little shorter than the last segment. This latter has its

posterior margin very shallowly angulate

*Legs*: Long, the third femur when adpressed reaching to the base of the first abdominal segment. Colour pale brown, the anterior surface of the tibia, the distal half of the anterior surface of the femur, and the tarsal claws brownish black. Tibial spines exceeding in length the tarsal claws.

18. *Lestes* ? *bilineata*, Selys.

*Lestes* ? *bilineata*, Selys, *Ann. Mus. Civ. Genova.* X (XXX), pp. 498—499. (1890—91).

A ♀ specimen in the British Museum labelled as *Lestes* ? *bilineatus*, Selys is evidently closely allied to the species last described. Unfortunately I have not had time to make a full examination of this individual, which is from Burma.

19. *Lestes* (*Sympycna*) *paedisca*, Everson. race. †

*Sympycna paedisca*, Kirby, *Cat. Odonata*, p. 164.

" " Förster, *Wien Entomol. Zeit.* XIX, p. 256—267, pl. iii, figs. 1-7 (1900).

" " Barteneff, *Ann. Mus. Zool. St. Petersburg*, XVI (1912-13).

*Lestes paedisca*, Ris, *Supplement. Entomol.*, No. 5, 1916.

4 ♂♂ 6 ♀♀ Jhelum Valley, Kashmir, 5,000 ft. (*H. T. Pease*) 1916, *Zool. S. Ind.*

These specimens all agree very closely with the form described by Barteneff as *S. paedisca*, approximating to *S. gobica*, Förster.

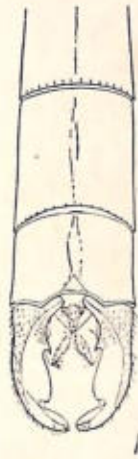
Ris (*loc. cit.*) makes some observations on the sections of the genus *Lestes*, which I have not yet had an opportunity of studying.

### EXPLANATION OF PLATE V.

Anal appendages and terminal segments of abdomen of males viewed from above. All the figures are  $\times 7\frac{1}{2}$ .

- FIG. 1.—*Lestes umbrina*, Selys, from Chota Nagpur.  
,, 2.—*Lestes nodalis*, Selys, from Burma (from specimen in British Museum).  
,, 3.—*Lestes thoracica*, n. sp., type-specimen collected by Dr. Hankin at Agra.  
,, 4.—*Lestes viridula*, Ramb., specimen from Gomdumri, Bhandara, C. P., collected by Dr. Imms. (Ind. For. Zool. Coll.)  
,, 5.—*Lestes elata*, Selys, specimen from Bangalore.  
,, 6.—*Lestes praemorsa*, Selys, from Sibsagar.  
,, 7.—*Lestes* sp. (?=*Platylestes platystyla* (Ramb.)), specimen from Calcutta.  
,, 8.—*Lestes cyanea*, Selys, specimen from Darjiling (B).

(For the photographs of venation in the text I am indebted to Messrs. H. and F. E. Champion to whom I wish to express my obligation. The other text-figures are diagrammatic. For the figures in the plate I am obliged to Mr. Highley of the British Museum.)



1.



2.



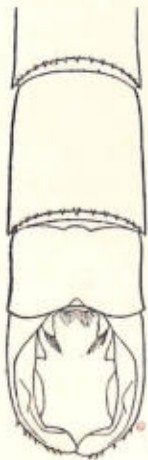
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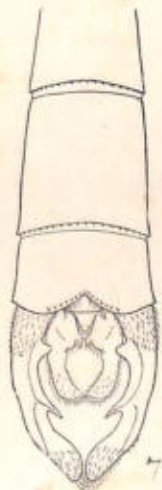
5.



6.



8.



7.

XIX. NOTES ON LAMELLIBRANCHS IN  
THE INDIAN MUSEUM.

(Plate IX.)

By B. PRASHAD, D.Sc., Assistant Superintendent, Zoological  
Survey of India.

I. *ARCIDOPSIS FOOTEI* (THEOBALD).

Theobald in 1876<sup>1</sup> described a peculiar species of Unionid from the Gutparba Falls, Kistna River, under the name *Unio footei*. His Latin description, drawn up from two specimens with much decayed beaks, is incomplete in many respects. The existence of the type-specimens is very doubtful, and Theobald's incomplete description was all that was available to Simpson<sup>2</sup> at the time of the preparation of his synopsis of the Naiadae. The peculiarities of shell-structure mentioned in Theobald's description led Simpson to create a new genus (*Arcidopsis*) for this species, but he added the following qualifying foot-note:—"Unfortunately Theobald's Latin description is not at all complete. No laterals are mentioned and he says nothing of the color of the epidermis or of the nacre. The beaks were too much worn in his specimens to give any characters. The shell resembles some of the Arcas of the *Barbatia* group, and may not belong to the Unionidae at all." The concluding remark seems to be due to Theobald making a casual comparison between the shape of this species and that of *Arca subtorta* in the note following his description. Preston's<sup>3</sup> description is merely a verbatim copy of the accounts in Theobald's and Simpson's works; he even ignored two more recent memoirs that refer to this species. The first of these is the incomplete monograph of Unionidae by Haas,<sup>4</sup> in which the author, besides reproducing the description and the two figures in Theobald's paper, gives a full description with three figures of a shell from Mysore, preserved in the Frankfürst Museum. This specimen Haas assigns doubtfully to Theobald's species. It is, however, clear from this description and the rather poor figures of the hinge, that the specimen does not belong to this species but is probably an *Indonaja*. The second work is an elaboration by Simpson<sup>5</sup> of his "Synopsis." In this monograph he gives

<sup>1</sup> *Journ. As. Soc. Bengal*, XV, p. 187, pl. xiv, figs. 9, 9a (1876).

<sup>2</sup> *Proc. U. S. Nat. Mus.* XXII, p. 861 (1900).

<sup>3</sup> *Faun. Brit. Ind. Freshw. Moll.*, p. 196 (1915).

<sup>4</sup> *Mart. and Chemn., Conch. Cab.* ed. Küster, *Die Unioniden*, pp. 119-121, pl. xi, figs. 2-4 (1910-1914).

<sup>5</sup> *Desc. Cat. Naiades*, III, pp. 1191-1192 (Michigan, 1914).

as complete an account of *A. footei* as can be adduced from Theobald's description and figures. He also includes in the references (without any comment, however,) the monograph by Haas cited above.

It is, therefore, of interest to be able to record the discovery of two complete young shells and the left valve of a full-grown specimen in the collections of the Zoological Survey of India. These can be assigned definitely to this species and may, owing to uncertainty as to the existence of the original types, be taken as the *neotypes* of *A. footei*.

The specimens were collected by Dr. F. H. Gravely in April, 1912, at Taloshi in the Koyna valley, Satara District, Bombay Presidency, at an altitude of about 2,000 feet.

The locality "Gutparba falls" may be considered here. No falls of this name are known on the Kistna River, but a tributary of the Kistna is known as the Ghatprabha and it is evident that the name Gutparba is only an old way of spelling Ghatprabha. The course of this stream is described in the Gazetteer<sup>1</sup> of the Bijapur District as follows:—"The Ghatprabha rises near the edge of the Sahyádris almost twenty-five miles west of the town of Belgaum. After an easterly course of about 140 miles through Belgaum and the Southern Marátha states, it enters Bagáلكot three miles north of Kaládgi. Through Bagáلكot it runs nearly east for about twenty miles, and then immediately below the town of Bagáلكot turns suddenly north. Between Bagáلكot and Yerka, about five miles north of Bagáلكot, it forces its way through two chains of hills, a pretty country with picturesque views of hills and water. Beyond the second range it enters the Krishna valley and falls into the Krishna about fifteen miles to the north-east opposite Chimalgi." The Koyna valley lies to the north-west of the Ghatprabha valley, and the Koyna, another tributary of the Kistna, flows through it. Dr. Gravely's specimens therefore extend the range of the species, but not beyond the river-system from which it was originally described.

Theobald's description of the shell of *A. footei* is incomplete, and the following description, based on the Koyna valley specimens, is therefore given:—

Shell moderately large and thick; elongate, subrhomboidal, very inequilateral. The dorsal and ventral outlines are nearly straight and parallel in the young, but owing to an antero-downward slope of the dorsal side become greatly inclined in the adult thereby greatly reducing the length of the anterior margin. Anterior margin strongly truncated above, rounded below; posterior margin truncated above and also truncated below in the young, but evenly rounded in the adult. A small but distinct posterior wing, better marked in the young than in the full-grown specimens. Umbonal region prominent, slightly swollen and

<sup>1</sup> Gazetteer of the Bombay Presidency—Bijapur, by J. M. Campbell (Bombay, 1884).

opposed in the young, becoming depressed and less marked in older specimens; sculptured with numerous low corrugated ridges arising from an eccentrically situated nucleus, and radiating outwards on the two sides but more or less parallel in the middle region; a few very minute striae also run transversely in this region. Older specimens with the beak much eroded and bleached and showing barely any striations. Shells swollen in the middle but depressed in front, below and behind. Periostracum coarse, with strong vertical ridges in the young radiating outwards, some with a well marked V-shaped course. In adult shells the striations less marked but distinct; a few minute transverse concentric ridges

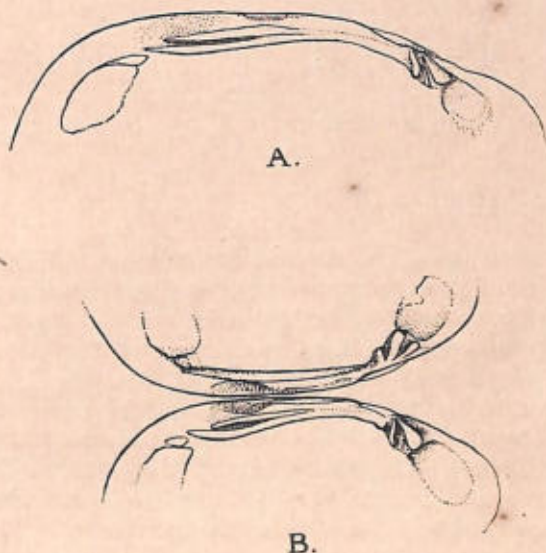


FIG. 1.—*Arcidopsis footei* (Theobald).

A. Hinge of the left valve of adult specimen,  $\times 1\frac{1}{2}$ .  
 B. Hinges and scars of the young specimen,  $\times 2$ .

also visible in both young and adults; regions of growth well marked. Periostracum of a yellowish brown colour with a few light green striae along the vertical striae, specially distinct in the young specimens. Nacre pearly white, iridescent. Hinge strongly developed; pseudocardinals three in the right valve with the middle tooth best developed, two in the left, the outer being much the larger; all these teeth vertically striate in adult shells. Laterals lamellar, nearly straight, one in the right, two in the left valve, in which the lower ridge is better developed, being longer and stouter than the upper. Muscular scars moderately impressed; anterior scars confluent, posterior scars distinct. Pallial line distinct though not deeply marked.

## Measurements of Shells (in millimetres).

	A.	B.	C. (Single left valve).
Length	17·1	25·2	43·4
Breadth	10·2	13·8	23·2
Height	7	8·5	7·1

Shells. No. M  $\frac{267A}{1}$ , M  $\frac{267B-6}{1}$ , Zoological Survey of India (Ind. Mus.).

*Relationships.* Simpson's remark quoted already regarding the mollusc being doubtfully a Unionid is not justified in view of the specimens now discovered. The genus *Arcidopsis* has a superficial resemblance to another Indian genus, *Trapezoideus*, Simpson, but there does not seem to be any true relationship. It is, however, impossible to discuss its true position until the anatomy has been investigated. I do not agree with Haas (*loc. cit.*) in considering *A. footei* as probably being congeneric with species like *Trapezoideus misellus* (Morelet), for the specimens before me more distinctly show that they do not belong to the genus *Trapezoideus*, the resemblance with this genus being purely superficial.

2. *LAMELLIDENS JENKINSIANUS* (BENSON) AND ITS SUBSPECIES.

In his catalogue of the Asiatic Naiades in the Indian Museum<sup>1</sup> Preston described a new species of the genus *Parreyssia*, Conrad, from a single dead shell from Dacca, Eastern Bengal. This form he named *P. daccaensis*. His description of the species is very short, being only a comparison with *P. jeddeni* (Theobald), to which he considered it to be closely allied. In his later work<sup>2</sup> in the "Fauna" series he did not add anything to his original description, but published figures of the type-shell. In Simpson's "Catalogue,"<sup>3</sup> which was published before the "Fauna" volume, Preston's original description is included without comment.

Whilst identifying a small collection of Unionids made by myself and Babu D. N. Sen, of the Bengal Fisheries Department, at Dacca and other places in the vicinity, I found on examining the type-specimen of *P. daccaensis* that the shell did not belong to the genus *Parreyssia* and that Preston was certainly mistaken in describing it as a new species of that genus. With the above-mentioned collection from the type-locality and other places in the district of Dacca, as also the large collections in the Indian Museum, I have been led to the following conclusions:—(1) Preston's *P. daccaensis* is a young shell of a highly peculiar but hitherto unrecognized form of Benson's *Unio jenkinsianus*,<sup>4</sup> (2) Benson's *Unio jenkinsianus* is not a distinct species of the genus *Lamellidens*, as Simpson doubtfully believed, nor is it an abnormal form of *L. marginalis*

<sup>1</sup> *Rec. Ind. Mus.* VII, p. 300 (1912).

<sup>2</sup> *Faun. Brit. Ind. Freshw.-Moll.* pp. 65, 66, figs. 16, 1—3 (1915).

<sup>3</sup> *Descr. Cat. Naiades*, p. 1114 (Detroit, Michigan, 1914).

<sup>4</sup> *Ann. Mag. Nat. Hist.* X, p. 185 (1862).

or *L. corrianus* as Hanley and Theobald<sup>1</sup> considered the unique type before them to be. It is indeed a form closely allied to *L. marginalis* through Hanley and Theobald's var. *obesa*. I cannot agree with Preston in regarding *L. jenkinsianus* as a subspecies of *L. marginalis*, and (3) the form *Unio marginalis* var. *obesa* of Hanley and Theobald must be considered as a species distinct from *L. marginalis* on both anatomical and malacological grounds. It is a large, rather thick-shelled form which appears to be very like the ancestral form, from which the thick-shelled forms *obesa*, *jenkinsianus* and *daccaensis* have been evolved. It shows only a slight modification from the closely allied *L. marginalis*, with which it has up to now been confused.

The ancestral type of shell in this group of series is the form to which Hanley and Theobald gave the name *obesa* in 1876. They did not properly describe the form but published the following note in the explanation of their plate;—"A giant form, which does not exhibit the ochraceous band, and is peculiarly swollen. It comes between the var. *lata* and the typical form. The upper anterior tooth is almost linear; the lateral are not bent at the extremity and the upper one in the left valve is scarcely developed." Their figure of the shell imperfectly shows the hinge in the right valve only, but this and the outline and form of the shell as shown in the full-size figure of the left valve are quite enough for distinguishing the form. Neither Preston nor Simpson added anything to the above meagre description. Benson's name *jenkinsianus* was given fourteen years earlier, but the form to which he assigned this name is only subspecifically distinct from Hanley and Theobald's *obesa*. Under the circumstances our only course is to describe *obesa* as a subspecies of *jenkinsianus*, which, owing to the priority of Benson's name, has to be taken as the name of this group of forms. Preston's name *daccaensis* is retained for the rather peculiar subspecies noted already, as a young shell of it was given this name. The relationships of these forms with one another and of the group as a whole with *L. marginalis* may be expressed as follows:—

*L. jenkinsianus* subsp. *daccaensis*.

|

*L. jenkinsianus*.

|

*L. jenkinsianus* subsp. *obesa*.

||

*L. marginalis*.

In a recent paper<sup>2</sup> Dr. Annandale and I described a Unionid from Seistan under the name *L. marginalis* subsp. *rhadinæus*.

<sup>1</sup> *Conch. Ind.*, p. 19, pl. xli, fig. 4 (1876).

<sup>2</sup> *Rec. Ind. Mus.*, XVIII, pp. 59—62, fig. 9 (A,B), pl. iii, figs. 9, 10; pl. viii, figs. 7—11 (1919).

We remarked on the resemblance of the hinge of this form to that of *L. jenkinsianus*. This resemblance is, however, superficial only, for the pseudocardinal teeth in *rhadinaeus* are much thinner and broader than in *L. jenkinsianus* and the laterals are not so well developed. The shape of the shell also is different resembling more the true *L. marginalis* than any of the forms of *L. jenkinsianus*.

Photographs of typical specimens of different forms of the latter are given on pl. IX, and of the hinge-teeth of the three forms in text-fig. 2.

***Lamellidens jenkinsianus* (Benson) subsp. *obesa* (Hanley and Theobald).**

(Pl. IX, figs. 1, 2.)

1877. *Unio marginalis* var. *obesa*, Hanley and Theobald, *op. cit.*, p. 20, pl. XIII, fig. 3.

I describe this subspecies before the typical form of the species since the shell is of a more central type and this treatment of the species makes it easier to understand the relationships of the different forms.

The shell in this species is elongate, subelliptical, posteriorly produced into a spatulate process about the middle line of the shell; rather thick, convex and greatly inflated; beaks rather small but swollen, incurved and meeting in the middle line above, with low somewhat curved corrugations in the young but eroded in full-grown specimens; surface marked with low concentric ridges corresponding to the regions of growth. Dorsal slope nearly straight in young but truncated anteriorly in adults, ventral margin straight or only slightly sinuate in its anterior part, curving up in a regular slope posteriorly to form the lower border of the spatulate process; anterior margin broad, regularly curved; posterior margin narrow, rounded; posterior ridge straight or slightly curved and with a narrow post-dorsal wing. Epidermis yellowish to dark brown in the young, becoming dark brown or even black sometimes interspersed with yellowish-brown concentric bars in the adult. Right valve with two lamellar pseudocardinals, of which the lower is well developed, strong and rugose, in some specimens more so than in others, and a single lamellar lateral, which is rather long, originates from just below the beak and is only slightly arched. Left valve with a well developed pseudocardinal, thick and more ragged than those of the right valve and lying in front of the beak, another pad-like tooth originating from underneath the beak itself is also present; and two blade-like slightly arched laterals of which the upper does not extend to the beak. Muscle-scars shallow, but more impressed than in *L. marginalis*; anterior ones separate, posterior confluent. Ligament very long and strongly developed. Nacre bluish tinged with salmon, in young specimens showing a purple band along the edge, iridescent.

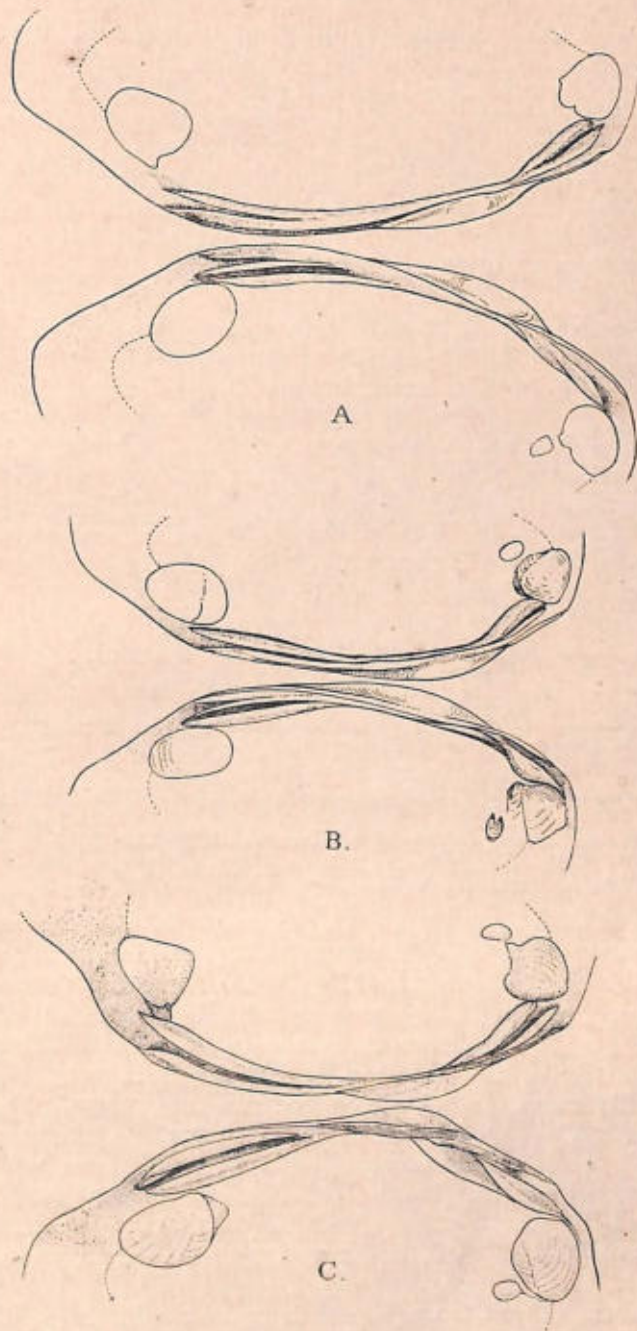


FIG. 2.—Hinge-teeth of *Lamellidens jenkinsianus* and its subspecies.  
 A. *L. jenkinsianus* subsp. *obesa*, shells from Upper Assam,  
 B. *L. jenkinsianus* (s.s.), shells from Upper Brahmaputra, Assam.  
 C. *L. jenkinsianus*, subsp. *daccaensis*, shells from Mirpur, Dacca District.

In a previous paper<sup>1</sup> I referred to the soft-parts of this form and included a description and drawing of its glochidium. A few further notes are here included. The inner pair of gills are much broader than the outer, and the outer pair of gills alone is marsupial. The palpi are elongate but rather shorter than in *L. marginalis*. The foot and the adductor and retractor muscles are very well developed. The branchial is double the size of the anal, which is of about the same size as the supra-anal. The animal on the whole has a much heavier build than that of *L. marginalis* and differs from it fundamentally in the outer pair of gills alone being marsupial.

The species though closely allied to *L. marginalis* differs from it in the heavier build of the shell, in the umbones being larger, more prominent and swollen, and in the hinge being more highly developed.

Hanley and Theobald's specimens of this form were obtained from the Irrawady river in Burma, but the species has a much wider range in Burma, Assam and Eastern Bengal. In the Indian Museum collection it is represented by specimens from Tonghoo, Burma; Silchar, Cachar and Sylhet, Assam; and from Chitagong and Dacca, Eastern Bengal.

#### *Lamellidens jenkinsianus* (Benson).

(Pl. IX, figs. 3, 4.)

1862. *Unio jenkinsianus*, Benson, *Ann. Mag. Nat. Hist.* X, p. 185.  
 1876. *Unio jenkinsianus*, Hanley and Theobald, *op. cit.* p. 19, pl. xli, fig. 4.  
 1900. *Lamellidens jenkinsianus*, Simpson, *Proc. U. S. Nat. Mus.* XXII, p. 857.  
 1914. *Lamellidens jenkinsianus*, Simpson, *Descr. Cat. Naiades*, pp. 1176, 1177.  
 1915. *Lamellidens marginalis*, subsp. *jenkinsianus*, Preston, *op. cit.* p. 184.

Benson's and Simpson's descriptions are fairly complete so far as the form of the shell is concerned, but as the peculiarities of the hinge have not been noticed by either author they are described here. Right valve with two pseudocardinals, of which the lower is rather long, extending from close above the scar of the anterior adductor muscle to the middle of the beak; it is very thick and heavily built, sometimes a little curved and very ragged; the upper one is usually thin and does not extend so far. There is a single blade-like lateral, rather shorter in the typical form but thicker and a little more arched. Left valve with a single pseudocardinal and a small pad-like tooth arising from the inner margin of the beak, and two lamellar teeth of the same type as in the typical form but thicker.

This form differs from the subsp. *obesa* in being less inflated and less deep but more solid and relatively more elongate, in the muscle-scars being more impressed and the hinge much more strongly developed.

<sup>1</sup> *Rec. Ind. Mus.* XV, p. 145, fig. 1a (1918).

The specimens which I assign to this form are from the Upper Brahmaputra (Tezpur), Assam, and a few from Dacca, Eastern Bengal in the district in which the Ganges and the Brahmaputra are closely adjacent.

Subsp. *daccaensis* (Preston).

(Pl. IX, figs. 5-8.)

1912. *Parreyssia daccaensis*, Preston, *Rec. Ind. Mus.* VII, p. 300.  
1914. *Parreyssia daccaensis*, Simpson, *op. cit.* p. 1114.  
1915. *Parreyssia daccaensis*, Preston, *op. cit.* pp. 165, 166, figs. 16 (1-3).

Preston's species was founded on a single young shell, but in the Indian Museum collection there are now a large number of specimens of this species from Dacca and Mirpur, Eastern Bengal, a young shell from Bhagalpur, Bengal, and many shells from Sylhet, Assam.

The species resembles the typical form but is much shorter, broader, more convex, much more swollen, with the umbones more distinct and convex, with the upper margin very much more arched and the hinge still more strongly developed. The pseudocardinals and the lateral teeth are both much stouter and thicker, and the former are in many cases so striate and ragged as to recall the condition in the genus *Parreyssia*. The second or posterior pseudocardinal of the left valve, which projects from the margin of the beak about its middle, has become larger, somewhat subtriangular in outline and has assumed a real tooth-like shape. In some shells the spout or the spatulate process on the posterior margin described in the subsp. *obesa* is more marked than in others, but in this form it is situated a little below the middle line.

It may be pointed out here that the system of hinge-teeth of this form is not at all like that of *Parreyssia feddeni* (Theobald) as Preston thought. Unfortunately Theobald's original description of the hinge of *P. feddeni* is incomplete in that he describes the pseudocardinal as "in valve dextro singulo," whereas there is a second much thinner ridge above the thick and larger lower pseudocardinal. Preston did not point out this inaccuracy in describing the teeth of his species as similar to those of *P. feddeni*.

It is also of interest to note in connection with the thick-shelled Unionids of the group of *L. jenkinsianus* and its subspecies considered above, that their shells are of great economic importance in the provinces of Bengal and Assam. They form the greater part of the raw material for the pearl-button industry and are also burnt in large quantities for making lime.

EXPLANATION OF PLATE IX.

Photographs of *L. jenkinsianus*, and its subspecies.

*Lamellidens jenkinsianus*, subsp. *obesa* (Hanley and Theobald).

- FIG. 1.—Adult shell from Tonghoo, Burma.  
,, 2.—Adult shell from Sylhet *Bhils*, Assam.

*Lamellidens jenkinsianus* (Benson).

- FIG. 3.—Adult shell from Upper Brahmaputra, Assam.  
,, 4.—Adult shell from Dacca, Eastern Bengal.

*Lamellidens jenkinsianus*, subsp. *daccaensis* (Preston).

- FIG. 5.—Young shell from Dacca, Eastern Bengal; type of  
*Parreyssia daccaensis*, Preston.  
,, 6.—Young shell from Bhagalpur, Bengal.  
,, 7.—Adult shell from Sylhet *Bhils*, Assam.  
,, 8.—Adult shell of an elongate type from Dacca district,  
Eastern Bengal.



1.



5.



2.



6.



3.



7.



4.



8.

S. C. Mondul, photo.

LAMELLIDENS JENKINSIANUS  
and its subspecies.

## XX. NOTES ON VIVERRIDAE.

By H. C. ROBINSON AND C. BODEN KLOSS.

The Director of the Zoological Survey of India has submitted to us a series of this family, mainly from the immediate vicinity of Calcutta, and we have therefore examined the whole of the material in our collection. The Indian and Indo-Malayan forms we are able to recognize are:—

### Genus *Viverra* Linn.

<i>Viverra zibetha zibetha</i> , Linn.	North Peninsular India, Himalayas.
<i>Viverra zibetha pruinosa</i> , Wroughton.	Burma, Tenasserim, S.W. and S. E. Siam.
<i>Viverra zibetha sigillata</i> , subsp. nov.	South Malay Peninsula.
<i>Viverra megaspila megaspila</i> , Blyth.	Burma, Siam, Malay Peninsula.
<i>Viverra megaspila civettina</i> , Blyth.	South India.
<i>Viverra tangalunga tangalunga</i> , Gray.	Malay Peninsula, Borneo, Sumatra.
<i>Viverra tangalunga lancavensis</i> , subsp. nov.	Langkawi Id., Straits of Malacca.

The races may be recognised by the following key:—

1.	{ White tail rings unbroken above ... .. 2
	{ White tail rings interrupted above ... .. 4
2.	{ Pattern distinct ... .. <i>V. s. sigillata</i> .
	{ Pattern indistinct ... .. 3
3.	{ General colour greyer ... .. <i>V. z. zibetha</i> .
	{ General colour yellower ... .. <i>V. z. pruinosa</i> .
4.	{ Dark bars on tail less than ten ... .. 5
	{ Dark bars on tail more than ten ... .. 6
5.	{ Markings on flanks and haunches confluent; black on tail less extensive ... .. <i>V. m. megaspila</i> .
	{ Markings on flanks and haunches discrete; black on tail more extensive ... .. <i>V. m. civettina</i> .
6.	{ Spots on body and rings on tail more conspicuous; general colour darker ... .. <i>V. t. tangalunga</i> .
	{ Spots on body and rings on tail less conspicuous; general colour paler ... .. <i>V. t. lancavensis</i> .

### *Viverra zibetha zibetha*, Linn.

There are three recent specimens from Calcutta which are typical of the form inhabiting the plains of Northern India.

Another from Darjiling has the pelage softer and more woolly as might be expected from the climatological conditions: it represents *V. undulata*, Gray (*Spic. Zool.* pl. 8, p. 9) which, however, we are not at present prepared to recognize. The same type of animal is found in the Abor Hills. Another specimen without locality (Zool. Survey India No. 10,391) is indeterminable sub-specifically: the flanks are distinctly marked, but there is a tendency to interruption of the white tail bands.

*V. z. picta* described by Wroughton on the same page, but before *V. z. pruinosa* (*postea*), and based on animals from Khamti, Upper Chindwin, Burma, has since been withdrawn by that author (*op. cit.*, XXVI, 1918, p. 46). It must, presumably, be regarded as synonymous with *V. z. zibetha*.

### *Viverra zibetha pruinosa*, Wroughton.

*Journ. Bombay, Nat. Hist. Soc.* XXIV, 1915, p. 64 (Tenasserim).

Mr. Wroughton appears to have inadvertently reversed the characters of this subspecies. So far from being greyer and less yellowish than the typical race, specimens from Tenasserim and neighbouring districts are invariably more yellow and less grey. We are in possession of two paratypes; also an example from Koh Lak, S.W. Siam, in the same latitude, and another from Sriracha, S.E. Siam, a little to the north on the opposite side of the Gulf of Siam.

### *Viverra zibetha sigillata* subsp. nov.

*Viverra zibetha pruinosa*, Kloss (*nec* Wroughton), *Journ. Nat. Hist. Soc. Siam*, II, 1917, p. 292

Type. Adult male (skin and skull): Bang Nara, Patani, Peninsular Siam, collected by Messrs. W. J. F. Williamson and M. A. Smith's native collector. 16th July, 1916. No. 2477/C.B.K.

Differs from the two other races in having the pattern above clearly defined; the forelimbs with a distinct tendency to bars and the under surface with dark blotches and markings more defined on the flanks. External measurements (taken in the flesh):—Head and body, 818; tail, 435; hindfoot (without claw) 121; ear, 51mm. Skull measurements:—greatest length, 142; basal length, 130; zygomatic breadth, 67.5; breadth of brain case, 39; maxillary tooth row exclusive of incisors (alveoli) 53; greatest length of upper sectorial, 14.7 mm.

Specimens examined. The type; one from Pelarit, Perlis; two from Perak (Temangoh and Taiping) and two from Selangor (Kuala Lumpur).

### *Viverra megaspila megaspila*, Blyth.

Two adults from Taiping and Kuala Lumpur. The black spots on the sides and haunches stand out with great distinction

on a deep buff ground. The type, which is no longer in existence, came from near Prome, North Pegu, Burma.

### *Viverra megaspila civettina*, Blyth.

We have examined the skull of the type and a flat skin with no exact provenance (Zool. Survey India. No. 10,394). The latter differs from *M. megaspila* only in having the marks on the haunches more confluent, the spots on the sides smaller, the erectile mane carried further up the neck and the tail rings much larger.

In the type skull the posterior upper premolar is larger than in either *V. zibetha* or *V. m. megaspila* and the anterior upper molar is also larger and more quadrate in outline than in other species: the bullae are highly compressed. All these characters, however, may be purely individual and series of the south Indian animal are highly desirable.

### *Viverra tangalunga lancavensis* subsp. nov.

Type. Adult female (skin and skull) from Batu Puteh, Langkawi Id., Straits of Malacca, 8th December, 1912. Collected by H.C. Robinson and C. Boden Kloss. F.M.S. No. 542/12.

Differs from Peninsular Malayan and Bornean animals in having the ground colour distinctly paler and less buffy and in having the spots on the body and rings on the tail reduced in size and less conspicuous. External measurements taken in the flesh:—Head and body, 650; tail, 342; hindfoot, 103; ear, 30;

Skull measurements:—greatest length, 130; basal length, 111; zygomatic breadth, 61; maxillary tooth-row exclusive of incisors (alveoli), 47; greatest length of upper sectorial, 12.5mm. Specimens examined: One, the type.

### Genus *Viverricula* Hodgson.

The series of this genus available to us shows that the original genotype founded on specimens and figures of animals obtained by Sonnerat in Malacca is easily separable from Peninsular Indian races by several characters of the tail, which in *Viverricula malaccensis malaccensis* (Gm.) is much paler towards the tip and has only seven dark rings against the eight of the Indian animals.

Specimens from Calcutta sufficiently agree with Gray's figure of *Viverra bengalensis* inhabiting "most part of Bengal" (*Ill. Ind. Zool.* I, 1830-2, pl. 4) and must be known as *Viverricula malaccensis bengalensis* (Gray and Hardw.). The Calcutta specimens are greyish buff, quite without any rufous tinge, and have the stripes and spots clear black and sharply defined.

Specimens from the neighbourhood of the Chilka Lake, on the borders of Orissa and Madras, are more reddish; but one from

Dharwar, South Mahratta country, resembles in colour one from Calcutta. All the skulls, however, differ from the Calcutta examples in their small size and much smaller bullae which are both shorter, lower and more compressed than in the northern form: greatest lengths:—Chilka, 94-95; Dharwar, 95 mm. against Calcutta, 104-105 mm. (one subadult example 103 mm.).

For the present we regard Chilka and Dharwar animals as representative of *Viverricula malaccensis indica* (Desmarest, *Nouv. Dict. d'Hist. Nat.*, VII, 1817, p. 170).

We have not seen *Viverricula malaccensis deserti*, Bonhote (*Ann. and Mag. Nat. Hist.* (7), I, 1898, p. 120) from Rajputana which is probably well entitled to subspecific rank.

A specimen from Cachar is impossible to identify subspecifically: it is boldly marked but the number of rings on the tail ally it to eastern rather than to Indian forms.

Kloss has recently described from South Central Siam as *Viverricula malaccensis thai* (*Journ. Nat. Hist. Soc. Siam* III, 1919, p. 352) a subspecies rather paler and duller than *V. m. malaccensis* and with skull characters approximating towards *V. m. rasse* (Horsfield) of Java. This probably extends into Southern Burma.

#### Genus *Paradoxurus* F. Cuv.

Dr. Annandale has submitted to us photographs of Buchanan-Hamilton's original paintings of *Ichneumen prehensilis* and *Ichneumen bondar* which formed the basis for the descriptions of Desmarest's *Viverra prehensilis* and *Viverra bondar* (*Mammalogie*, 1820, pp. 207, 210).

We have received specimens from the vicinity of Calcutta which quite agree with Buchanan-Hamilton's figures and with the descriptions based on them by Desmarest.

*Viverra prehensilis* is the first name applied to any Indian *Paradoxurus* and the Bengal form would bear the name *P. hermaphroditus prehensilis* were it not that Desmarest's name is preoccupied by *Viverra prehensilis*, Kerr (*Animal Kingdom*, 1792, p. 169 = *Cercoleptes caudivolvulus*, the Kinkajou, fide Blanford, *P.Z.S.* 1885, p. 784). The name, therefore, of the Bengal subspecies must be *Paradoxurus hermaphroditus bondar* (Desm.) to the figure of which many Calcutta specimens closely approximate. So, indeed, do others to the figure of *Viverra prehensilis*: but all races of *Paradoxurus* show a good deal of variation within themselves due principally to age and we are not prepared to admit, on the existing material, the occurrence of two forms or species in Bengal.

In addition we have a specimen from Dharwar obtained by the Mammal Survey of the Bombay Natural History Society which has been listed by Wroughton as *Paradoxurus niger* (*Viverra nigra* Desmarest, *op. cit.* p. 208, Pondicherry) and which, allowing for certain individual abnormalities, agrees with Desmarest's description.

On the other hand the specimen will not fit in with Wroughton's synopsis of the genus as given later (*Journ. Bombay Nat. Hist. Soc.* XXV, 1917, pp. 48-51; XXVI, 1918, p. 49) and we cannot but think that some topographical confusion has taken place.

The Zoological Survey also possesses a specimen from the Daffa Hills which agrees, so far as its condition permits to say, with the form described as *Paradoxurus vicinus* Schwarz (*Ann. and Mag. Nat. Hist.* (8) VI, 1910, p. 230) from Assam which Wroughton has identified with *Paradoxurus hermaphroditus strictus*, Horsfield (*Ann. and Mag. Nat. Hist.* (2) XVI, 1837, p. 105. Nepal plains).

It appears that *Paradoxurus birmanicus*, Wroughton (*op. cit.* XXIV, 20th March 1917, p. 51), from Sagaing, Upper Burma, is antedated by *Paradoxurus hermaphroditus laotum* Gyldenstolpe (*Kunigl. Sv. Vet. Akad. Handl.*, 57, No. 2, 2nd Feb. 1917, p. 26, pl. iv, figs. 2, 4) from Chiangmai, North Siam, since Wroughton himself says that this race extends throughout Burma eastwards into Siam and south to meet in Tenasserim *P. h. rarus* Miller, which is the North Malayan form. More recently Gyldenstolpe, who has presumably examined Burmese material, states (*Journ. Nat. Hist. Soc. Siam*, III, 1919, p. 147, note) that *P. birmanicus* is absolutely identical with *P. h. laotum*.

A specimen in the Zoological Survey recorded as from Rangoon but obtained from a Menagerie is not this race but belongs to the *bondar* section and can be matched by examples from Calcutta. Its locality is probably wrong.

## MISCELLANEA.

### BIRDS.

#### A further note on the Red Jungle Fowl.

In our paper "On the proper name of the Red Jungle Fowl from Peninsular India,"<sup>1</sup> Mr. H. C. Robinson and I expressed doubt as to the wildness of the birds of Pulo Condore which Linnaeus cited under *Phasianus gallus* (*Syst. Nat.*, ed. 12, 1758, p. 270) because Mr. W. J. F. Williamson's bird-collectors, who visited the island last year, obtained no specimens.

I have, however, recently been looking up accounts of Pulo Condore and the following two passages show quite clearly that there is, or was, a Jungle Fowl on the island.

The first is from Dampier's "Voyage round the World." He visited the group in 1687 and wrote:—

"Here are many sorts of birds, as Parrots, Parakites, Doves and Pigeons. Here are also a sort of wild Cocks and Hens. They are much like our tame Fowl of that kind; but a great deal less, for they are about the bigness of a Crow. The Cocks do crow like ours, but much more small and shrill; and by their crowing we do first find them out in the Woods where we shoot them. Their flesh is very white and sweet."

The other is from the "Voyage of Discovery to the Pacific Ocean" (Captain Cook's Third Voyage), Vol. III, 1874, by Captain King, LL.D., F.R.S. He wrote (p. 463) of his visit in 1780:—

"Our sportsmen were very unsuccessful in their pursuit of the feathered game, with which the woods are well stocked. One of our gentlemen had the good fortune to shoot a wild hen; and all the shooting parties agreed that they heard the crowing of the cocks on every side, which they described to be like that of our common cock, but shriller; that they saw several of them on the wing, but that they were exceedingly shy. The hen that was shot was of a speckled colour, and of the same shape, though not quite so large, as a full grown pullet of this country. Monsieur Sonnerat has entered into a long dissertation, to prove that he was the first person to determine the country to which this most beautiful and useful bird belongs, and denies that Dampier met with it here."<sup>2</sup>

So there can be no objection to accepting Linnaeus' Pulo Condore birds as Jungle Fowl.

<sup>1</sup> *Rec. Ind. Mus.* XIX, pp 13-15 (1920).

<sup>2</sup> Sonnerat, however, though writing about Jungle Fowl, was really dealing with another species—his "Coq Sauvage des Indes" (*Gallus sonnerati* Temm.) and not with the present one.

Nevertheless we cannot accept the *Phasianus gallus* of the "Systema Naturae" as the name for the Red Jungle Fowl for he had used it previously in the *Fauna Svecica* for domesticated European birds and it cannot be employed again for something else. This contention must hold whether names based on domesticated races are accepted or not. It refers to a domestic breed or is not available. There are several species of Jungle Fowl and, as Mr. Stuart Baker points out in his latest remarks on a form of *Gallus* (*Journ. Nat. Hist. Soc.*, Siam IV, 1920, p. 33), there is nothing to prove that Linnaeus' domestic fowl was unquestionably the direct descendant of the Red Jungle Fowl. The name *Phasianus gallus* therefore cannot properly be applied to this last: we cannot even regard it as a subspecies of *Ph. gallus*.

While our paper was being printed Messrs. Bangs and Penard published an article on "The name of the Common Jungle Fowl."<sup>1</sup> They discuss the synonymy of the species and, considering that *Phasianus gallus* is adequately described and can apply to none other than the Red Jungle Fowl, select Bengal as the "terra typica" restricted.

This finding I cannot accept, even if I accepted for a wild bird the *Phasianus gallus* of the 12th Edition. Even then it would not be available for the western race since the distribution given by Linnaeus is "India Orientali: Pouli candor, etc." India orientali merely means the East Indies as contrasted with the West Indies, not the eastern part of India, and we cannot regard Pulo Condore as other than a "terra typica" restricted by Linnaeus himself. Messrs. Bangs and Penard's selection of Bengal comes therefore too late.

There is no question as to the application of *Tetrao ferrugineus*, Gmelin (vide also Hartert, *Nov. Zool.*, IX, 1902, p. 218) so that the specific name of the Red Jungle Fowl is *Gallus ferrugineus* (Gm.), "terra typica" countries east of the Bay of Bengal, the eastern subspecies being thus *Gallus ferrugineus ferrugineus*. The western race was without a name until recently (a point on which Messrs. Bangs and Penard are in agreement) and this we have supplied by proposing as popular a name as possible: *murghi* (fowl) is perhaps one of the best known words in the Indian vernacular.

Mr. Stuart Baker is quite out of order in using *bankiva* as the specific name (*l.c.s.* and *Journ. Bombay Nat. Hist. Soc.* XXV, 1917 pp. 1-21) the more so in that he employs *ferrugineus* as a subspecific one (though crediting it to Blyth instead of Gmelin). *Tetrao ferrugineus* was proposed by Gmelin in 1788 (*Syst. Nat.*, ed. 13, p. 761), whereas *Gallus bankiva* was not published until 1813 (Temminck, *Hist. des Pigeons et des Gallinaces*, II, p. 87; Java and Sumatra: not, fide Baker, *Phasianus bankiva* Raffles, *Trans. Linn. Soc.*, XIII, 1822, p. 319; Sumatra).\*

<sup>1</sup> *Proceedings of the New England Zoölogical Club*, VII, pp. 23-25 (1919).

<sup>2</sup> Mr. Baker commits another error, as what Raffles recorded was *Phasianus gallus*, Linn.

Messrs. Bangs and Penard also give Sumatra as the type locality of *bankiva* but Java must be taken, as the specific name is merely a slightly altered Javanese one. It is quite true, however, that the race occurs in Sumatra as well. I have lately seen in the Zoological Museum at Buitenzorg specimens from the south-west of that island though *f. ferrugineus* is found in the north-east.

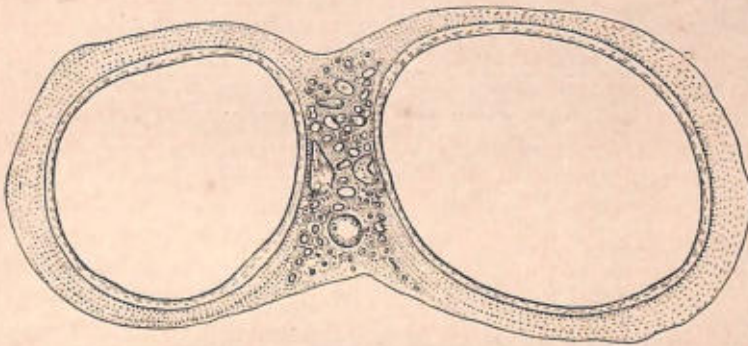
C. BODEN KLOSS,  
M.B.O.U., C.M.A.O.U.

#### BATRACHIA.

#### A short note on the structure of the Compound limb bones of *Rana*.

This short note is published with a view to record an observation on the structure of the bone of the common large frog of Lahore (*Rana tigrina*) that I made sometime ago. Owing to the pressure of other work, not having as yet a chance to elaborate the problem in detail, I wish to bring this observation to the notice of other workers.

In all accounts of the histological structure of the bone of frogs, the bony substance is described as compact, consisting of very thin lamellae superimposed on one another, and without any Haversian system of canals intersecting or passing through them.



Transverse section of the tibio-fibula of the frog *Rana tigrina*,  $\times 16$ .

For example, one may refer to the description given in Parker and Parker's "An elementary course of practical Zoology," pp. 116-117 and 125.

In one of the sections of the tibio-fibula prepared by me by the ordinary grinding method, however, I found a different state of things. The structure of the outer walls of the two component elements of this bone was similar to that of any other bone of the frog, but in the middle, where the two bones have fused together, one finds instead of the compact structure, a regular system of canals traversing this area as seen in the figure. Seen with a

microscope this system appears identical with the Haversian canal system in the bones of higher vertebrates.

Numerous other sections of this region and of other bones similarly prepared yielded the following results:—That a system of canals of the type described above is present also in the region of the union between the radius and the ulna, the tibia and the fibula and in the ridge on the proximal end of tibio-fibula.

SUNDER LAL HORA, *M.Sc.*,  
*Research Assistant, Zoological Survey of India.*

XXI. NOTES ON SOME INTERESTING  
LARVAE OF DRAGONFLIES (ODONATA)  
IN THE COLLECTION OF THE  
INDIAN MUSEUM.

By F. F. LAIDLAW, M.A.

ZYGOPTERA

LIBELLAGINAE.

*Rhinocypha unimaculata*, Selys.

Larvae 1 ♂, 1 ♀ Kalimpong, Darjiling Dist., Apr.-May, 1915.

F. H. Gravely  $\frac{84}{H1}$ .

Determined from venational characters. The specimen is a male in the last instar, its total length is 19.5 mm. It lacks the lateral triquetral gills. In general the specimen bears a resemblance to that of the larva of *Micromerus lineatus*, Burm. (Fraser, *Rec. Ind. Mus.* XVI, 1919, pp. 197-198, pl. xxiii). From examination of this specimen I can add the following to his account. The tergite of the eleventh abdominal segment is present, unmodified as a gill, and apparently identical in structure with the appendix dorsalis of the Anisoptera.

The gizzard consists of sixteen folds. Each carries a single row of about five conical teeth, distant from each other. I cannot make out any differentiation into major or minor folds.

This larva, and equally that of *Micromerus*, exhibit certain primitive characters, especially in the mask, the gizzard, and in the possession of an unmodified appendix dorsalis.

They approach in some respects the larvae of the Calopteryginae, whilst remaining I think rather less specialized. They show no evidence of near relationship to the Epallaginae. This is rather surprising as the venation of the adult has by most students been regarded as indicating a fairly close connection between these two subfamilies.

Their structure certainly emphasized the desirability of according the group subfamily rank.

SYNLESTINAE.

*Megalestes major*, Selys.

(Text-figs. 1-3.)

3 examples; Pashok, 5,500 ft.  $\frac{3463}{H1}$ .

Mr. Tillyard has pointed out to me that these larvae, which I had previously identified from an examination of the venation, are not Lestine but most distinctly Synlestine in their characters. He was able to demonstrate a very close similarity in structure between the larva of *Megalestes* and that of the Australian genus *Synlestes*. Hence it is necessary to remove the genus *Megalestes* from the neighbourhood of *Lestes* and refer it to the subfamily Synlestinae as defined by Tillyard (*The Biology of Dragonflies*, p. 277). The subfamily will then include three genera:—*Synlestes*



TEXT-FIG. 1.—Gizzard (4 folds shown) of *Megalestes major*.

from Australia, *Megalestes* from India, and *Chlorolestes*, which is African. Needham has already described an unidentified larva of large size from India, which in important respects (e.g. structure of mask and caudal gills) is clearly related to *Megalestes*, though belonging to a larger insect. There is only one known Indian genus, *Orolestes* of Maclachlan, to which this larva can be assigned with any degree of probability; and in respect of details of venation, as noted by Needham, this ascription is very reasonable. Moreover, Mr. Tillyard has recently examined the type specimen of *Orolestes selysi* Macl. in the Maclachlan collection, and informs me that the species is a true Synlestine; so that when the identification of the larva is settled the genus must in all probability be added as a fourth to those of the subfamily. (See

Needham, *Entomol. News* XXII, 1911, pp. 342—344, pl. xi, figs. 1—4.)

I quote here Tillyard's definition of the larva of the Synlestinae (*Biology of Dragonflies*, p. 277).



TEXT-FIG. 2.—Labium of *Megalestes major*.

“Larva very slender and elongated, with exceedingly long spider-like legs, mask with incised median lobe, lateral lobe narrow, cleft into two sharp teeth and with a denticulate inner border; movable hook long and slender; no setae present, antennae with greatly elongated pedicel, caudal gills with secondary tracheae somewhat oblique to gill axis. Gizzard with dentition reduced to a few large teeth on each field.”

This definition was drawn entirely from the larva of *Synlestes*, but it will be evident that the *Megalestes* larva (and also Needham's larva) show a close approach to the same type.

The measurements of the largest of the three larvae of *Megalestes major* (final instar?) are as follows:—

Total length 19.5 mm.; gills 5.75 mm. additional; abdomen

14 mm.; mask 3.25 mm.; antennae 3.5 mm. Breadth of head 4 mm.; length of hindermost femur 6 mm.

The creature is smooth and slender with long legs, and is of a nearly uniform sandy colour.

*Head*, widest across the middle of the large eyes; hind angles rounded, not spinulose. Antennae seven-jointed, the first and second segments stouter than the remainder, the third segment is the longest. Labium elongate, with hinge reaching to between second and third pairs of legs posteriorly. Median lobe cleft by a median incision which extends just below the level of the base of the lateral lobes. Lateral lobes with a long and strong movable hook, and with two stout incurved hooks on the end; the outer hook simple and half as large as the inner. Inner margin of lobe finely serrate. *No raptorial setae.*



TEXT-FIG. 3.—Lateral anal gill of *Megalstes major*.

*Legs* slender, longitudinally carinate. *Wings* reaching to base of fifth segment. *Abdomen* cylindrical, segment 10 slightly compressed, a dorsal ridge is present on 8-9-10, margin of the last segment entire. Lateral carinae on segments 1-9; on 6-9 these carinae each end apically in a small sharply pointed spine. Gills elongate oval, narrowed somewhat at their bases, each jointed on to a small basal segment, rounded regularly at their apices.

## ANISOPTERA.

### CORDULEGASTRINAE.

#### *Anotogaster* sp.

1 ♀ Dalat, Langbian Province, Southern Annam, 5,000 ft., C. Boden Kloss. March—May 1918.  $\frac{1455}{H_2}$ .

Total length 45 mm; anal appendages 3.25 mm. additional. Head 9 mm. in width, equal to the greatest width of the body; labium 12 mm. long. Length of abdomen 33 mm; of hinder wing-case 9 mm. The specimen is a female, probably in the last instar. It is interesting geographically as it is I believe the first Cordulegastrine recorded from so far south, in Asia at any rate. I do not know of any record hitherto south of the Tropic of Cancer. Also its large size makes it remarkable and leads me to suppose that it is probably a larva of *Anotogaster sieboldi*, the largest species of the subfamily. The adult female of this Japanese species has a span of over 120 mm.

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## XXII. OBSERVATIONS ON A CARNIVOROUS LAND-SNAIL.

By N. ANNANDALE, D.Sc., F.A.S.B., Director, and B. PRASHAD, D.Sc., Assistant Superintendent, Zoological Survey of India.

In the genus *Ennea*, H. and A. Adams, there are at present included a number of species which differ greatly in the complexity of the armature of the mouth of the shell. These were separated into subgenera by Pfeiffer in Vol. V of his *Monographia Helicorum Viventium* as long ago as 1859, but we have been unable to find any detailed description of the armature in any of the more complex forms that may be accepted as *Ennea*, s.s.<sup>1</sup> All descriptions of shells of this type that we have been able to find refer merely to the external appearance of the aperture and fail to discuss the internal structure of the folds and teeth connected therewith. As we have recently had an opportunity of examining the commonest and most widely distributed species of the genus both living and preserved, we propose to publish here an account of the structure of the shell and to add certain observations on other points of interest.

### *Ennea bicolor* (Hutton).

1908. *Ennea bicolor*, Blanford and Godwin-Austen, *Faun. Brit. Ind.*, Moll. I, pp. 19, 20, fig. 12.

For the synonymy and literature of the species see the reference cited. Published descriptions of the shell omit several particulars of interest in connection both with the aperture and with other parts. We give, therefore, as a preliminary to the description of a new insular race, a fresh description of the shell of the species.

The shell is small but somewhat variable in size, with from 6 to 8½ whorls, subcylindrical, with the apex blunt; hyaline and almost colourless when fresh but rather thick. The whorls are never more than slightly swollen. Their proportions differ somewhat in different forms of the species. The body-whorl is compressed from side to side and bears on each side a funnel-shaped depression. That on the inner aspect surrounds the umbilicus, which is completely closed. The sculpture consists of very fine, straight vertical ribs, which are strongly developed just below the

<sup>1</sup> H. and A. Adams in their original description of the genus, as a subgenus of *Pupa*, selected no type-species but mentioned *E. bicolor* first on their list, see *Gen. Recent Mollusca*, II, p. 171 (1858). Whether we accept *E. bicolor* (with Blanford and Godwin-Austen) as the type-species of the genus, or *E. elegantior* (Pfeiffer) with von Martens and Nevill, *Huttonella*, Pfeiffer is synonymous with *Ennea*, s.s.

suture on all but the apical whorls and give it a fimbriated or almost subspinose appearance. On the greater part of the shell these ribs are obsolescent on the lower parts of the whorls, but on the whole surface of the outer aspect of the body-whorl they are well developed. They are absent from the first two and a half whorls. The shell as a whole has a smooth and polished surface. The aperture is subquadrate but varies somewhat in outlines and proportions. It always has the angles rounded. The armature consists of two obtuse, somewhat compressed teeth and two elongate internal folds. We will describe first its external appearance and then its internal structure. The actual orifice is conspicuously trilobed owing to the unusually strong development of the armature. The three lobes are unequal. The uppermost is a narrow sinus lying between the outer lip and a strong internal fold, which projects out of the orifice for a short distance in the form of a ridge. The second lobe, which is considerably broader, lies between this ridge and the columellar margin, while the third, which is intermediate in size, is bounded externally by a blunt tooth lying inside the outer lip at the base of the first lobe. There is a second internal tooth near the inner anterior angle of the orifice, while a second internal fold lies inside the columellar part of the peristome. The peristome itself is thickened and a little expanded. It is interrupted by the upper lobe or sinus of the orifice, which is pointed and slightly curved, and is often imperfectly developed between the termination of the upper fold and the upper extremity of the columella.

The two folds and the two teeth may now be described in detail. The upper fold arises on the floor of the shell about half way up the body-whorl and runs down, following the twist of the spiral, to emerge from the aperture at the upper extremity a short distance within the outer margin. It has the form inside the shell of a highly convex crest, but on the edge of the aperture assumes that of a low ridge. It is rather thick as a whole and has a blunt, but not thickened free edge. The lower fold, although less conspicuous externally, is considerably longer and in other respects better developed. It arises on the internal column near the suture of the body-whorl and runs along the former as a convex crest, diverging slightly from the line parallel to that of the upper fold. The free margin is considerably thickened on the inner side. A broad deep gutter, which expands somewhat towards the aperture, is thus produced between the two folds. The foot slides along this gutter as the animal emerges. The outer tooth represents on the internal surface of the shell the external funnel-shaped depression on the outer aspect and is thus to a considerable extent hollow. It forms with the upper fold a narrow sinus in which the pulmonary orifice and the anus lie when the animal is expanded. The internal or basal tooth is solid and is not represented by any external depression. The depression on the inner aspect of the whorl is represented internally by a barely perceptible thickening at the outer extremity of the lower fold.

There is preserved in the Indian Museum a series of shells from the old A. S. B. collection that Nevill<sup>1</sup> believed to be "probably typical specimens from Hutton." These differ constantly from the figure published in the "Fauna" and cited above, in tapering less, in having the body-whorl less swollen and in the shape of the aperture, which is more elongate and has the columellar and outer margin more nearly equal in length. The specimens have the sculpture we have described above well developed, though the shell has usually been described merely as smooth and polished.

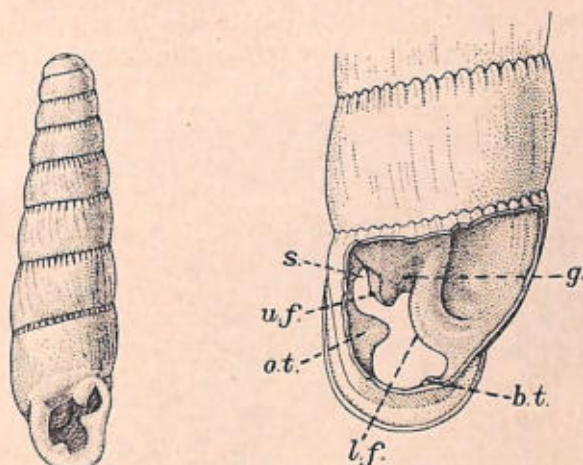


FIG. 1.

FIG. 2.

FIG. 1.—Shell of *Ennea bicolor* race *barkudensis*, Annandale & Prashad. Ventral view, x 8.

FIG. 2.—*E. bicolor* race *barkudensis*, dorsal view of the last two whorls with the shell of the body-whorl removed to show the folds and teeth, x 16.

*b.t.* basal tooth, *g* gutter, *l.f.* lower fold.  
*o.t.* outer tooth, *s.* sinus, *u.f.* upper fold.

#### Race *barkudensis*, nov.

As we find that individuals from a small island in the Chilka Lake differ quite constantly from what we take to be the *forma typica* from the Ganges valley, and also from any of the forms already described and relegated to the synonymy of the species, we propose to describe the race as new under the above name.

The shell is considerably narrower than that of the *forma typica*, the proportions of breadth to height being 1 : 4.5; it tapers less and has when mature  $8\frac{1}{2}$  whorls; the apex is usually a little swollen and the aperture is relatively smaller and narrower. The structure and sculpture of the shell, however, are precisely similar to those of the typical form.

<sup>1</sup> *Hand List Moll. Ind. Mus.* 1, p. 6 (1878).

## Measurements of shells (in millimetres).

	A.	B.	C.
Length .. .. .	6.8	6.3	6.5
Maximum breadth .. .. .	1.6	1.5	1.5
Length of the mouth .. .. .	1.5	1.5	1.6
Breadth of the mouth .. .. .	1.2	1.3	1.3

The animal agrees in colouration with those originally described by Hutton<sup>1</sup> and only differs from Stoliczka's description<sup>2</sup> and Semper's coloured figure<sup>3</sup> in that the scarlet colour of the head and body is completely restricted to the internal structures connected with the eye-stalks. The rest of the extruded parts are of a

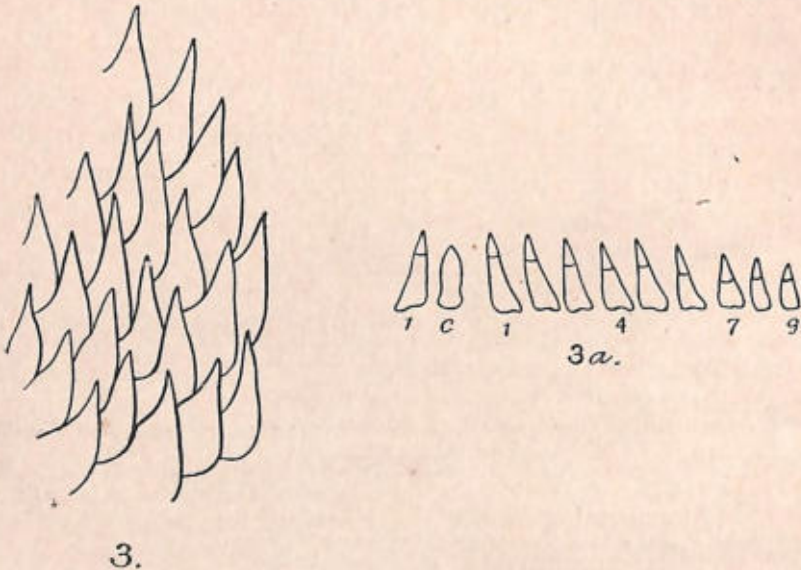


FIG. 3.—Radular teeth of *E. bicolor* race *barkudensis*, general arrangement.  
 .. 3a.—Radular teeth, one side of a complete row of teeth.  
 c. central; 1, 4, 7, and 9 lateral teeth.

bright shade of lemon-yellow and the mantle is orange-scarlet. We figure the radular teeth. Their shagreen-like arrangement is shown in fig. 3. In general facies, doubtless also in function, it has an interesting resemblance to that of the papillae on the tongue of certain carnivorous mammals.

*Type-specimen.* No. M <sup>11711</sup>, Zoological Survey of India (*Ind. Mus.*).

We found this race of *E. bicolor* fairly common, but by no means abundant, on Barkuda Island in the Chilka Lake in the

<sup>1</sup> *Four. As. Soc., Bengal*, III, pp. 86, 93 (1824).

<sup>2</sup> *Ib.*, XI, pt. 2, pp. 169-171, pl. viii, figs. 7, 8 (1871).

<sup>3</sup> *Reis. d. Philippinen*, III, p. 250, pl. viii, fig. 14 (1870-1894).

latter half of June, 1920. The snails were taken on a low flight of stone steps leading to a bungalow. They emerged in wet weather, and especially on damp evenings, from the interstices of the stone-work and the earth at its base. The largest number of individuals we saw on any one evening was half a dozen. The *Ennea* was accompanied, in much larger numbers, by an *Opeas*, which Col. Godwin-Austen<sup>1</sup> has identified provisionally as *O. gracilis* (Hutton). The *Ennea* was evidently preying upon the *Opeas*, for we found one or two individuals of the former attached to the foot of individuals of the *Opeas*. The attack, however, was by no means vigorous and we could discover very few fresh empty shells. Probably this was due to the fact that the carnivorous species was just recovering from its hot-weather aestivation. Godwin-Austen in the "Fauna" records another instance of the association of the two species, observed by Mr. Collet on the sea-wall at Galle, Ceylon. Semper also found *E. bicolor* in the Philippines preying on a form of *O. gracilis*.<sup>2</sup>

It would, appear, therefore that these two species (both of which are remarkable for their wide distribution and are often found in India in places where pot-plants are kept) or closely allied forms habitually occur together. On Barkuda the vegetarian snail is, as might be expected, very much the more abundant of the two. As Godwin-Austen points out in the "Fauna," there is a certain resemblance between the shells, and this is also so with the animals; but they are readily distinguished in life by the scarlet markings of the *Ennea*. These are entirely absent in the *Opeas*, the mantle and exposed parts of which are of a uniform bright yellow colour.

The resemblance between the gutter produced by the internal folds of the shell in *Ennea* and *Clausilia*<sup>3</sup> is very close and must be entirely convergent. There is, of course, no clausilium in *Ennea* and the origin of the two main folds is slightly different in the two genera. Moreover, supplementary palatal plicae are absent in *Ennea*, as are oral teeth in *Clausilia*. In other words, the internal armature has become exceedingly complex in *Clausilia*, doubtless in correlation with the production of the clausilium, while in *Ennea* the external armature is better developed. In the latter genus the armature does not suffice to close the shell completely when the animal is retracted, but seems rather to protect the more important external parts of the body in the act of and on the completion of expansion. This may perhaps be useful to a carnivorous animal which burrows into soft tissues and mucus while feeding, at any rate so far as the upper sinus and the pulmonary orifice are concerned. The walls of the gutter between

<sup>1</sup> *Rec. Ind. Mus.* XIII, p. 351 (1917). Col. Godwin-Austen informs us that he proposes to describe this form shortly as a new species.

<sup>2</sup> Semper, *loc. cit.* pp. 137-138, where the species is referred to as *Stenogyra panayensis*; on pl. viii, fig. 15, Semper calls it *Subulina panayensis*; for synonym see Gude, *Faun. Brit. Ind. Moll.* II, pp. 355, 357 (1914).

The association of the two species is referred to by Semper on p. 250.

<sup>3</sup> Smith and Woodward, *Ann. Mag. Nat. Hist.* (6) V, pp. 209-213, pl. xi, A (1890).

the two main folds may also assist in cleaning the foot and head as they are retracted. It is possible, therefore, that whereas, as is clearly the case, the whole structure is protective in function in *Clausilia*, in *Ennea* it assists in active aggression. The case is all the more remarkable in that *Ennea* belongs to a family (the Testacellidae) in which the shell is often completely degenerate; but it is perhaps more common<sup>1</sup> than is generally realized to find animals of similar habits and related structure adopting in the course of evolution diametrically opposite methods of improving their means of attack or defence.

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<sup>1</sup> See Annandale, *Four. As. Soc. Bengal* (n.s.), IX, p. 75 (1913); *Mem. Ind. Mus.* V, p. 54 (1915) and *Mem. As. Soc. Bengal*, VI, pp. 196-197 (1918) and Prasad; *Rec. Ind. Mus.* XVI, p. 401 (1919).

XXIII. REVISION OF THE INDIAN HOMALOPTERIDAE AND OF THE GENUS  
*PSILORHYNCHUS* (CYPRI-  
NIDAE).

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(Plates X, XI.)

In investigating the means whereby the small fish of the mountain torrents of India adhere to rocks and stones, I have been obliged in the first instance to consider the taxonomy of the Indian species assigned by Day to *Homaloptera*. Great confusion prevails as to both the generic position and the specific limits of the species. In this paper I attempt to elucidate these questions.

Only three Indian species of the genus are described by Day in his *Fishes of India* and *Fauna of British India*, viz. *H. brucei*, *H. maculata* and *H. bilineata*. Of these species in their correct interpretation the first two were figured by Gray and Hardwicke as *Balitora brucei* and *B. maculata* in the *Illustrations of Indian Zoology* in 1832. *Homaloptera bilineata* was described later by Blyth, who distinguished it from the true *Balitora* of Gray by the following vague phrase, as Bleeker puts it:—"Homaloptera, Kuhl and van Hasselt. A form intermediate to the ordinary spineless loaches and *Balitora* of Gray." I intend to criticise this statement when discussing the relationships of the family, but it will not be out of place to point out here for the sake of clear understanding that, except Day and probably Günther, no ichthyologist who has examined specimens of *Balitora brucei*, *B. maculata* and *Homaloptera bilineata* has put them all in the same genus. The following have been the probable causes of confusion:—

(i) The publications by Gray of the figures in the "*Illustrations*" without any description.

(ii) The fact that Day confused South Indian species with those from the Eastern Himalayas and Assam, and further included more than one species under each name he accepted. There is much inconsistency in Day's earlier and later works in the descriptions of the various species he assigned to *Homaloptera*.

Vinciguerra,<sup>1</sup> who studied *Balitora brucei* and *Homaloptera bilineata* from specimens from Burma, found himself compelled

<sup>1</sup> Vinciguerra, *Ann. Mus. Stor. Nat. Genova* XXIX, pp. 325—335 (1889—1890).

to separate *H. bilineata* from *B. brucei* and constituted a new genus (*Helgia*) to accommodate the former. *H. bilineata* possesses a long, pointed snout and a slightly depressed body. In these and other characters it comes so close to the true *Homaloptera* from Java as figured in Bleeker's "*Atlas Ichthyologique*" that it cannot be separated generically. *Balitora brucei* and *B. maculata* have a broad, trenchant snout, with the head and body greatly depressed, and broad pedunculate pectorals.

I have been able to examine specimens from both Northern and Southern India. So far from those found in the neighbourhood of the Nilgiris being specifically identical with those from the Himalayas, they seem to me to be generically distinct. Further I agree with Blyth<sup>1</sup> and Vinciguerra (*op. cit.*) that the Burmese forms differ generically from those of the Himalayas, and that neither type agrees with the South Indian forms. I am, therefore, forced to recognise three genera, namely *Homaloptera* van Hass., *Bhavania* gen. nov. (for the South Indian forms) and *Balitora* Gray. These three genera may be distinguished by the following key:—

#### KEY TO THE INDIAN GENERA OF HOMALOPTERIDAE.

Pectoral fins definitely pedunculate and greatly expanded. Head short and broad; semicircular trenchant snout; short conical barbels; upper lip tentaculate. Head and body much depressed; 21 rays in pectoral	...	...	...	<i>Balitora.</i>
Pectorals of almost normal size, and devoid of a well-developed fleshy peduncle. Head normal; snout bluntly pointed; short thick barbels. Thick well-developed lips devoid of tentacular processes. Head and body moderately depressed; 19 rays in pectoral	...	...	...	<i>Bhavania.</i>
Pectorals normal. Head long and narrow, almost cylindrical; snout long and pointed; short barbels; fleshy lips. Head and body slightly depressed; rays in pectoral	...	...	...	<i>Homaloptera.</i>

#### *Balitora*, Gray and Hard.

Gray and Hardwicke, *Ill. Indian Zoology*, 1, pl. 88, figs. 1 and 2 (1832).

Head and body greatly depressed, eyes small, situated almost on the dorsal aspect of the head; mouth crescentic with tentacular lips; six short, stout barbels; pectorals and ventrals greatly expanded, the former with 21 rays and the latter with 11 rays; pectorals provided with a definite fleshy peduncle.

The two species of the genus, recorded from the Eastern Himalayas and Burma, can be distinguished by the following key:—

#### KEY TO THE SPECIES OF BALITORA.

1. Pectorals just reaching the ventrals, lower caudal lobe the longer	...	...	...	<i>B. brucei.</i>
2. Pectorals reaching beyond the ventrals, lobes of the caudal almost equal	...	...	...	<i>B. maculata.</i>

<sup>1</sup> Blyth, *Four. As. Soc. Bengal*, XXIX, p. 172 (1860).

**Balitora brucei**, Gray and Hardwicke.

(Plate XI, figs. 2—4.)

1832. *Balitora brucei*, Gray and Hard., *Ill. Ind. Zoology*, I, pl. 88, fig. 1.  
 1842. *Platycaira anisura*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 587, pl. lxviii.  
 1889. *Homaloptera brucei*, Vinciguerra, *op. cit.*, p. 323.

P. 9—10/12—11. V. 2/9.

The nature of the confusion referred to above can be fully realised on reading the description of *Homaloptera brucei* by Vinciguerra, who has recorded this fish from Upper Burma. I quote an English translation from this author which makes the whole matter quite clear:—

“It was after long hesitation, and not without reserve, that I decided to refer the many specimens of *Homaloptera* collected by Fea in the Meekalam river at the bottom of Mt. Mooleyit to *H. brucei* (Gray and Hardwicke). Of this species I do not know the original except from the reproduction made by McClelland and the descriptions given by Günther and Day. Between them such a difference is to be noticed, that it made me suspect that the specimens in the hands of one were not identical with those examined by the latter author, or, to put it better, that the specimens found in the Nilgiris mountains which served for the first description of Day, one of which passed to the collection of British Museum and served for the description of Günther, are specifically different from those described in the publication the *Fishes of India*.” Vinciguerra then proceeds to point out the discrepancies in the various descriptions. I am able to confirm Vinciguerra's doubt and with collections from various parts of India before me, I am in a position to separate Day's species from the Nilgiris from those of the Eastern Himalayas. Day's *H. brucei* from Southern India is the same as Jerdon's *Platycaira australis*, which I describe as *Bhavana australis* in this paper.

I have examined five specimens of *B. brucei*, one of which (No. 1509 of the Indian Museum) is in a very bad state, while four others, which were found in the same bottle with *Psilorhynchus balitora*, are from Cherrapunji in the Khasi Hills. Specimen No. 1509 is noted to have been purchased from Day, while the others were given to the Museum by Lt. Burne. All of them are very old, but still in a fairly good state of preservation.

*B. brucei* is a very peculiar fish with the head and body greatly depressed. The snout is semi-circular with trenchant margins. The eyes are small and approximated. On account of the depressed head and body the dorsal profile is but slightly arched, the ventral being almost horizontal. The region of the body in front of the ventral fin is devoid of scales on its ventral surface. The head is likewise scaleless, its length being contained  $6\frac{1}{2}$  times in the total length. The length of the caudal fin is contained  $5\frac{1}{4}$  times in the total length and the depth of the body about

11—13½ times. The eye is very small, situated on the dorsal aspect of the head and looks outwards and upwards; its diameter is contained 6½ times in the length of the head, which is almost as broad as long. The diameter of the eye is contained 3⅔-times in the length of the snout and 2⅔ times in the interorbital width.

*Barbels*:—There are six short, fairly thick barbels; four rostral and one at each angle of the mouth. The integument of the spaces between the barbels is thickened and sometimes it becomes very difficult to see them. Those near the angle of the mouth are sometimes sunk in grooves and become almost imperceptible.

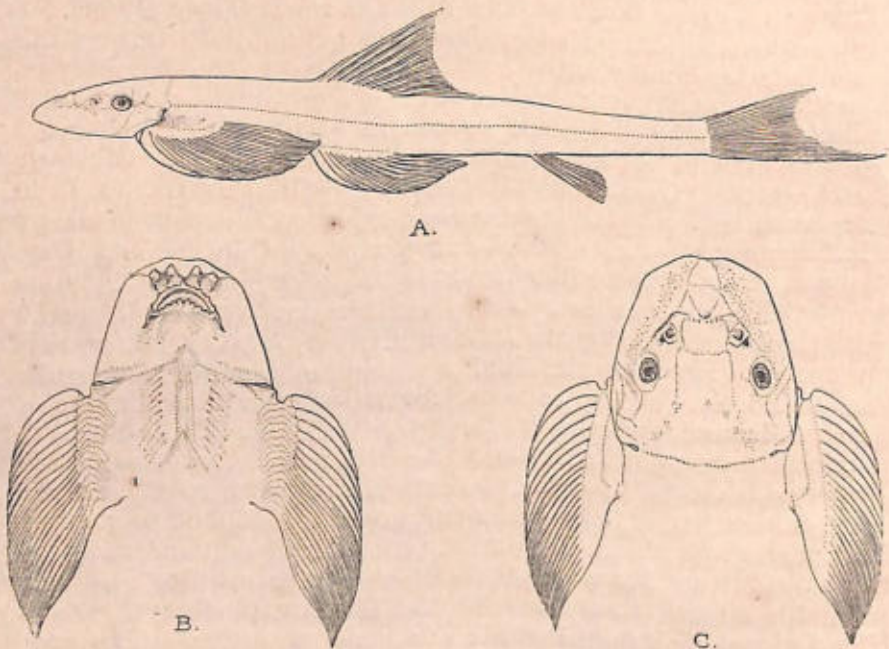


FIG. 1.—*Balitora brucei*, Gray and Hardwicke.

- A. Lateral view (nat. size).  
 B. Ventral view of head and chest  $\times 1\frac{1}{2}$ .  
 C. Dorsal view of head  $\times 1\frac{1}{2}$ .

*Fins*:—The pectoral and the ventral fins are greatly expanded and have thick cushion-like longitudinal pads of muscle on the ventral aspect of the simple rays. In the pectoral fin there are 21 rays in all, and either 9 or 10 of these may be simple. The first of these simple rays is greatly expanded and horizontally striated. The two first rays of the eleven of the ventral fin are simple. The two lobes of the caudal fin are unequal, the lower lobe being much the longer.

*Scales*:—Lepidosis is normal with the exception of the chest and belly. The scales are small and their number along the lateral line varies from 62 to 69.

A scale from the dorsal surface is squarish with almost central nucleus and about a dozen circular striae, which are

interrupted by 12 radii to the base and the same number to the apex. The following are the measurements of a scale from near the dorsal surface :—

Length	..	..	..	1.5 mm.
Breadth	..	..	..	1.5 mm.
Distance of base from the middle of nucleus	..	..	..	0.65 mm.

The specimen from which the scale for measurement was taken measures 85 mm. in length, excluding the caudal fin.

*Pharyngeal teeth*:—There are about nineteen teeth arranged in a single row. They are slightly curved near their extremities. Those at the top of the bone are longer than the others.

*Air-bladder*:—The air-bladder is much reduced and in general appearance resembles that of the Cobitidae. It is completely divided into two lateral portions which send small tubes inwards. These tubes come very close to each other but do not meet. Each of the lateral portions is enclosed in a bony capsule, which looks like a small bag placed on the under surface of the transverse process of the second vertebra, of which it seems to be a modification.

*Colouration*:—The specimens before me have lost their natural colouration, and, moreover, I do not find any detailed description given by Vinciguerra. Under the circumstances I can only refer to Gray's figures, which I think can be relied upon in this respect.

*Geographical Distribution*:—Eastern Himalayas (Darjiling); Khasi Hills, Assam; Eastern Tenasserim.

The following are the measurements (in millimetres) of two complete specimens:—

	A	B
Total length (including caudal)	100	100
Length of caudal	19	19
Greatest depth of body	9	7.5
Length of head	15.5	15.5
Width of head	13	15
Length of snout	9.2	9.2
Diameter of eye	2.4	2.4
Interorbital width	6.5	7.3
Length of caudal peduncle	15.0	17.5
Depth of caudal peduncle	4.0	4.2
Longest ray of dorsal	15.0	16.5
Longest ray of anal	7.5	10.5
Length of pectoral	23	23.2
No. of rays in pectoral...	10/11	9/12
No. of rays in ventral	2/9	2/9
No. of scales along L.L.	62	69

### *Balitora maculata*, Gray and Hardwicke.

(Plate XI, fig. 1.)

1832. *Balitora maculata*, Gray and Hard., *Ill. Ind. Zoology*, I pl. 88, figs. 2 and 2a.

1868. *Homaloptera maculata*, Günther, *Cat. Fish.* VII, p. 340.

D. 3/8. P. 9/12. V. 2/9.

The true *Balitora maculata* originally figured by Gray and Hardwicke differs considerably from the fish described by Day under the name of *Homaloptera maculata*. The differences are so great that I have separated Day's species and have described it under a new genus as *Bhavana annandalei*. Apart from the characters of the mouth, jaws and barbels, the following points of differences are clear from a comparison of the figures in Day's "*Fishes of India*" (pl. cxxii, fig. 2) and in Gray's "*Illustrations of Indian Zoology*":—

Gray's species differs from Day's in the very great expansion of the pectoral fins, in their being definitely pedunculate, in the shorter and broader head and in markings. Day's figure of the

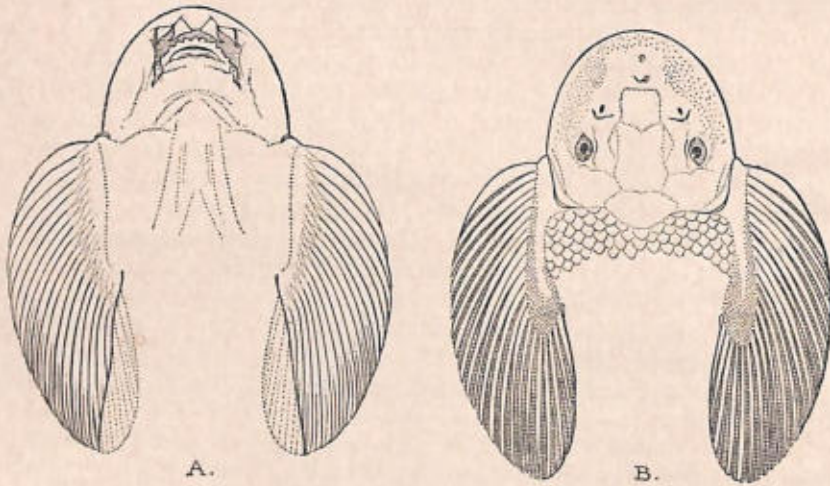


FIG. 2.—*Balitora maculata*, Gray and Hard.  
A. Ventral view of head and chest  $\times 1\frac{1}{2}$ .  
B. Dorsal view of head and fleshy pectoral peduncles  $\times 1\frac{1}{2}$ .

mouth shows only two pairs of barbels, the two at the angle of the mouth being very long; while Gray's figure shows two pairs of short, stumpy rostral barbels.

There are two specimens in the collection of the Indian Museum (Cat. No. 939), labelled by Day as *Homaloptera maculata* which can be referred to *Balitora maculata* of Gray. These specimens were collected by Dr. Wallich at Darjiling and the one figured by Gray was probably collected in Northern India as were most of the specimens figured in the "*Illustrations*." It is a pity that Day's South Indian specimen (No. 1510) in the Museum is in a very bad condition, as it is probably the original of his figure.

In both specimens of the true *B. maculata* I have seen the caudal fin is wanting, otherwise they are in a fairly good state

in spite of the fact that they have been preserved in alcohol in Calcutta for at least a century.

The head and body of this species is much depressed and the chest and belly are quite flat and scaleless. The length of head is contained  $5\frac{1}{2}$  times in the total length excluding the caudal and the depth of the body about 10 times. The eye is very small and situated on the dorsal surface of the head; its diameter is  $\frac{1}{8}$  of the length of the head, which is almost as broad as long. The anterior border of the snout is semicircular and its margin trenchant. The dorsal profile is slightly arched, and is highest near the base of the dorsal fin.

*Barbels*:—There are six short and stumpy barbels, fairly broad near their bases and tapering to a point. Of these, 2 pairs are rostral and one pair just at the angle of the mouth.

*Fins*:—The pectoral fin is greatly flattened and is pedunculate, the dorsal surface of the peduncle being covered with scales. There are 9 simple rays, the first being flattened, and 12 branched ones. The ventral fin has two simple rays and 9 branched ones, the first simple ray being moderately flattened. The first few rays of both the pectorals and ventrals are provided with thick cushion-like muscles on the ventral surface.

*Pharyngeal teeth*:—It is very difficult to see the exact number of teeth because they are loose and readily fall off. However in my preparation there are about 13 long, delicate teeth arranged in a single row.

*Scales*:—With the exception of the chest and belly, the whole of the body is covered with fairly large scales. There are about 60–64 along the lateral line, which shows a downward curvature in front of the origin of the ventrals. Eight rows of scales are present between the lateral line and the dorsal surface and 6 rows between it and the base of the ventral fin.

A scale from the dorsal surface is rectangular in general outline, with a flat base and an arched upper margin. There is no well defined nucleus. A few circular striae (6–7) are present near the base, while on the lateral margins and near the apex there are about a dozen. The striae are not interrupted as the radii to the base are wanting and only about 5–6 radii to the apex are present. There are also a number of shorter radii. In a scale from the lateral line the base and apex are both flattened but slightly emarginate. Other characters are the large number of circular striae and a few ill-defined radii to the apex.

The following are the measurements of a scale from near the dorsal surface of a specimen 95 mm. in length:—

Length .. .. .	1.7 mm.
Breadth .. .. .	1.3 mm.
Distance from the centre of the nucleus to the base .. .. .	0.5 mm.

*Colour*:—The specimens before me have completely lost their

natural colouration. I can only refer to Gray's figures, which I think can be relied upon in this respect.

*Locality*:—Eastern Himalayas.

The following are the measurements (in millimetres) and proportions of the specimens in the Museum:—

	A.	B.
1. Total length of body (caudal excluded) ...	89.5	93.2
2. Depth of body ...	9.5	9.5
3. Length of head ...	17.3	17.0
4. Width of head ...	16.0	16.2
5. Length of snout ...	10.5	11.5
6. Diameter of eye ...	2.3	2.3
7. Interorbital width ...	8.1	9.2
8. Length of pectoral fin ...	25.5	29.0
9. Length of ventral fin ...	20.0	24.0
10. Longest ray of dorsal ...	16.2	17.6
11. " " " anal ...	8.4	10.0

### Bhavanaia, gen. nov.

Head moderately long and broad, becoming rather pointed towards the snout; head and body depressed, eyes on the dorsal surface, looking outwards and upwards, mouth provided with thick, fleshy lips and usually with a number of muscle-bands running outwards and backwards from the angles and the lower lip. Pectorals and ventrals of almost normal size, with 19 rays in the former and 9 in the latter.

This genus has been so indiscriminately confused with *Balitora* from the Eastern Himalayas that great difficulty has been experienced in separating its species. Day (*Proc. Zool. Soc.*, p. 348, 1867) records *Homaloptera brucei* from the Wynaad Hills in Madras. I think this is the species described by Jerdon as *Platycaera australis*. In his later work Day confused it with *Balitora brucei* from the Eastern Himalayas. In the *Journal of the Asiatic Society*, XLI, p. 29, 1872, a description of *H. maculata* from Bhutan and the Khasi Hills is given, but the description does not agree with the figure of a male Wynaad specimen in the *Fishes of India*. Captain (now Major) Sewell's collection from Southern India clears up this confusion to a great extent. In it there are young of two species of *Bhavanaia*, in one the lower lobe of the caudal fin is slightly longer than the upper, the other has the lobes almost equal and also certain peculiarities of the lower lip and jaws. Under this South Indian genus, therefore, I have been able to distinguish two species.

### Key to the species of *Bhavanaia*.

Snout broad and obtuse, lower lip interrupted, caudal lobes equal ...	<i>B. annandalei</i> .
Snout somewhat pointed, lips continuous, lower caudal lobe the longer ...	<i>B. australis</i> .

**Bhavanaia annandalei**, sp. n.

(Plate X, figs. 1—3 ; pl. XI, figs. 5—7.)

1878. *Homaloptera maculata* (in part), Day, *Fishes of India*, II, p. 526.  
 1889. *Homaloptera maculata* (in part), Day, *Fauna Br. Ind.*, Fish. I, p. 243.  
 1909. *Homaloptera maculata*, Jenkins (*nec* Gray), *Rec. Ind. Mus.*, III, pp. 289.

Day has figured in the *Fishes of India* a male specimen from the Wynaad, but his figures are far from being accurate. Instead of the usual three pairs of barbels he figures only two and does not show anything of the musculature of the lower lip. His specimen No. 1510 in the Indian Museum from the Wynaad, perhaps the original of his figure, is in a very bad state as it has been allowed to desiccate.

I have taken specimen No. 2254 of the Zoological Survey of India from Tenmalai as the type-specimen for this species.

Like the other members of its family, the fish is highly specialised for an existence in rapid-running waters. The mouth is provided with thick lips, the lower one being widely interrupted on both sides near the angle of the mouth. Posterior to but immediately following upon the middle piece of the lower lip, there is a pair of prominent papillae which probably act as adhesive organs. The musculature connected with the lower lip is very interesting. Two bands of muscles proceed backwards from these papillae along the middle line for a short distance and then diverge from each other, thus appearing like an inverted letter Y. There are two more bands on either side running from the angle of the mouth outwards and backwards. The former pair pulls the middle piece of the lower lip in a backward direction, while the latter pulls the angle of the mouth outwards, thus straightening the flexure near the angle. When all the muscles act simultaneously the mouth is converted into a circular adhesive disc. The function is probably that of decreasing the air pressure in the cavity as in other adhesive organs.

The fish has a very graceful form, its ventral profile being almost straight and the dorsal slightly arched ; it is highest near the beginning of the dorsal fin and sinks gradually towards both ends. The head and body are depressed. The length of the caudal is contained  $6\frac{1}{2}$ , the height of the body 9, the length of head  $6\frac{1}{2}$  times in the total length including the caudal. The eyes are dorso-lateral in position, their diameter being contained 5 times in the length of the head.

*Barbels* :—In all there are six barbels, 2 pairs rostral situated close together and 1 pair maxillary, situated slightly anterior to the angle of the mouth. All of them are well developed, the outer rostral pair being slightly shorter than the others.

*Fins* :—The pectoral fins have eight simple rays, followed by 9 branched ones, which are in their turn followed by two more

simple rays, bringing the total to 19 in all. The ventrals have 2 simple rays, and 5 branched ones. On the ventral surface of the simple rays, both in the pectoral and ventral fins, transverse muscular bands are developed which probably help the fish in adhering to pieces of stone. The caudal fin has almost equal lobes and is slightly emarginate.

*Pharyngeal teeth* :—In young individuals the pharyngeal teeth seem to be arranged in more than one row and their number is very difficult to count. In the type they are disposed in a single row; five sharp, slender teeth are present on the upper part of the pharyngeal bone, while in the lower part there are some minute teeth very difficult to count. The former are slightly curved near their extremities.

*Scales* :—The entire body is covered with small scales, except in the region of the belly and the chest. There are about 70 scales along the lateral line. The tubes of the lateral organs in the anterior region are very prominent. There are 10 rows of scales above the lateral line and 9 below it.

A scale from the dorsal surface is almost cycloid in appearance, with a flat base and an arched upper margin. The nucleus is eccentric and is nearer to the base. There are about 16—18 concentric striae going round the scale, evidently closer near the base than near the apex. The circular striae are interrupted by 16 radii to the base and 12 to the apex, only 5 of each lot reaching the nucleus.

The following are the measurements of a scale from the dorsal surface of the type-specimen :—

Length	..	..	..	0.92 mm.
Breadth	..	..	..	0.90 mm.
Distance of nucleus from base			..	0.25 mm.

*Colour* :—The colouration is described from spirit specimens. The dorsal and the lateral surfaces are of a chestnut brown colour, while the chest and belly are almost white. Behind the dorsal fin there are 4 bands across the dorsal surface descending to the lateral line on both sides. Just in front of the dorsal fin there is another broad band which goes to the base of the ventrals. There are two more shorter and narrower bands in front of it. The head is of a deeper colour and is spotted all over with big blotches. There are seven bands on the pectoral, three on the dorsal and ventral, one or two on the anal and 4 bands across the caudal fin. In young specimens about 24 mm. long we have indications of 7 bands on the body, though the dorsal blotches are distinct from the lateral. Three imperfectly developed bands are seen on the caudal, while the dorsal and pectorals have few spots.

*Geographical Distribution* :—The type-specimen was collected by Dr. Annandale on the western side of the Eastern Ghats in Travancore, while the others (young specimens) were collected by Captain Sewell in the Nilgiris and Malabar districts (mostly in the Wynaad) of Madras: three specimens in a hill stream on the

Calicut-Vayitri Road, at mile 29, at an altitude of 500 ft.; one from a branch of Kabani River below Rasselas Estate, Manantody, at an altitude of about 2,350 ft.; 4 specimens in a stream flowing through a swamp, Wentworth Estate, Cherrambadi, at an altitude of 2,750 ft. in the Nilgiris district, and one specimen in a stream on the Nellimunda Estate at an altitude of 1,800 ft. in the Malabar district.

The following are the measurements (in millimetres) of the type-specimen, which is an adult female:—

Total length including caudal	...	...	...	74 mm.
Length of caudal	...	...	...	12 "
Greatest depth of body	...	...	...	8.2 "
Length of head	...	...	...	12 "
Width of head	...	...	...	10 "
Length of snout	...	...	...	7 "
Diameter of eye	...	...	...	2.4 "
Interorbital width	...	...	...	4.8 "
Length of caudal peduncle	...	...	...	10.5 "
Depth of caudal peduncle	...	...	...	5.2 "
Longest ray of dorsal	...	...	...	11.5 "
Longest ray of anal	...	...	...	7.8 "
Length of pectoral	...	...	...	14.2 "

### *Bhavana australis* (Jerdon).

(Plate X, figs. 4—6; pl. XI, fig. 8.)

1849. *Platycaura australis*, Jerdon, *Madr. Jour. Sci. Lit.* p. 333.  
 1867. *Homaloptera brucei*, Day, *Proc. Zool. Soc.*, p. 348.  
 1868. *Homaloptera brucei*, Günther, *Cat. Fish.*, VII, p. 340.  
 1878. *Homaloptera brucei* (in part), Day, *Fishes of India*, II, p. 525.  
 1889. *Homaloptera brucei* (in part), Day, *Fauna Br. Ind.*, Fish I, p. 243.

I have examined only young individuals of this species. I do not, therefore, attempt to describe it in detail. The fish is very much like the other species, *B. annandalei*, from which it differs in having a longer and narrower head, in having continuous upper and lower lips, in the absence of a pair of papillae on the lower lip and in the position of the mouth, which is near the anterior end of the snout in such a position that the barbels are seen even from the dorsal surface.

The mouth is a semicircular opening surrounded by uninterrupted thick lips. There are three pairs of barbels, two pairs rostral and one maxillary. The rostral barbels are situated close together at the anterior end of the snout, the maxillary pair being a short distance anterior to the angle of the mouth. The musculature for converting the mouth into a suctorial disc is very much like that of *B. annandalei*, but the papillae are not well developed.

For a detailed description Day's Monograph of Indian Cypriidae (*op. cit.* 1867) may be consulted under the name *Homaloptera brucei*.

Young individuals were collected by Captain Sewell in October, 1919, at the following localities:—

(i) Two specimens in a stream at Nadgani at an altitude of 2,500 ft. in the Nilgiri district.

(ii) One specimen in a stream flowing through a swamp, Wentworth Estate, Cherrambadi, at an altitude of 2,750 ft., Nilgiri district.

(iii) One individual in a stream on the Nellimunda Estate, at an altitude of 1,800 ft., Malabar district.

### Homaloptera, v. Hasselt.

This genus is characterised by the shape of the body, which instead of being flat, as in the other two genera, is subcylindrical. The head although a little depressed is far from having the same flattened shape. The snout is long and pointed. The eyes, which in *Balitora* and *Bhavana* look upwards and outwards, are here turned laterally. This genus, in the Indian Empire, is probably restricted to Lower Burma and especially to the Tenasserim districts. Only two Burmese species are known, *i.e.* *Homaloptera bilineata*, Blyth, and *Homaloptera (Helgia) modesta*, Vinciguerra. I have examined only one specimen of *H. bilineata*; it probably served for the original description of Blyth and later on for that of Day's *Nemachilus serpentarius*. The specimen (No. 1226) is in a very bad state now. I have not examined any specimen of *H. modesta*.

The fish belonging to this genus are so very like *Nemachilus* and so different from the two preceding genera that an Ichthyologist of Day's standing was led to describe *Homaloptera bilineata*, Blyth, as a *Nemachilus*. I have no specimen from Java for comparison, but a short footnote on page 9 of Weber and Beaufort's *Fishes of the Indo-Australian Archipelago*, Vol. III, makes the matter clear. It runs—"Through the kindness of Dr. R. Gestro, Director of the Musco Civico di Genova, we had the opportunity to study 2 specimens of *Helgia modesta*, Vinciguerra from Burma. They are closely allied to *Homaloptera wassinki*, Blkr.," etc., etc. This note shows that *Helgia* of Vinciguerra is not distinct from *Homaloptera* as known from Sumatra and Java.

*Homaloptera modesta* according to Fowler<sup>1</sup> will go to his genus *Homalopteroides*, because the origin of the dorsal fin is behind the origin of the ventrals, while *Homaloptera bilineata* in which the origin of the dorsal is before the origin of the ventrals belongs to *Homaloptera (s. str.)*. Weber and Beaufort do not recognize two distinct genera merely on the position of the dorsal fin relative to that of the ventral, and as I have not examined any specimen of *H. modesta* I do not feel myself justified in separating it from *H. bilineata* generically.

The two Indian species are distinguished by Vinciguerra by the following key:—

Insertion of dorsal fin posterior to the ventrals. Eight pharyngeal teeth on either side. Colour grey with black spots	...	...	...	...	<i>H. modesta.</i>
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<sup>1</sup> *Proc. Acad. Nat. Sci. Phil.* (2) I.VII, p. 475 (1905).

Insertion of the dorsal fin in front of the ventrals. Fifteen pharyngeal teeth on either side. Colour reddish, with a brown stripe from the margin of the eye to the base of the dorsal fin ... .. *H. bilineata.*

**Homaloptera modesta** (Vinciguerra).

1889. *Helgia modesta*, Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, XXIX, p. 326.

*Geographical Distribution*:—Upper Tenasserim.

**Homaloptera bilineata**, Blyth.

1860. *Homaloptera bilineata*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 172.

1869. *Nemachilus serpentarius*, Day, *Proc. Zool. Soc., London*, p. 551.

1878. *Homaloptera bilineata*, Day, *Fishes of India*, II, p. 526.

1889. *Homaloptera bilineata*, Day, *Fauna of British India*, Fish I, p. 244.

1889. *Homaloptera bilineata*, Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, XXIX, p. 332.

Good descriptions of this species are given by Vinciguerra and other ichthyologists and as I have examined only one specimen in a very bad state I do not attempt to give an account of this animal except to describe a scale.

A scale from the base of the dorsal fin is pear-shaped with a central nucleus. There are a large number of circular striae running circumferentially. There are about 20 near the base and half that number towards the apex, the interspaces being consequently wider near the apex than near the base. There are only two complete radii to the apex and about 3 short ones in the other direction.

*Geographical Distribution*:—Tenasserim districts, Burma.

Fam. CYPRINIDAE.

Subfam. CYPRININAE.

Genus *Psilorhynchus*, McClelland.

As the species of this genus are often confused with those of *Homaloptera* I have included a revision of the genus in this paper.

This genus is abundantly distinct from the Homalopteridae and cannot be distinguished from the Cyprinidae by any valid character. From the former it is distinguished by the possession of an air-bladder consisting of two parts arranged longitudinally and not enclosed in a bony capsule, by the structure of the pharyngeal bones, by the possession of large well-developed scales in the adult and by the less extreme modification of the paired fins.

It may be defined as follows:—

A genus of Cyprininae consisting of small fish modified for life in mountain torrents. The head and body are but slightly depressed, but the ventral surface is flattened and the chest highly muscular. The paired fins are expanded but not greatly

so. The dorsal contains relatively few rays and commences slightly in front of the ventrals. The lateral line runs straight along the side of the body to the base of the caudal fin. The scales are large, cycloid and well-developed, but absent on the head. The air-bladder, though more or less degenerate, is relatively large and consists of two parts, one posterior to the other; it is not enclosed in a bony capsule. The pharyngeal bones are comparatively stout and the pharyngeal teeth are arranged in three rows; they are relatively long and more or less sharply pointed.

The following may serve as a key to the three species of the genus:—

1. Barbels absent.
  - (a) Air-bladder showing signs of degeneration, fins moderately expanded, curved grooves proceeding backwards and outwards from the angles of the mouth ... .. *P. balitora*.
  - (b) Air-bladder fairly well-developed, paired fins greatly expanded, undersurface of head flat and without any grooves ... .. *P. sp. (juv.)*.
2. Pair of barbels present.
  - (c) Lower lip bilobed, air-bladder quite normal, fins moderately expanded ... .. *P. tentaculatus*.

### **Psilorhynchus balitora** (Ham.-Buch.).

1822. *Cyprinus balitora*, Ham.-Buch., *Fishes of Ganges*, pp. 348, 430.  
 1838. *Psilorhynchus variegatus*, McClelland, *Asiatic Researches*, pp. 300, 430.  
 1842. *Cyprinus balitora*, Cuv. and Val., *Hist. Nat. des Poissons*, XVI, p. 451.  
 1868. *Psilorhynchus balitora*, Günther, *Cat. Fish.*, VII, p. 343.  
 1871. *Psilorhynchus balitora*, Day, *Journ. As. Soc. Bengal*, p. 106.  
 1889. *Psilorhynchus balitora*, Day, *Fauna Brit. Ind. Fish.*, I, pp. 244, 245.

McClelland the author of the genus does not recognise any type-species. His figure of *Psilorhynchus sucatio* (= *Cyprinus sucatio*, Ham.-Buch.) looks very much like a species of *Homaloptera* on account of its elongate snout, but the absence of oral barbels removes it from that genus. Day has put it as a synonym of *H. bilineata*, but as I have no specimens of this species to refer to, I am unable to confirm his suggestion. *P. variegatus*, McClelland is, as he himself states, a synonym of *Cyprinus balitora*, Ham.-Buch. I take this as the type-species of the genus.

There are only two specimens in the old collection of the Indian Museum. Both of these are very old and badly preserved and have grown very brittle. The specimen (Cat. No. 940) was presented by Mr. Beavan and is labelled as being the type-specimen of the species, but there is reason to believe that none of Hamilton-Buchanan's specimens passed into the collection of the Indian Museum. The second specimen (No. 1098) was purchased from Day and is the original of his figures in the *Fishes of India*.

The condition of these specimens does not permit of any detailed description. I have, however, partially dissected them

to see the nature of the air-bladder, which in the genus shows progressive degeneration from the normal type. Indeed even in these two specimens it shows a marked difference. In specimen (No. 1098) the air-bladder is very much reduced. The essentials of a normal Cyprinid type are retained, though they are not well marked. The posterior chamber is relatively small, while the anterior one is covered by thick fibrous tissue. The coating of fibrous tissue is incomplete anteriorly where the bladder abuts against the platform formed by the transverse processes of the second vertebra, while posteriorly it admits the passage to the posterior chamber of the bladder. The transverse processes of the second vertebra show a marked expansion near their vertebral ends, much as was noticed in describing the air-bladder of *Balitora brucei*, but in that species the vessel is not covered by a fibrous

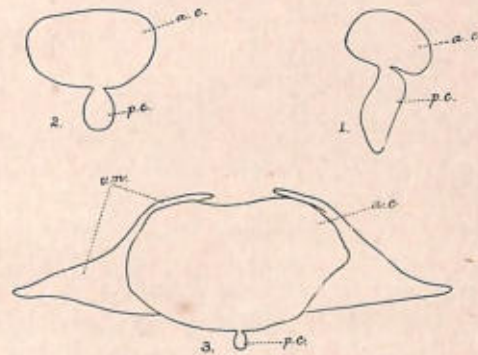


FIG. 3.—Modifications of the air-bladder in the genus *Psilorhynchus*.

1. Air-bladder of *Psilorhynchus* sp. (juv.)  $\times 8$ .
2. Air-bladder of *Psilorhynchus balitora*, specimen Cat. No. 940.  $\times 8$ .
3. Air-bladder of *Psilorhynchus balitora*, specimen No. 1098, (magnified).

a.c.=anterior chamber; p.c.=posterior chamber; v.m.=vertebral modifications.

tissue but by a bony capsule. In *B. brucei*, moreover, the posterior chamber of the vessel is absent and the anterior one is divided into two lateral chambers which show a tendency to separate from one another.

In the second specimen (Cat. No. 940.) the air-bladder is comparatively large and is apparently not covered by a thick coat of fibrous tissue. In this case both the chambers are well-developed, but the posterior one seems to have been pushed out of its place during development and comes to lie against the anterior chamber on the left side partly covered by it. The anterior end of the bladder abuts against the specially modified transverse processes of the second vertebra. As the specimen was already opened, I cannot be certain about the exact nature of the covering of the air-bladder in this case; but the two specimens, between which there is no reason to suspect any specific

difference, undoubtedly show a progressive degeneration as regards this organ.

A scale from the base of the dorsal fin is cycloid in outline with an irregular flat base and an arched apex. The nucleus is situated close to the base, about 9 radii going out from it to the apex. The number of circular striae is indefinite; there may be as many as twenty. Near the base they come very close to one another and are difficult to count.

Since the above description was written, I have found four well-preserved specimens (collected by Dr. Annandale, F<sup>665-8</sup><sub>1</sub>) in the unnamed collection of the Indian Museum. All of these are young, the longest being 25 mm. in total length.

The chest and the belly are flat, naked and highly muscular. The upper lip is thick and muscular but not fringed, the lower lip



FIG. 4.—Scale from base of dorsal fin of *Psilorhynchus balitora*.

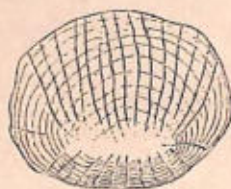


FIG. 5.—Scale from base of dorsal fin of *Psilorhynchus tentaculatus*.

and the area just behind it are tuberculated. At the angles of the mouth there are fleshy appendages.

The air-bladder is not covered by a thick fibrous coat and is quite normal except that the posterior chamber is much reduced and the anterior one slightly expanded.

*Localities*:—Both the old specimens are from the Khasi Hills, Assam. Those collected by Dr. Annandale are from the Mahananda River at Siliguri (alt. 200 ft.), just below the Darjiling Himalayas.

### *Psilorhynchus*(? *tentaculatus*, Annandale.<sup>1</sup>

1919. *Psilorhynchus tentaculatus*, Annandale, *Rec. Ind. Mus.* XVI, p. 128.

The air-bladder in this species is quite of the normal Cyprinid type, the posterior chamber being larger than the anterior one.

<sup>1</sup> In a paper to be published shortly I give reasons for placing this species in a separate genus.

In all probability, therefore, the species is the most primitive of those I assign to *Psilorhynchus*.

A scale from the base of the dorsal fin is almost cycloid in general appearance with a slightly irregular flat base. The nucleus is situated close to the base. There are about 15 radii to the apex and 11 to the base. The number of circular striae varies from 9—15 proceeding from the base to the apex.

*Localities*:—Poona and Satara districts of the Bombay Presidency at altitudes of 2000—3000 ft. A specimen from Panchmari in the Mahad Hills in the Central Provinces (*F. H. Gravelly*) is also present in the collection of the Z.S.I.

***Psilorhynchus* sp. (juv.).**

A few young *Psilorhynchus* were recently captured by myself in a hill stream at Piphima in the Naga Hills. I have not been able to refer these young individuals to either of the two known species, but I do not think myself justified in drawing up the description of a new species from them on account of their immaturity. I am including the following notes in this paper to facilitate reference in future.

D. 3/6. A. 1/5. P. 6/11. V. 2/6.

The fish has a graceful form with the head and body moderately depressed. The ventral profile is almost horizontal, while the dorsal is slightly arched, being highest near the commencement of the dorsal fin. The paired fins are greatly expanded and possess a number of unbranched rays which are provided with muscles on their ventral aspect. The dorsal commences slightly in advance of the ventral, and the pectorals when adpressed do not reach the ventrals. The mouth, which is situated on the undersurface slightly behind the anterior end of the snout, is provided with thick, almost continuous lips. The lower lip is rather interesting. It can be divided into four pieces, two prominent tubercles in the middle and relatively broad flaps adjacent to them, one on each side. The lips, the undersurface of head and its sides are covered with glandular tubercles. Probably the mouth can be converted into a suction disc but the muscular structures connected therewith cannot be made out in my specimens.

There are no scales, probably on account of the immaturity of the specimens.

The air-bladder in this little fish is very interesting. While in all essentials it is like that of normal Cyprinid fishes, it shows certain retrogressive modifications. The posterior chamber is small as compared with the anterior one, which is more flattened laterally than in the normal forms. The bladder lies quite free in the abdominal cavity without any thick fibrous sheath and is not otherwise abnormal.

The fish is pale olivaceous with a large number of irregular black dots scattered all over the body, the upper surface and

sides of the head. These dots are arranged in a regular row along the middle line on each side; below this they become fewer in number and totally disappear from the undersurface of the head and body. The fins are colourless.

A complete specimen measures 21 mm. in length. The length of the caudal is 4.5 mm. and that of the head about 4.2 mm. The length of the head is contained  $4\frac{2}{3}$  times in the total length and about  $3\frac{7}{10}$  times in the length without the caudal. The eyes are situated about the middle of the head and are directed outwards and upwards.

*Locality*:—Piphima in the Naga Hills, Assam, at an altitude of 3000 feet.

The specimens were captured during the month of February, 1920.

The following observations were made in the field by keeping the fish alive in water in a glass tube:—

The pectoral fins were pressed against the sides of the tube, their undivided rays being in close contact with the glass, while the divided rays were in constant motion. The fish was also observed opening and closing its mouth constantly and sometimes it was seen to dart rapidly from one place to another, probably by the help of its unpaired fins, but the movements were too rapid for detailed analysis in the circumstances.

The families of Cyprinoidea may be distinguished by the nature of the air-bladder. By most of the older authors the sub-order was divided into three families, which would be distinguished thus:—

"Air-bladder well-developed, divided into two chambers arranged longitudinally and lying free in the abdominal cavity	...	...	1. Cyprinidae.
Air-bladder divided into two lateral chambers and enclosed by a bony capsule	...	...	2. Cobitidae.
Air bladder absent	...	...	3. Homalopteridae.

We now know that the Homalopteridae possess an air-bladder which is of the same type as is found in the Cobitidae. But whereas in the Cobitidae the two lateral chambers are still connected by a tube, and sometimes a small process may be present directed backwards from the tube, probably representing the posterior chamber of the typical Cyprinoid fishes; in the Homalopteridae the two lateral chambers show a tendency to separate off from one another and all remains of a posterior chamber are absent. The Homalopteridae are more highly specialized for a life in mountain torrents than the Cobitidae, and probably the further reduction in the air-bladder of the former is due to this adaptation. The uniserial nature of the pharyngeal teeth in both of these families points to their close relationship.

The species of *Psilorhynchus* show a marked resemblance to those of *Homaloptera* or *Bhavana*, but as is abundantly clear from dissections the resemblances are only superficial. Life in hill-

torrents has called for the reduction of the bladder, but it has not gone so far as in the two families mentioned above. In *P. tentaculatus* the air-bladder is quite normal. In *Psilorhynchus* sp. the posterior chamber is reduced while the anterior one shows lateral expansions. In some individuals of *P. balitora* (Cat. No. 940.) the posterior chamber is pushed out of its place and comes to lie close to the anterior one, partly covered by it, while an extreme phase is reached in other individuals of the same species (No. 1098), in which the bladder is much reduced but still retains the essentials of the normal form, the posterior chamber being very small while the anterior one is covered by a thick fibrous coat. Even the vertebral elements near the bladder show slight modifications.

When dealing with forms especially adapted to a particular environment it is very difficult to distinguish homologous from analogous characters and there is always a probability that fishes coming from an absolutely different stock have been similarly modified in response to a particular environment. In a former paper by Dr. Annandale<sup>1</sup> and the author it was pointed out that two absolutely different stocks, Schizothoracinae and Salmonidae, have come to have a close superficial resemblance to one another, owing to their life in rapid running streams which necessitates migrating up stream at certain periods in their lives. Numerous other such instances could of course be adduced.

Day in his *Fishes of India* points out that the genus *Psilorhynchus* is intermediate between *Homaloptera* and *Discognathus*. We have already seen that *Homaloptera* is closely allied to the Cobitidae, whereas *Psilorhynchus* belongs to the Cyprinidae. It will be worth while to discuss its relations with *Discognathus* at this stage. I agree with Dr. Annandale<sup>2</sup> that *Psilorhynchus* is not a primitive form of *Discognathus*, but that both of these genera have been evolved from a primitive form like *Crossochilus* or *Labeo* and show a parallel evolution. The specialisation in the former is due to its life in mountain streams, while that in the latter is due primarily to its peculiar mode of feeding. The forms like *Garra nasutus* and *D. blandfordii*, which in all probability have come to live secondarily in hill streams, the muscles of the chest are modified like those found in *Psilorhynchus*, and thus true convergence is established.

The following has been the probable course of evolution in these different genera, so far as it can be known in the present state of our knowledge:—

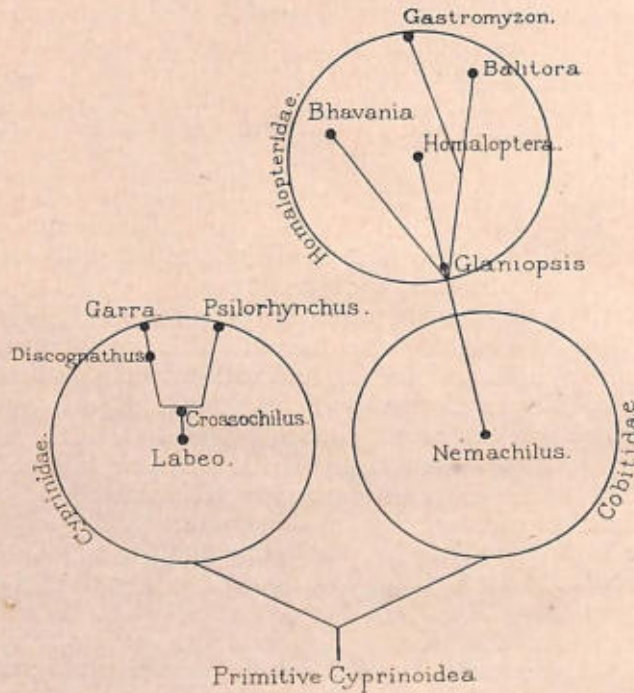
Taking *Labeo* as a central type of Cyprinidae I believe that the evolution of a form like *Crossochilus* has taken place; from this evolution proceeded along two lines which ran more or less parallel to one another. One of these lines culminated in *Psilorhynchus*

<sup>1</sup> Annandale and Hora, *Rec. Ind. Mus.* XVIII, p. 168.

<sup>2</sup> Annandale, *Rec. Ind. Mus.* XVI, pp. 113—116.

and the other in *Garra*<sup>1</sup> with *Discognathus* as an intermediate form.

I believe that the evolution of the Homalopteridae has occurred along the line of the Cobitidae of which we may take *Nemachilus* as a central genus. Among the *Homalopteridae*, a Bornean genus *Glaniopsis*, Boulenger,<sup>2</sup> is very much like *Nemachilus*,



as can be inferred from its figure in Beaufort and Max Weber's *Fishes of the Indo-Australian Archipelago*. This peculiar Homalopterid genus possesses a pair of barbels between the two nostrils and we know that a similar pair of barbels occurs in an Indian loach *Nemachilus evezardi*.<sup>3</sup> Of the three Indian genera of this family, *Homaloptera* is the most primitive, *Bhavana* has evolved independently from the same stock in South India and *Balitora*, the most highly specialized genus, has also been independently evolved from the original primitive stock. The extreme form of specialisation is reached in another (Bornean) genus *Gastromyzon*,<sup>4</sup> Günther; but the discussion of the forms outside India is beyond the scope of the present paper.

The relationships of the various genera discussed in this paper are graphically represented on the opposite figure.

<sup>1</sup> Annandale and Hota, *Rec. Ind. Mus.* XVIII, p. 162.

<sup>2</sup> Boulenger, *Ann. Mag. Nat. Hist.* (7) IV, p. 228 (1899).

<sup>3</sup> Annandale, *Rec. Ind. Mus.* XVI, p. 114 (1919).

<sup>4</sup> Günther, *Ann. Mag. Nat. Hist.* (4) XIV, p. 454 (1874).

In conclusion I have to express my sincere thanks to Dr. N. Annandale, Director, Zoological Survey of India, for suggesting to me this interesting line of work and for the great help and valuable suggestions that he gave to me from time to time while I was carrying it out. I hope to deal later in greater detail with certain structural modifications of these and other analogous fish from mountain torrents.

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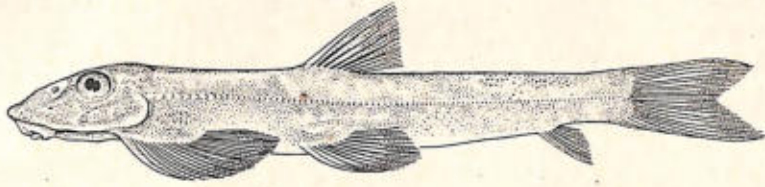
EXPLANATION OF PLATE X.

*Bhavana annandalei*, sp. n.

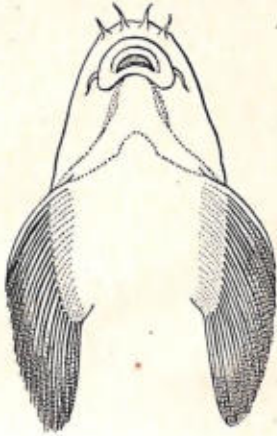
- FIG. 1.—Type-specimen (adult female) from Tenmalai,  $\times 1\frac{1}{2}$ .  
FIG. 2.—Ventral surface of head of same specimen,  $\times 3$ .  
FIG. 3.—Dorsal surface of head of same specimen,  $\times 3$ .

*Bhavana australis* (Jerdon).

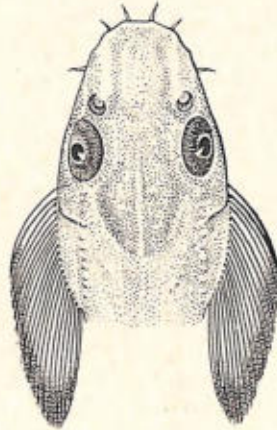
- FIG. 4.—Young specimen from base of Nilgiri Hills,  $\times 3$ .  
FIG. 5.—Ventral surface of head and chest of same specimen,  
 $\times 4$ .  
FIG. 6.—Dorsal surface of head of same specimen,  $\times 4$ .



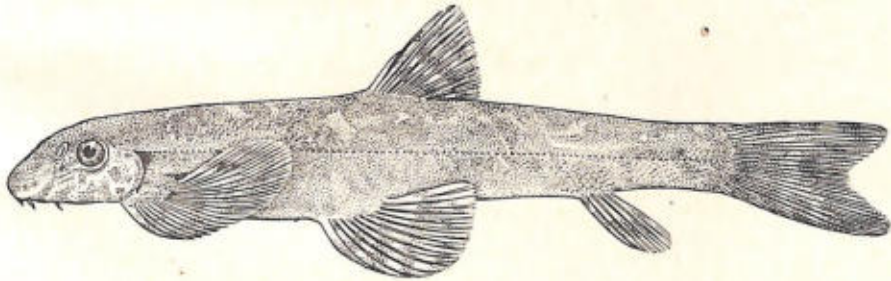
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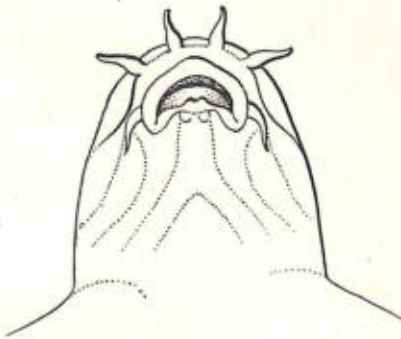
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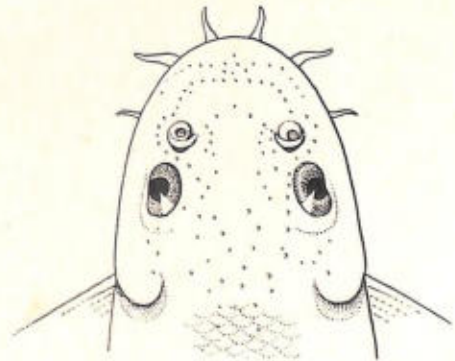
6.



1.



2.



3.

EXPLANATION OF PLATE XI.

*Balitora maculata*, Gray and Hard.

FIG. 1.—Scale from base of dorsal fin,  $\times 30$ .

*Balitora brucei*, Gray and Hard.

FIG. 2.—Scale from base of dorsal fin,  $\times 30$ .

FIG. 3.—Pharyngeal bone (magnified).

FIG. 4.—Air-bladder *in situ*,  $\times 5$ .

*Bhavana annandalei*, sp. n.

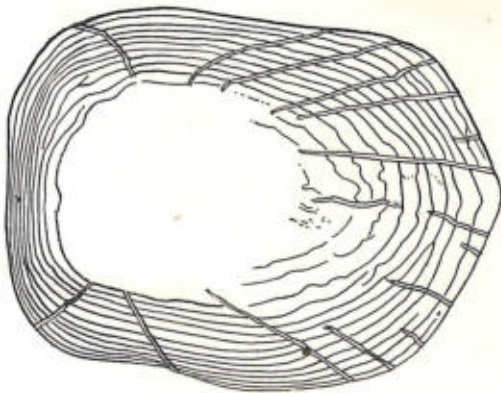
FIG. 5.—Type-specimen, scale from base of dorsal fin,  $\times 30$ .

FIG. 6.—Day's specimen (No. 1510), scale from base of dorsal fin,  $\times 30$ .

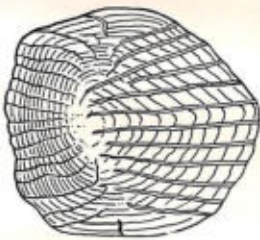
FIG. 7.—Pharyngeal bone of same,  $\times 10$ .

*Bhavana australis* (Jerdon).

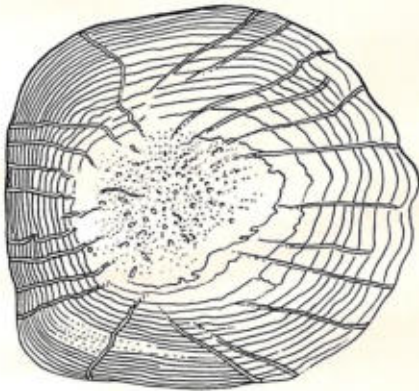
FIG. 8.—Pharyngeal bone of a young specimen,  $\times 30$ .



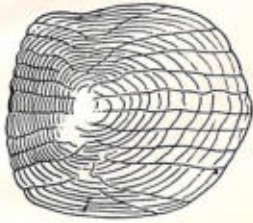
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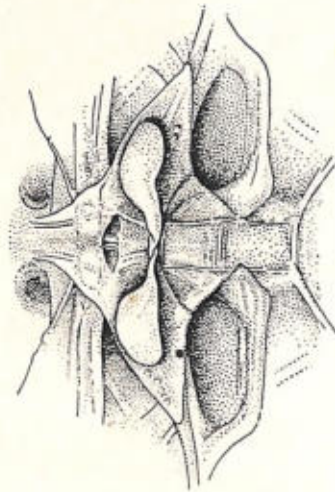
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